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Electronic
Apparatus
Development

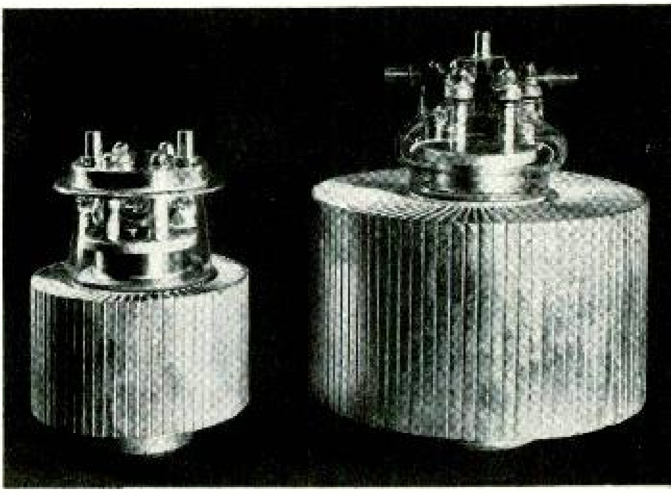
NEW VACUUM TUBES FOR THE VERY HIGH FREQUENCIES

One of the obstacles to the application of very high frequencies to communication, and particularly to radio broadcasting, has been the difficulty in designing high frequency tubes of the ordinary types for large outputs. High frequencies demand small size and closely spaced elements, while with high power outputs, small size and spacings tend to excessive concentrations of heat. In the magnetrons used extensively during the war, pulse powers of several thousands of kilowatts were employed at frequencies of thousands of megacycles. The durations of the pulses were very short, however, and thus there was ample time for the heat to dissipate itself between pulses. The average output of even the larger magnetrons was not more than a very few kilowatts. In the few cases where magnetrons were used for continuous output, the distortion levels were high. This was not objectionable in the applications made of such tubes – chiefly for radar jamming – but for FM or television, the distortion must be kept very low.

At the end of the war, no commercial high-power tubes for operating in the very high frequency ranges with low distortion were available. For use in a new line of FM broadcast transmitters, the Western Electric Company needed tubes for continuous outputs up to 50 kw and for frequencies from 88 to 108 mc, which is the new band allocated by the F.C.C. to FM broadcasting. Development of such tubes was at once undertaken by the Laboratories. Although none of the tubes developed during the war could be used as a basis, certain techniques and practices arising from the war work made the development less difficult, and suggested methods of securing tubes of the desired characteristics at costs that would not be prejudicial to the projected transmitters.

During the war, microwave tubes were

Fig. 1—The 5530 *forced-air cooled tube at the left and the* 5541 *at the right*



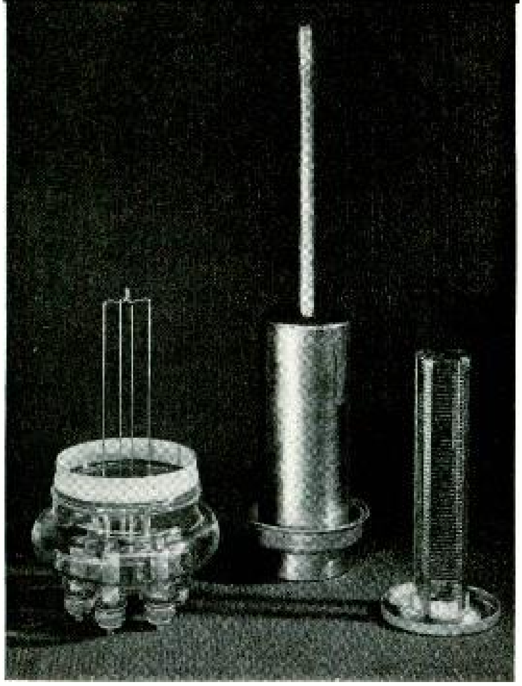


Fig. 2—Parts of the 5541 *tube*

required in very large quantities, and since interchangeability and close tolerances in the finished product were of prime importance, an assembly-line method of production was essential. For such a method, tools, jigs, and fixtures are provided to turn out large quantities of the various parts, which will all be alike to very close tolerances. These components are then fed into the assembly line at the proper points to permit production to flow rapidly and smoothly. With the comparatively small number of large power tubes made prior to the war, this method had never seemed feasible. The tubes were more or less tailor-made, and assembly procedures requiring considerable operator skill were often required.

When the new line of power tubes for very high frequencies was projected after the war, it seemed essential to take advantage of these practices that had been developed during the war so as to gain the very real economies they permitted. With this in view, the entire line of proposed tubes was studied to determine to what extent identical or similar parts could be used for all of them, and to devise simple assembly methods that could be performed with a maximum utilization of jigs and fixtures. The first two tubes of the new line, the 5530 and the 5541, rated at 3 and 10 kw, respectively, illustrate the success that has been attained with the new procedure. The completely assembled tubes are shown in Figure 1. The tubes—using forced-air cooling—are triodes with their plates in the form of a copper cylinder, shown in the middle of Figure 2. Cooling air passes up through an assembly of vanes brazed to a metal sleeve that fits closely over the plate cylinder and is soldered to it. The outer edge of each vane is bent at right angles to touch the adjacent vane, thus closing off the wedge-shaped passages between the vanes so as to force the circulating air to go vertically and not out. The construction is evident in Figure 3, which is a view of the 5541.

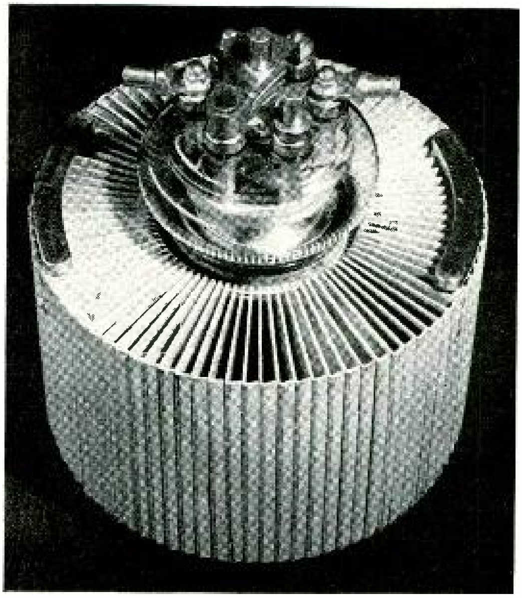


Fig. 3—The production model of the 5541 *has a retractable handle for insertion and removal*

At its upper end, on which it is resting in Figure 2, the plate cylinder is attached to a glass cup, shown at the left of Figure 2. Six terminals sealed in the glass top support the filament and the grid structure, shown at right of Figure 2, that slips over the filament. Two of the terminals are for the filament, which is rigidly attached to them and requires no other support. The grid is wound around four supports forming the corners of a square.

This structure is attached to and supported by the four remaining terminals. The lower end of the plate cylinder is closed except for a short projecting tube at the center, projecting upward in Figure 2, which is used for pumping after the assembly is completed, and is then sealed.

Identically the same terminal arrangement, and the same diameter plate cylinder and grid support are used for a number of tubes. Greater power is secured by lengthening the elements and making the cooling vanes wider so that they project farther out from the plate. This is evident in Figure 1. The glass terminal cups are similar but that for the larger tube is flared.

The connections made to the filament and grid will vary with the use to which the tubes are to be put. Designed for a grounded grid circuit, the 5530 has a ground grid ring attached to the four grid terminals, while the 5541, designed for a grounded plate circuit, has a double top grid terminal. Either tube, however, will accommodate either type of connection.

To simplify the assembly procedure, the tube has been designed so that pre-molded glass parts are used without exception. Glass-to-metal seals are made by induction heating throughout with holding jigs to secure proper tolerances when the seals are completed. Nickel-iron-cobalt alloys are employed at the seals with glasses that match them in temperature coefficient. Special processing of the metal surfaces is required to prevent excessive heating in these alloys caused by the high frequencies at which the tubes operate. Eutectic solders are widely used.

Throughout the design of the tubes, many precautions have been taken to reduce the heating inherent in very high frequency tubes of large power rating. Grid heating, chiefly because of the large capacitance currents, becomes particularly serious. By using materials of low thermal impedance and by applying a suitable surfacing process, satisfactory results have been obtained. The use of thoriated tungsten rather than pure tungsten cathodes materially assisted in reducing heating, since greater emissions may be obtained at lower temperatures.

All external metal surfaces are silver plated and dipped in thin lacquer to preserve the finish. This protective surface is too thin to prevent electrical contact. Heavy current carrying contacts are also plated with a refractory corrosion-resistant metal.

To the other tubes of this new series that will shortly follow, the same basic philosophy of maximum dependence on accurately made parts and assembly jigs in the assembly process will be applied. Over a considerable range of power and frequency, many parts may be identical to those of the tubes already developed. Where this is not possible, every effort will be made to keep the number of different parts to a minimum, the number of common parts to a maximum, and to use parts so made that with the aid of suitable tools the assembly processes will be rapid and inexpensive.

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A 96-CHANNEL PULSE CODE MODULATION SYSTEM

C. B. FELDMAN
Multiplex
Telephony

In the ordinary carrier method of transmission, a band of relatively high frequencies is divided into a number of contiguous narrower bands, each of which serves as a channel for speech. A schematic representation of a system for six channels is shown in Figure 1. In the composite band, frequencies representing all of the channels are present all the time. Such a method is called frequency-division multiplex—from the assignment of each of the multiple speech wave trains to one of a number of equal divisions of the allotted frequency band. Another method of multiplexing, known as time division multiplexing, has been receiving increasing attention

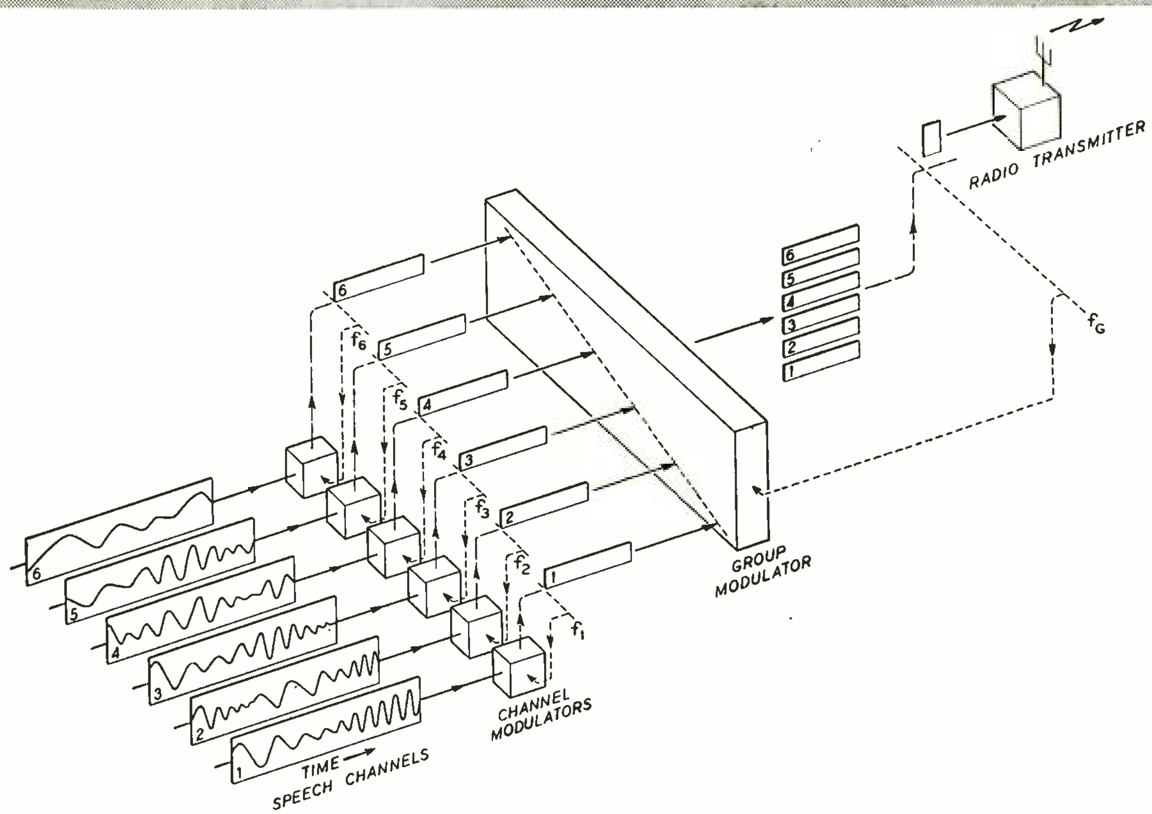


Fig. 1—In frequency-division multiplex, all the voice waves are transmitted continuously, but each uses only a small part of the total frequency band

in recent years. In it the entire allotted frequency band is used for each of the speech channels but not at the same time. Very short — essentially instantaneous — samples of the speech wave of each channel are taken successively and transmitted. After one set of samples of all the channels has been transmitted, another set is taken and transmitted, and so on continuously. At any one instant, therefore, only one of the speech wave trains is represented in the transmitted band. One such system may be represented as in Figure 2.

As indicated in this diagram, the samples taken successively of each channel are not transmitted in the form they are taken, but instead, the amplitude of each sample is converted into a rapid sequence of pulses that forms a code symbol for the amplitude. From this fact, such a method is known as pulse code modulation, or more briefly, PCM. The number of different values of the sample that may be transmitted in such a system depends on the number, n, of pulse positions in the code used. If simple on-or-off pulses are used, like a teletypewriter code, the number is 2^n. With $n = 5$, there are $2^5 = 32$, possible codes and thus 32 different values of the sample may be transmitted. If a seven-position code were used, 128 values of the sample could be sent.

It would be possible, of course, to use fewer pulses to represent a given number of signal values if each pulse could have any of several values. The number of pulses required to represent each value of the signal would then be k^n, where n, as before, is the number of pulses, and k is

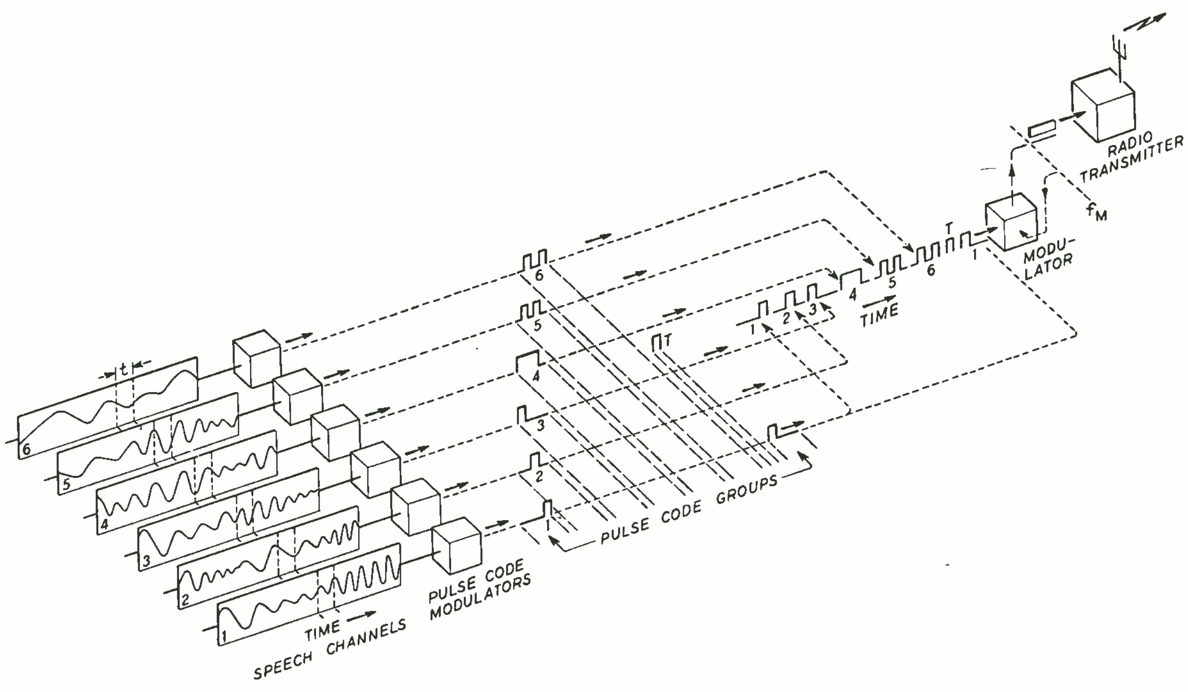


Fig. 2—In time-division multiplex, the entire frequency band is used for transmitting each voice wave, but each uses the band for only a small part of the total time

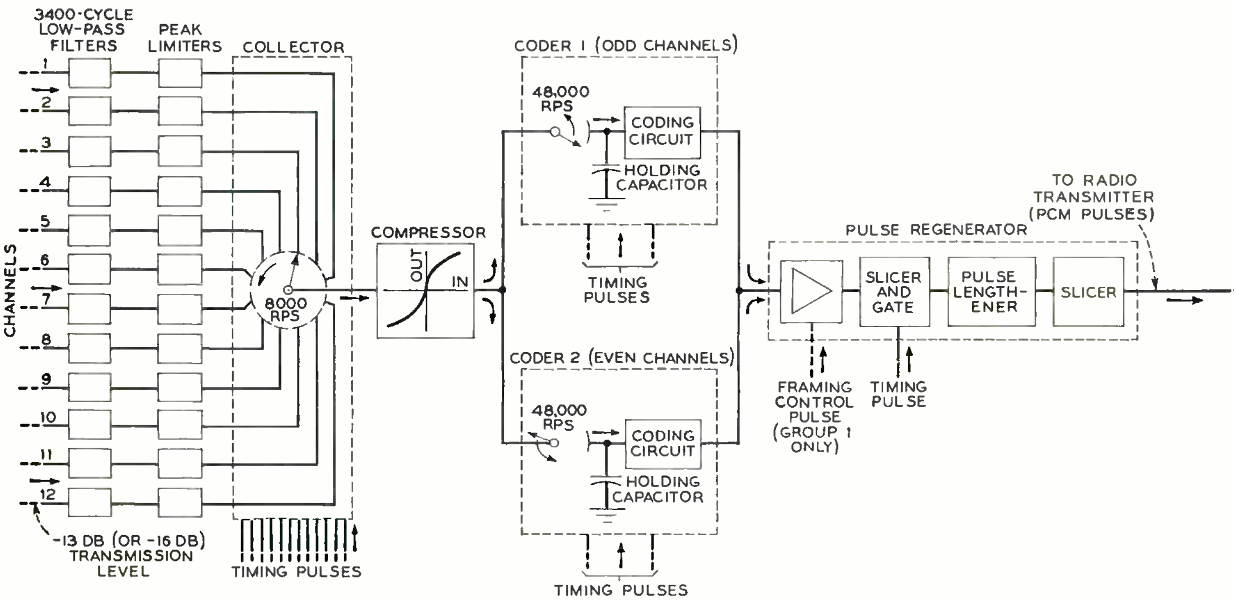


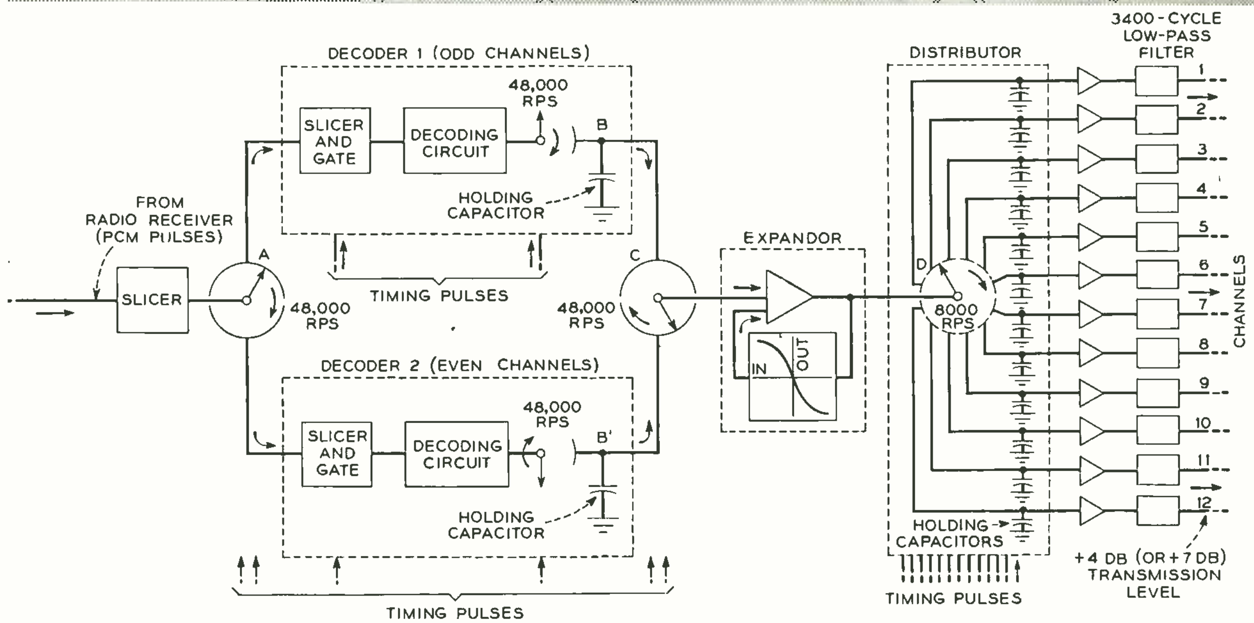
Fig. 3—Block diagram of the transmitting end of a PCM system

the number of different values that each pulse may have. Carrying this to the limit, 128 values of the sample could be transmitted by one pulse having 128 different possible magnitudes. When a single pulse is used to represent the magnitude of the sample, the frequency band could theoretically be the same as used for a frequency division multiplex system of the same number of channels. If more than one pulse is used per sample, however, the frequency band must be widened.

The use of code symbols permits the transmission of speech, music, or any wave form without acquiring any noise or distortion from the transmission medium, provided the pulses in the code symbols are not so disturbed as to be interpreted as having an amplitude different from the discrete one intended. The likelihood of such a misinterpretation becomes greater the larger the number of values each pulse may have, since the difference between adjacent values becomes smaller. By employing a wider frequency band to permit the number of values of each pulse to be decreased by increasing the number of pulses used to represent each sample, the amount of pulse distortion that may be permitted is increased. A simple on-or-off system thus achieves the greatest tolerance to distortion, since the magnitude of the pulses is no longer critical; only their presence or absence need be distinguished.

In any PCM system — and here lies one of the significant advantages of PCM — the pulses may be regenerated at a repeater point and given a fresh start completely free of the noise and distortion encountered before the repeater. This may be done at the end of each span in a multi-span repeater system, and the code symbols then emerge from the system exactly as they were transmitted at the point of origin.

Even though noise is not acquired from the transmission medium, it is not to be inferred that PCM is a perfect, noise-free system. The recovered signal, speech, or music suffers from noise-like distortion because of the granularity imposed by the substitution of a limited number of code signals for the continuous amplitude range of the sample. However, this granularity noise is reduced by many decibels for each



'ig. 4—Block diagram of the receiving end of a PCM system

additional pulse position or digit in the code symbol. In the system to be described, seven on-or-off pulses (128 steps) give adequately fine granularity for toll transmission with unregulated volume, although more are required for the transmission of wide volume range music.

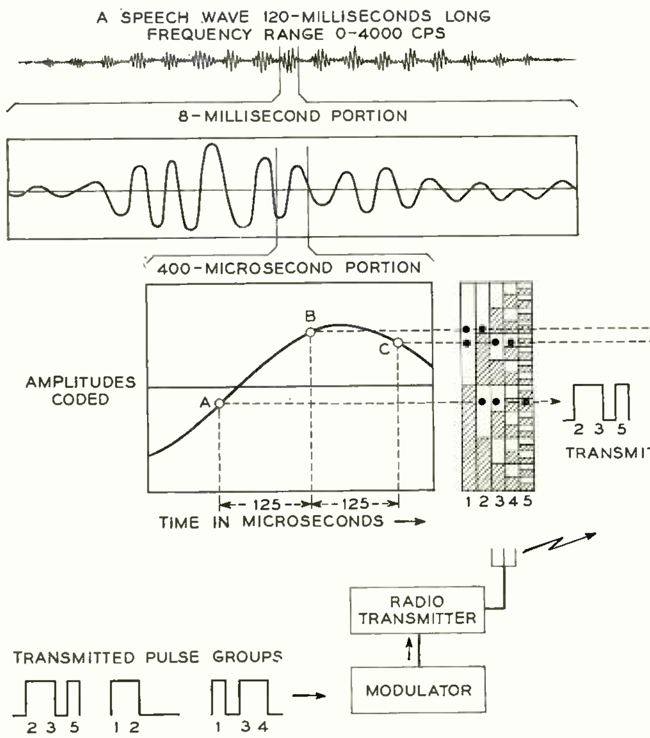
Some of the factors involved in PCM and the improvements it offers have already been described.* One of its greatest advantages is that band-width may be exchanged for tolerance to noise and interference, as already described, and thus a wider band-width is employed to utilize this possibility. Frequency modulation is another method which permits an exchange of band-width for tolerance to interference, but in PCM the exchange is much more favorable. Also, the reduction of channel noise with increasing band-width occurs at a far faster rate than any other known system, being, in an on-or-off system, 6 db for each additional pulse position in the code.

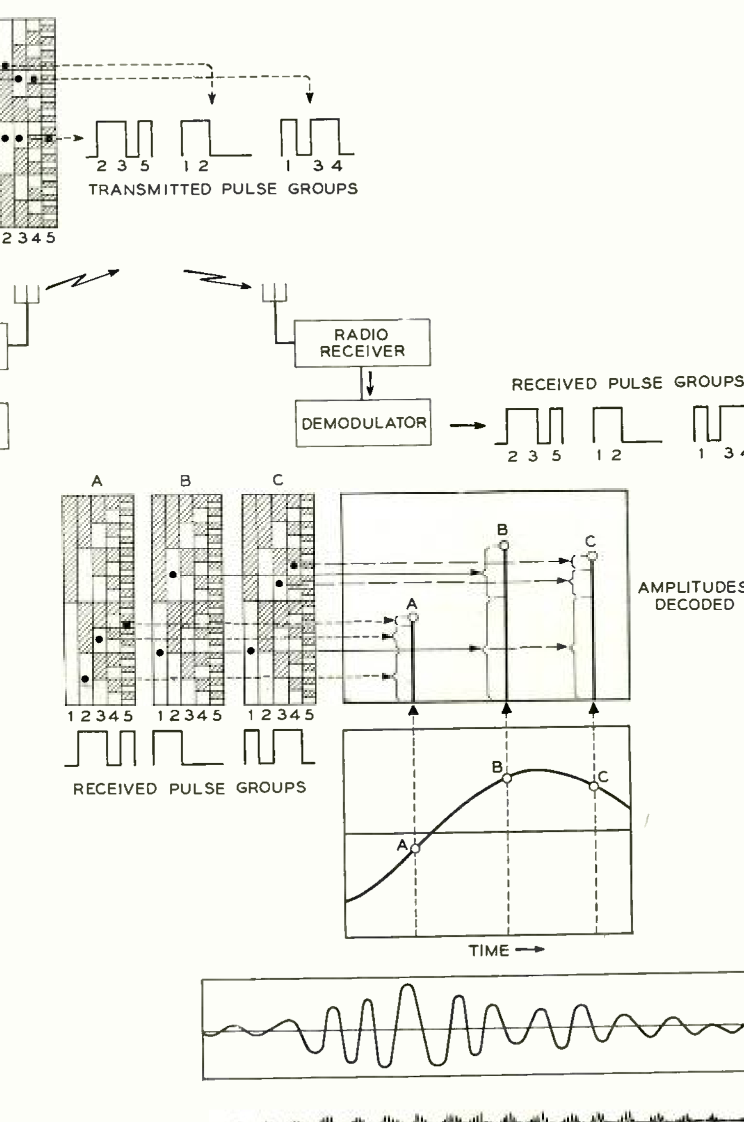
This exchange of band-width for transmission advantage is highly significant in radio relay systems where radio interference as well as noise plagues the transmission in spite of the high antenna directivity possible with microwaves. It will permit many relay routes in congested areas to use the same frequency bands, whereas other systems, more susceptible to interference require multiple frequency assignments to prevent interference. Thus it is believed that PCM will be found economical as to total frequency occupancy in the future as more and more relay routes converge in urban areas.

To make fundamental studies of the characteristics of PCM and the problems associated with its instrumentation, an experimental 96-channel system was designed and constructed at Murray Hill during 1946. The channels are assembled in eight groups of twelve each, but only two groups of twelve were actually equipped. Figures 3 and 4 show functional block diagrams of the sending and receiving terminals. At the left of Figure 3, the twelve channels are shown connected to a commutator so that each may be sampled successively. In the actual system,

*Record, *July*, 1947, *page* 265.

Each sample may be considered as measured by the checkered scale whose five columns are divided into fractions of the total amplitude (1/2, 1/4, 1/8, 1/16, and 1/32). If the sampled amplitude as projected on this scale cuts the unshaded portion of any column, a pulse is placed in the corresponding position of the pulse code group. The sum of the position values of all the pulses appearing in a five position group represents the value of the sample





Similarly, the received pulse code groups are decoded by the checkered scale. When a pulse is received in any pulse group position, the fractional value of the total amplitude represented by the unshaded portion of the corresponding column is projected. The sum of these projected values is then the sampled amplitude value that was represented by the pulse code group. Since the pulse group representing amplitude A, at the right, has a space in position 1, no value is projected; since it has a pulse in position 2, 1/4 is projected; since it has a pulse in position 3, 1/8 is projected; since it has a space in position 4, no value is projected; and since it has a pulse in position 5, 1/32 is projected. The total value of the sample is thus 13/32

Fig. 5—Simplified schematic drawing of the encoding process

electronic gates controlled in sequence by timing pulses are used instead. After the samples are taken, they pass through an instantaneous compressor that reduces the granularity effect for a given number of sample values by giving more steps to the weaker samples.

The encoding process, which follows next, will be described in a subsequent article, but its general principles are indicated in Figure 5 which extends from the voice wave of one channel, at the upper left, to the corresponding reproduced wave at the lower right. The process employs a new electronic beam tube in which the beam is swept across a checkered mask indicated at the right of the upper drawings of the illustration. Each sample may be considered as measured by the checkered scale whose five columns are divided into fractions of the total amplitude – 1/2, 1/4, 1/8, 1/16, and 1/32. If the sampled amplitude value, as projected on this scale, cuts the unshaded portion of any column, a pulse is placed on the corresponding pulse position of the pulse code group, which thus represents the total value of the amplitude of the sample. Since the sampled amplitude A is less than 1/2, the pulse group position 1 has a space, since it is more than 1/4, the pulse group position 2 has a pulse, since it is more than 3/8, position 3 has a pulse, since it is less than 7/16, the pulse group position 4 has a space, and since it is more than 13/32, pulse group position 5 has a pulse. This process is repeated for each sample as indicated for B and C. The resulting sequence of codes is then transmitted and received as indicated along the central line of the diagram.

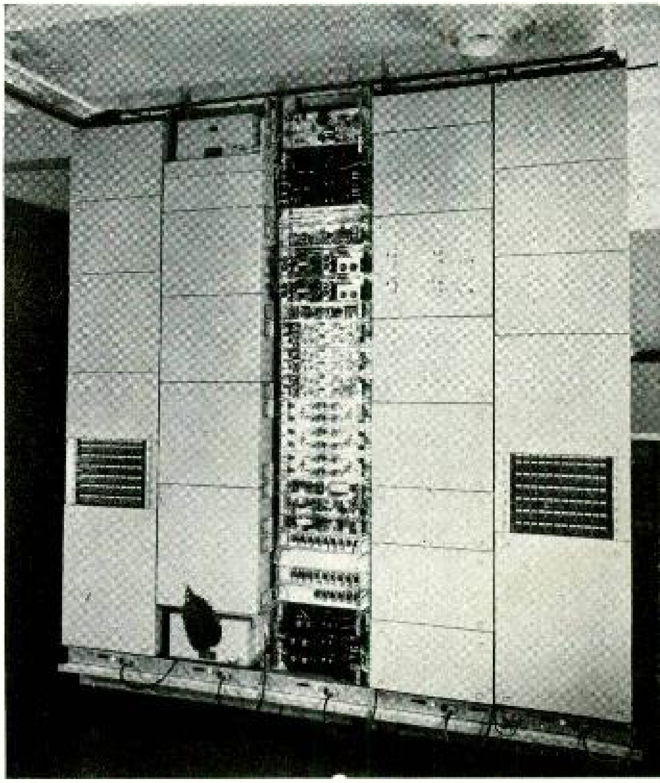


Fig. 6—Panel arrangement for the 96-channel pulse code modulation system

A similar checkered scale is used for decoding at the receiving end. Thus for pulses received in any pulse group position, the fractional value of the total amplitude represented by the unshaded portion of the corresponding column is projected. The

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sum of these projected values is the sampled amplitude value that was represented by the pulse code group. Since the pulse group representing amplitude A has a space in pulse group position 1, no value is projected, since it has a pulse in position 2, 1/4 is projected, since it has a pulse in position 3, 1/8 is projected, since it has a space in position 4, no value is projected, and since it has a pulse in position 5, 1/32 is projected. The total value of the sample is thus 13/32. Electronic circuits which ascribe these values to the various pulses present and add them, are used in the experimental equipment.

After this decoding, the signals are passed through an expandor to restore the values existing prior to the compression at the sending end, and then are distributed to their respective channels as indicated at the right of Figure 4. The envelope of the amplitude values, which are spaced by the original sampling interval of 125 microseconds, is the reconstructed speech wave, and is obtained by passing the decoded samples through a low-pass filter.

The coding process, and also the decoding, employ duplicate equipments which take turns. This is to allow the equipment a period of preparation before it functions, and yet not waste that time. Some of the apparatus and methods employed in this new system will be described in forthcoming issues of the RECORD.

THE 81-C-1 TELETYPEWRITER SWITCHING SYSTEM

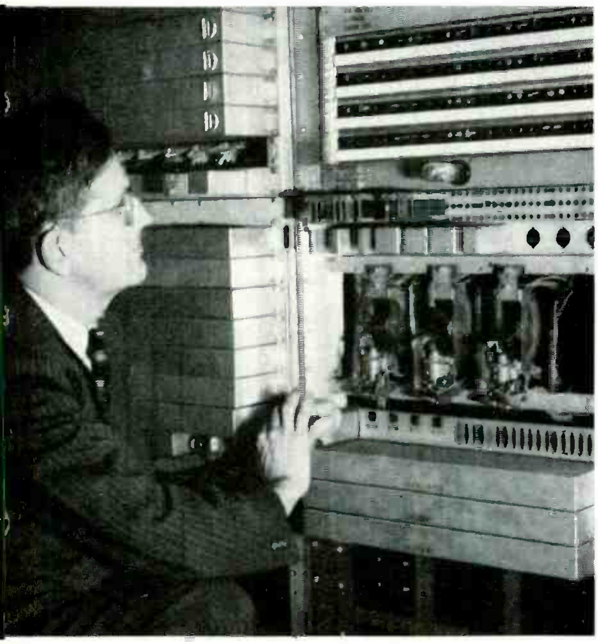
Development is now practically completed on the 81-C-1 teletypewriter switching system, with over-all systems tests finished and the test set-up in the telegraph laboratory in Graybar-Varick now being used for demonstration. The first working system, one for Pan American Airways, is currently scheduled for completion in October; one for General Motors in November; and one for Eastern Airlines early next year.

Designed for more than one switching office, the new system is in other respects an enlargement and improvement of the system installed for Republic Steel in 1941.* As installed for Pan American the new system will have three switching offices, and for Eastern Airlines,' two. It also permits multi-address messages to be sent to all offices, or to prearranged groups, by a single group-code; or to any number of offices by using address-codes for the individual offices. It also permits routine messages to be classed as "deferred", in which case they will yield precedence to other traffic. Even if three switches are made, the receiving machine will start within a matter of seconds after the original tape is started through the transmitter, provided an idle path is available. At peak load periods, a delay of only a minute or two is usually enough to secure an idle path.

As in the 81-B-1 system, the switching office will query each station on a line in rotation for inward traffic. An improvement over the early system is the provision of full selective calling when several stations are connected to the same line. In addition, there is a simple and inexpensive system available for nearby stations which are connected to the switching center over individual lines. The new system also uses the 14-D reperforator transmitter unit previously described* by Ross A. Lake of Teletype Corporation.

*RECORD, *January*, 1948, *page* 20.

*RECORD, *March*, 1948, *page* 106.

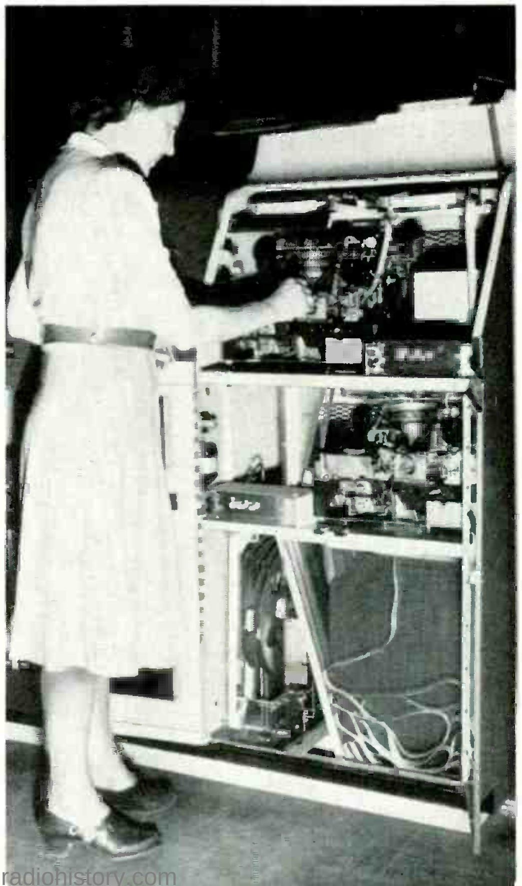


W. M. Bacon looks over a laboratory mock-up of the control board at an 81-C-1 switching office

J. A. Krecek checks relay operation in the 81-C-1 teletypewriter switching

George Knandel inspects control equipment for an outlying station

Mildred Lammers replaces tape in a reperforator-transmitter in the teletypewriter switching system



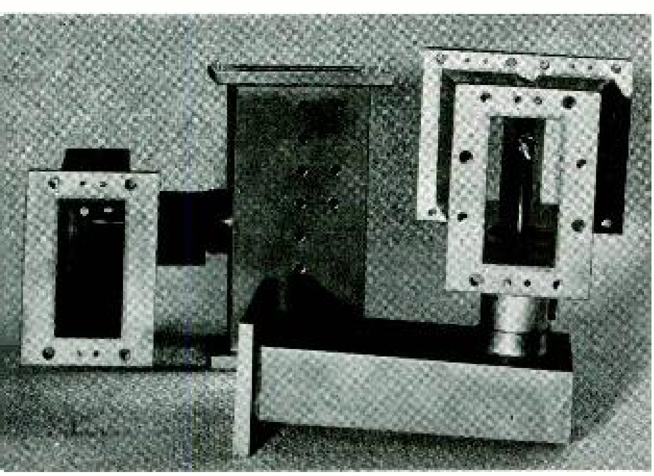
A WAVEGUIDE BRANCHING FILTER

W. D. LEWIS
Radio
Research

Radio relay systems, like that now in operation between Boston and New York and that now being installed to connect Chicago and New York,* provide two or more broad-band channels in each direction. When used for television, each of these channels carries one television program, but when voice circuits are applied to the system, each broad-band channel will include a large number of voice channels. Each of the broad-band channels is amplified separately, however, since at these very high frequencies – in the neighborhood of 4,000 megacycles – techniques for amplifying the entire group of channels with satisfactory performance have not yet been sufficiently far developed. As a result, channel branching equipment is necessary between the antennas and the amplifiers at each repeater as well as at the terminals.

Coil and capacitor filters are not suitable at these very high frequencies, and thus branching filters as used in lower-frequency carrier systems will not serve. For the relay system between Boston and New York, which now operates only two channels, two waveguide channel-passing filters, connected in a Y as indicated in Figure 1, give convenient and adequate separation. Besides passing one and only one band, such filters must be designed so that neither has any unfavorable reaction on the behavior of the other. With only two filters, this latter requirement is not serious. As the number of channels increases above two, however, it becomes more and more difficult to meet. It was finally decided, therefore, that for multi-channel systems such as that between New York and Chicago, a different method of channel branching would be required.

The waveguide hybrid used in conjunction with the branching network



The arrangement adopted after a study of several possibilities uses waveguide hybrids† in conjunction with band reflection filters in a circuit indicated in Figure 2. A waveguide hybrid is a four-arm waveguide unit as indicated in Figure 3, which shows its circuit equivalent above. Input to arm C divides equally between arms A and B with no output to arm D, and similarly input to arm D divides equally between arms A and B with no output to arm C. Although equal outputs are always obtained in arms A and B with an input to either C or D, the relative phase of the outputs in A and B differs in the two cases. When the input is from arm C, the outputs in arms A and B are in phase, while when the input is from arm D, the outputs in arms A and B are in phase opposition. This difference in phasing may readily be seen to result from the circuit shown in the upper

*Record, *December*, 1947, *page* 437. †Record, *January*, 1948, *page* 24.

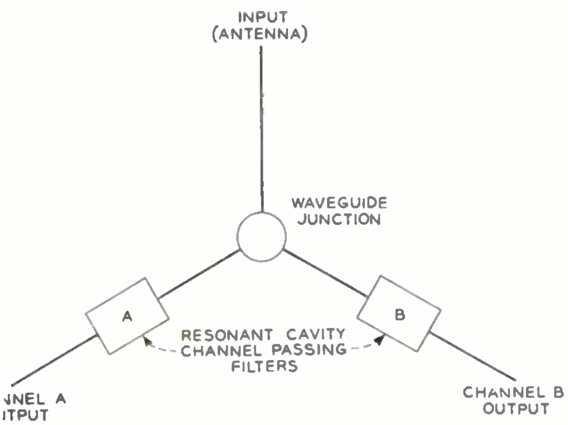


Fig. 1—For the radio relay system between Boston and New York, a Y branching network is used

and B result in no output to arm D and full output to arm C. If the input to arms A and B were in phase opposition, on the other hand, there would be no output in arm C and full output in arm D.

With this behavior of the hybrid in mind, one may easily follow the action of the circuit shown in Figure 2. Input to arm C at the top divides equally into arms A and B with no output to arm D. The band reflection filters in arms A and B reflect one band of frequencies, which may be assumed to be that corresponding to channel 1, and pass all other frequencies. The unreflected frequencies continue on and enter the second hybrid by way of its arms A and B. Since the energies flowing in these two arms are in phase, they add in arm C to

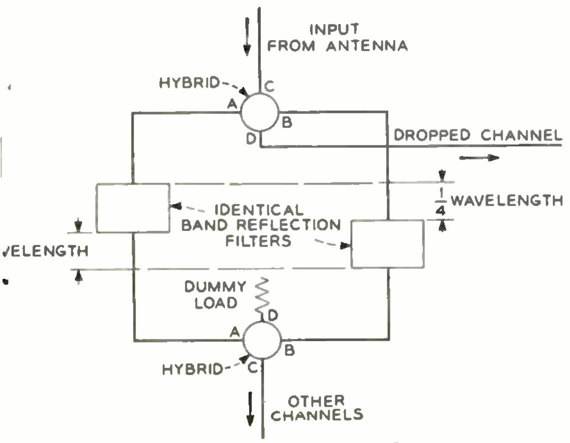


Fig. 2—Each section of the network consists of two hybrids and two band reflection filters

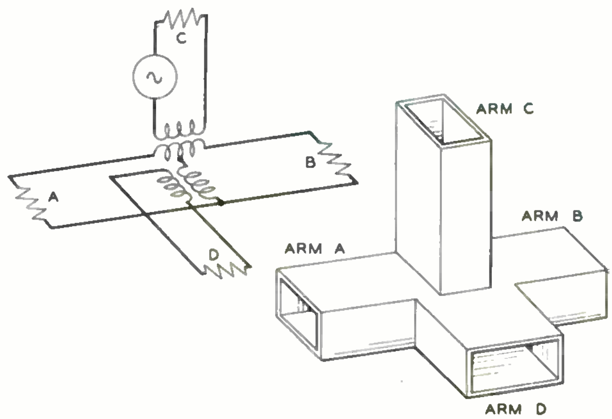


Fig. 3—Diagrammatic representation of the hybrid, right, with the equivalent wire circuit, left

part of Figure 3. With the input from branch C, current circulates around the series loop including A and B, and thus in the same direction in each of these two branches. If the current circulates in a clockwise direction in branch A, it also circulates clockwise in branch B. With the input from branch D, on the other hand, the current circulates in opposite directions in branches A and B; if it circulates clockwise in A, it circulates counter-clockwise in B. Because of this action of the hybrid, equal and in-phase voltages applied across arms A

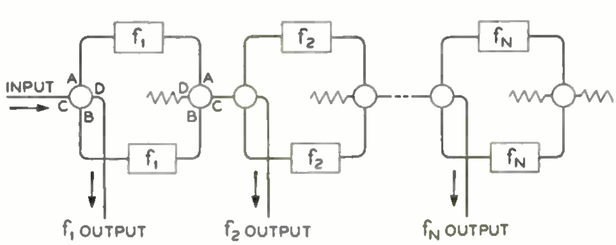


Fig. 4—A complete branching circuit consists of one or more sections connected in series as indicated above

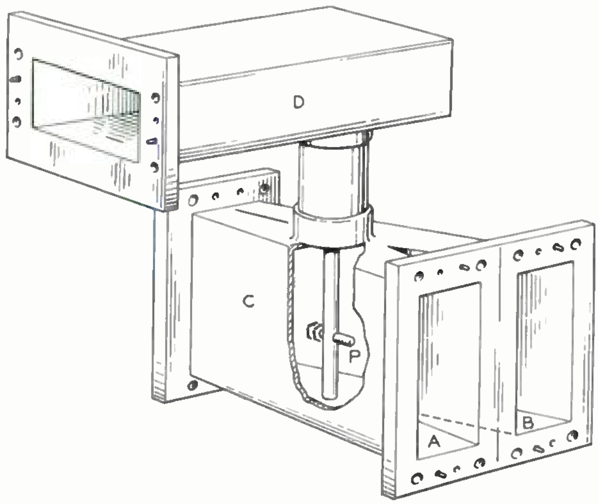


Fig. 5—The waveguide hybrid as developed for the branching network

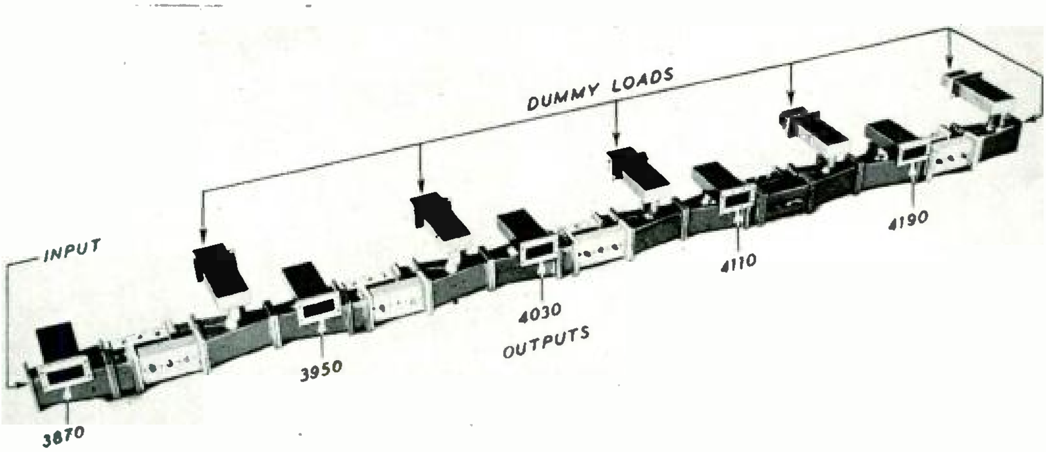
become equal to the input of arm C of the upper hybrid. No output is transmitted to arm D.

The bands reflected from the filters in arms A and B, on the other hand, travel back to enter arms A and B of the upper hybrid. These reflection filters, however, are not symmetrically located in arms A and B. In the A arm, the connection between the filter and the lower hybrid is one quarter wave-length longer than that between the filter and the upper hybrid, while in the B arm the connection between the filter and the upper hybrid is one quarter wave-length longer than that between the filter and the lower hybrid. The band that is reflected by the filter in arm B thus travels a path one half wave-length longer than that traveled by the band reflected in arm A – one quarter wave-length before reflection and another quarter wave-length after reflection. As a result, the reflected waves reaching the upper hybrid are in phase opposition, and thus they add to give full output in arm D and have no effect on arm C.

The net result of the arrangement shown in Figure 2 is thus to transmit all but one frequency band, and to drop off that band for amplification. By connecting a number of such arrangements in tandem, as indicated in Figure 4, each drops off one channel for amplification and passes the remaining channels on to the next section. For a ten-channel system, there will be ten of these channel-dropping filters connected in tandem and each would supply one channel amplifier. A similar chain would be connected with the output sides of the channel amplifiers.

A waveguide hybrid of the form shown in Figure 3 would be awkward to use in a chain circuit such as Figure 4 because

Fig. 6—A five-section branching network



of the large number of right-angle wave-guide bends that would be required. As a result, a hybrid junction of the form shown in Figure 5 was designed. Here the A and B arms are in line with the C arm while arm D is connected to the A and B arms by a coaxial line, and may be turned in any direction. The central conductor of the coaxial connection projects into the Y junction space where arm C branches into arms A and B in such a way that the transverse probe P couples D to A and B but not to C.

The arrangement of these hybrids in a five-channel branching filter is shown in Figure 6. The D arms of the second hybrid of each channel-dropping filter, and both the D and C arms of the second hybrid of the last filter are terminated in dummy loads, while the D arm of the first hybrid of each filter connects to a channel amplifier. In this illustration, the light colored sections are the band reflection filters. A one quarter wave-length section of wave-guide may be seen at the left of one band reflecting filter and at the right of the other in each channel-dropping filter.

One of the band reflecting filters is shown in Figure 7, while its construction is shown a little more clearly in Figure 8 together with its electrical circuit equivalent. Three probes spaced one quarter wave-length apart project into the section from one of the narrow sides, and near the opposite wall are tipped with capacitance discs. The capacitance of the disc, and consequently the resonant frequency of the circuit, is adjusted by a screw in a wall opposite the disc. Other screws, inserted in the broad side of the guide opposite the probes, provide adjustable coupling by disturbing the symmetry of the field. Changing the distance these screws project into the guide changes the coupling and consequently the bandwidth of the series resonant circuit, which may be changed from infinity to any value within the range required.

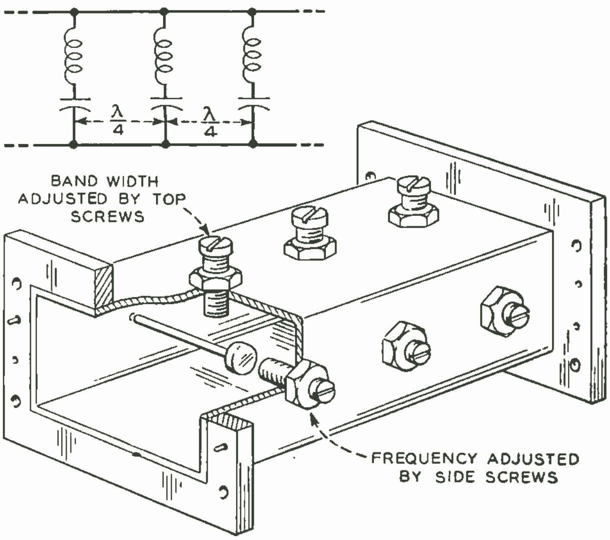


Fig. 8—The band reflection filter with its transmission line equivalent above

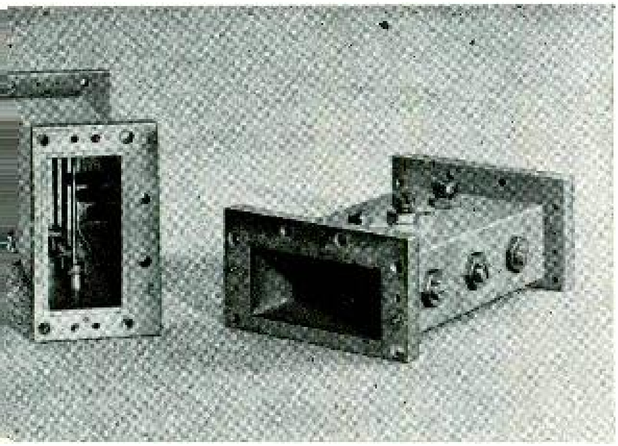


Fig. 7—The band reflection filter

The constant-resistance five-channel branching filter described above and shown in Figure 6 was designed, built, and adjusted with typical requirements of a practical radio relay system in mind. As a result of experience with this prototype filter, it can be stated with some safety that these requirements can be fulfilled with a network of this type. Experimentally observed impedance, insertion loss, and phase characteristics were fully satisfactory. In addition, the circuit appears to be flexible enough both electrically and mechanically to fulfill the various types of system needs which may be encountered at branch points or at times when channels must be added or interchanged.

The early studies of this type of branching network were carried out largely by the writer, but its subsequent development is in large part the work of L. C. Tillotson. It should prove useful for many microwave branching problems besides the particular one described.

THE AUTHOR: W. D. Lewis received an A.B. in Communication Engineering from Harvard University in 1935. In the same year he went as a Rhodes Scholar to Oxford University, England, from which he received a B.A. in Mathematics in 1938. He then returned to Harvard to work for his Ph.D. in Mathematical Physics, which he received in 1941. He has been a member of the technical staff of Bell Telephone Laboratories since July 1941, working at Holmdel in the Radio Research Department. During the war he worked on radar antennas. At present he is in charge of a group engaged in circuit research.

PROGRAM TRANSMISSION OVER A 10,750-MILE CIRCUIT

During recent tests of the first complete installation of the 8000-cycle carrier program circuit (see opposite page), test programs including some from actual orchestras were transmitted over a loop 10,750 miles long. The loop was composed of seventeen carrier links in tandem derived from cable carrier systems between Los Angeles and Omaha. In traversing the loop beginning and ending at Los Angeles, the program signal was translated in frequency 68 times and amplified 731 times by 2192 vacuum tubes. The total time required for the signal to travel around the loop was about 233 milliseconds, about one half of a beat of music played in march time. Although the circuit was 70 per cent longer than the longest commercial circuits now in use or contemplated in the forseeable future, the program at the output end of the loop was a remarkably faithful reproduction of the original program put into the input end. In a series of listening tests, the programs before and after transmission over the long circuit were compared by connecting the input and output of the circuit alternately to a high-quality amplifier and loudspeaker system. Experienced observers could detect small differences between the input and output signals, but when the listening conditions were unannounced, several, to their chagrin, chose the output signal as being of higher quality.

R. W. CHESNUT
Carrier
Systems
Engineer

PROGRAM TRANSMISSION OVER BROADBAND CARRIER SYSTEMS

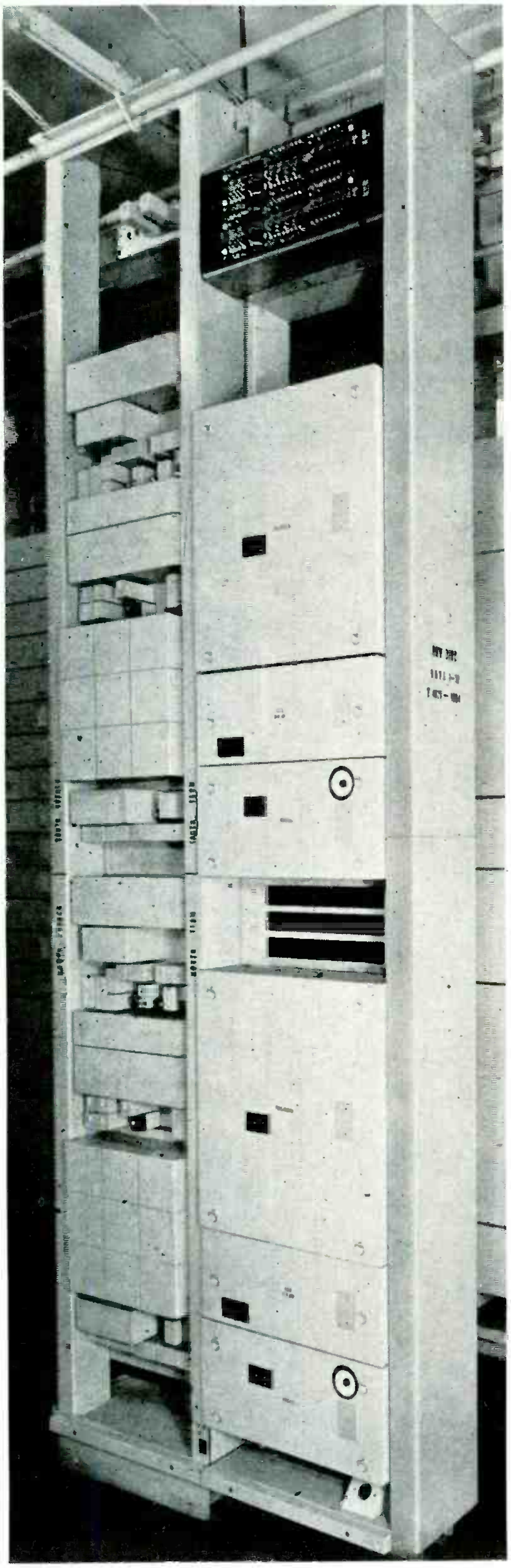
Ever since the beginning of radio broadcasting about twenty-eight years ago, the Bell System has cooperated with the broadcasting industry by supplying the needed interconnecting links between the radio transmitter stations and the studios and other pick-up points where the programs originate. At first, voice-frequency facilities were engineered to give the higher grade of transmission desired for program networks.[1] Later, with the rapid extension of broadband carrier systems, which now provide more than twenty-five per cent of the long-distance telephone circuit mileage, it became desirable to have program channels for the K and L carrier systems. These were developed, and a field trial of the equipment over K cable facilities between New York City and Boston was conducted in 1941.[2] Because of the war, however, the first commercial installations were not in service until early in 1946. The equipment for the New York-Boston trial provided for 5 kc or 8 kc program band width. A system capable of providing a program band width of 15 kc was also demonstrated the same year. Although program circuits utilizing 15 kc band width are now coming into use, this discussion will be limited to the description of the system suitable for 5 or 8 kc transmission. A new design of the 15-kc equipment is now under test and will be described in a future issue of the RECORD.

Broadband carrier systems all make use of the same channel terminal equipment,[3] which modulates twelve different voice channels to form a basic twelve-channel group in the frequency range from 60 to 108 kc. This basic group is then handled as a unit, and is placed in a suitable frequency location for transmission over the line by one or more additional modulations. The main purpose of the carrier program terminal is to insert a program channel in place of a number of ordinary message channels in the basic 60 to 108 kc group. Means for reversing the direction of program transmission over the carrier link are also provided to fit in with the existing network of voice-frequency program facilities, which are reversible under remote control of the broadcasting operator.[4] The program terminal equipment proper consists of three units: a modulator-demodulator panel; a demodulator-amplifier panel; and a reversing panel. Two complete program terminals are shown on the right-hand bay of Figure 1.

Telephone channels in the broadband carrier systems are about 3200 cycles wide, and to provide this width the carriers are spaced 4 kc apart – from 64 to 108 kc inclusive. This new system for high-grade program transmission was, on the other hand, designed to pass a band extending from 40 to 8,000 cycles. In addition, space must be provided for the signals used to reverse the program circuits. As a result, it is necessary to remove three telephone channels from a channel group to make room for one 8 kc program circuit. Only one program circuit is inserted in any one channel group, and the space normally assigned to telephone channels 6, 7, and 8 is used for this purpose. The carriers for these three channels are 88,000, 84,000, and 80,000 cycles. When an 8 kc program channel is used, the 80,000 and 84,000-cycle carriers are not used, and the 88,000 cycle carrier is used for modulating the program.

How the program circuit is connected to

[1]RECORD, *January*, 1931, *page* 233; *February*, 1934, *pages* 162 and 167; and *February*, 1935, *page* 177. [2]RECORD, *July*, 1941, *page* iv. [3]RECORD, *May*, 1938, *page* 315. [4]RECORD, *April*, 1941, *page* 234.



the channel terminal is indicated in Figure 2. The telephone channels are all two-way circuits and thus include modulators and demodulators which connect to the voice circuit through a hybrid coil. The program circuit, on the other hand, although it may transmit in either direction, transmits in only one direction during any one program period. A single unit called a modem is thus used to act as either a modulator or a demodulator depending on the direction of transmission, and the connection to it on the line side is switched by the reversing system to either the transmitting group modulator or the receiving group demodulator.

The line side of the band filters of the telephone channels are all tied together for connection to the group modulator or demodulator. The wider band filter of the program terminal differs in characteristics from those of the telephone channels, and thus does not lend itself to direct paralleling with them. Instead of tying the program channel filter directly to the telephone channel filters, therefore, the connection is made through a hybrid coil as shown. This prevents the possibility of inter-reaction between program and telephone circuits, and at the same time leaves the No. 6, 7, and 8 telephone filters available for use at any time the program facilities are not needed.

In the program channel the carrier should be balanced out in the modulator even more completely than in the telephone channels with which it is being transmitted in the group, so that very little of it will be transmitted over the carrier line and through the carrier repeaters, where it may become modulated by 60-cycle power or other disturbances and carry them on into the program channel when it is demodulated at the receiving end. The less the carrier transmitted, the lower these disturbances, or noise, will be. In the program channel, however, the lowest frequencies – 35 to 40 cycles – are so near the carrier that the band pass filter is not very effective in reducing carrier

Fig. 1—Two complete broad-band program terminals are mounted in the right-hand bay

leak, while in telephone channels the lowest frequency is 200 cycles away, and the band pass filter is fairly effective. Because of this, the perfection of balance in the program modulator must be considerably higher than in the telephone modulator. This higher balance is attained by making use of probability; 64 copper oxide pellets make up the four arms of the program modulator, sixteen in each arm, whereas only four are used in the four arms of the telephone modulator, one in each arm. Even though the individual pellets vary appreciably one from another, the arms made up of sixteen pellets for the program modulator will balance each other to a high degree.

To secure additional suppression of the adjacent carriers in the 88-kc carrier supply, which if present would result in 4 and 8 kc tones in the program channel, an additional 88-kc carrier-supply band filter is provided. When the program terminal is used with the type-K carrier system, a supplementary 120-kc band filter is also inserted in the carrier supply leads for the group modulator and demodulator to secure additional suppression of adjacent 4-kc harmonics that also might otherwise appear as unwanted tones in the channel.

Band filters unavoidably introduce phase or delay distortion in the vicinity of their cut-off frequencies. To correct this distortion produced by the 79.5 to 88-kc band filters used with the program modem units, delay equalizers are incorporated. Part of the correction is done by a network operating at carrier frequencies to correct the distortion that would appear in the voice range below 1,000 cycles, but the major part of the distortion, which would appear in the range from 1,000 to 8,000 cycles, is corrected by a voice-frequency delay equalizer that provides at the same time a certain amount of amplitude equalization.

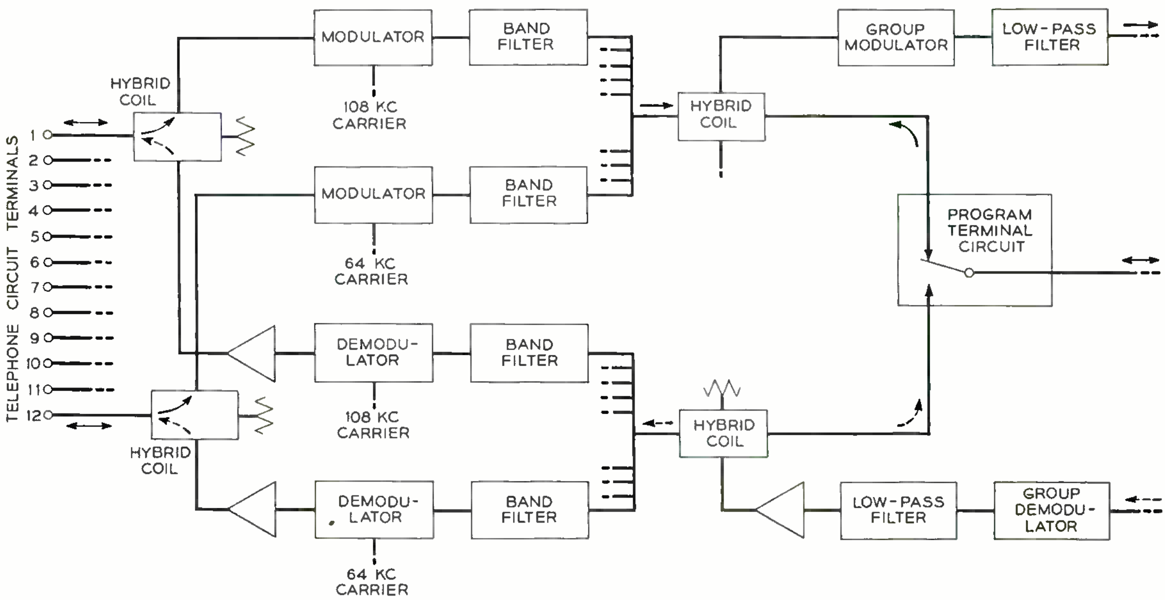


Fig. 2—Block schematic indicating how the program terminal is connected to the main channel terminal

A block diagram for the program terminal is shown in Figure 3, where the program path is shown in heavy lines, and the switching control circuit and carrier supply in light lines. In the transmitting direction, the modem circuit is preceded by a predistorter mounted on the reversing panel. This network emphasizes the high-fre-

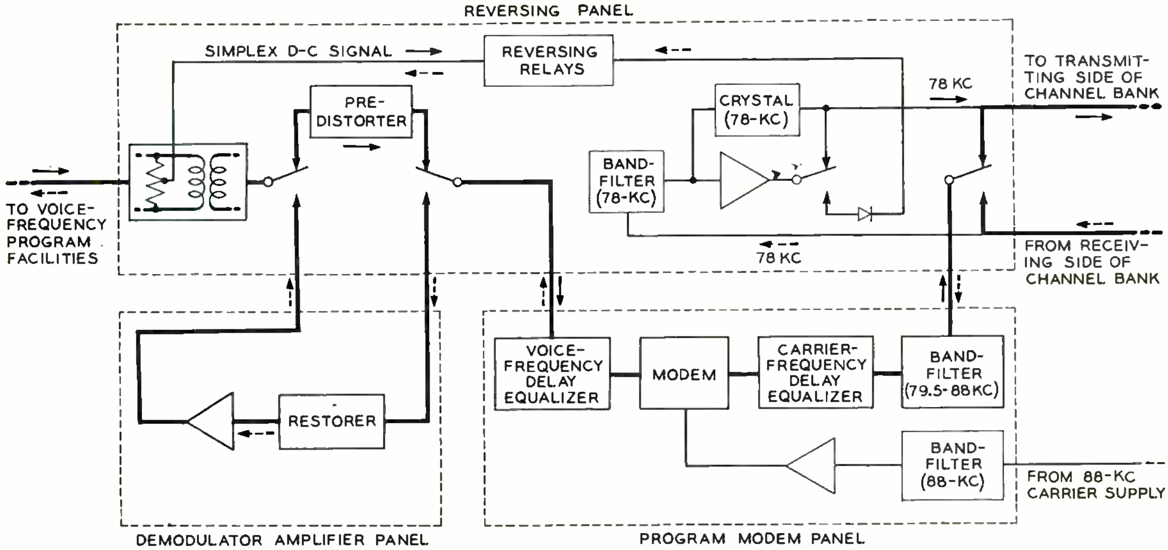


Fig. 3—Block diagram of the program terminal equipment

quency portion of the program signal, the energy of which is relatively small compared to that of the lower frequencies, so as to improve the signal-to-noise ratio before the signal is sent over the carrier line. At the receiving end, a restoring network – shown in the demodulator-amplifier panel – restores the signal components to their original amplitude

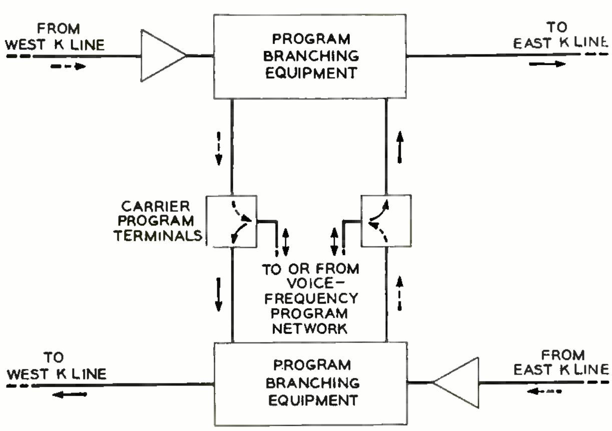


Fig. 4—Association of the program terminals with the branching equipments in each four-wire program line

relations. The 79.5 to 88-kc band filter and both the voice-frequency and carrier-frequency delay equalizers are shown in the modem panel.

All the switches indicated on the reversing panel in Figure 3 are actually switching relay contacts, and those in the program path are all either up or down at any one time. The switching relays are controlled by intermediate relays, which are so arranged that on receipt of control current over a simplex circuit from the voice-frequency side, the switches are all operated to the transmitting position, while on receipt of a rectified 78-kc current from the line side, the switches in the program path are all operated to the receiving position. When in the transmitting condition, the switch at the output of the amplifier on the reversing panel connects a 78-kc quartz crystal into a feedback path from output to input of the amplifier to form an oscillator which sends a 78-kc control tone over the line to the distant terminal, where it operates the switches in the program path to the receiving position. To reverse the program channel, the program attendant at the transmitting terminal releases control, which de-energizes the simplex circuit. This does not affect transmission over the channel because the switches in the program circuit remain locked in the positions held prior to release of control; but the switch at the output of the amplifier on the reversing panel disconnects the 78-kc crystal and connects a rectifier circuit to the output of the amplifier, thus conditioning the terminal for receiving a control tone from the line. When time for reversal arrives, the attendant at the distant end assumes control by energizing his simplex circuit. This reverses the direction of transmission at his terminal, operating all of the switches from the receiving to the transmitting direction, and sending a 78-kc control tone along the line. This control tone passes through the 78-kc band-pass filter, amplifier, and rectifier shown in Figure 3, and thence to the reversing relays to operate the switches in the program path to the receiving position, and to send a direct current out over the simplex to the voice-frequency terminal which will reverse other program circuits that may be connected in tandem.

Procuring satisfactory transmission, even over the longest distances contemplated, is not the whole story. Certain traffic requirements must be met. A nation-wide broadcasting network interconnects a large number of broadcasting stations to form continually changing combinations of studios and transmitting stations. In one period of fifteen minutes or half an hour, the same program – originating in Washington, for example – may be broadcast throughout the country, while in the following period the same network may be split into a number of separate sections, each with a different program. The older voice-frequency program facilities easily provided for this flexibility by splitting the

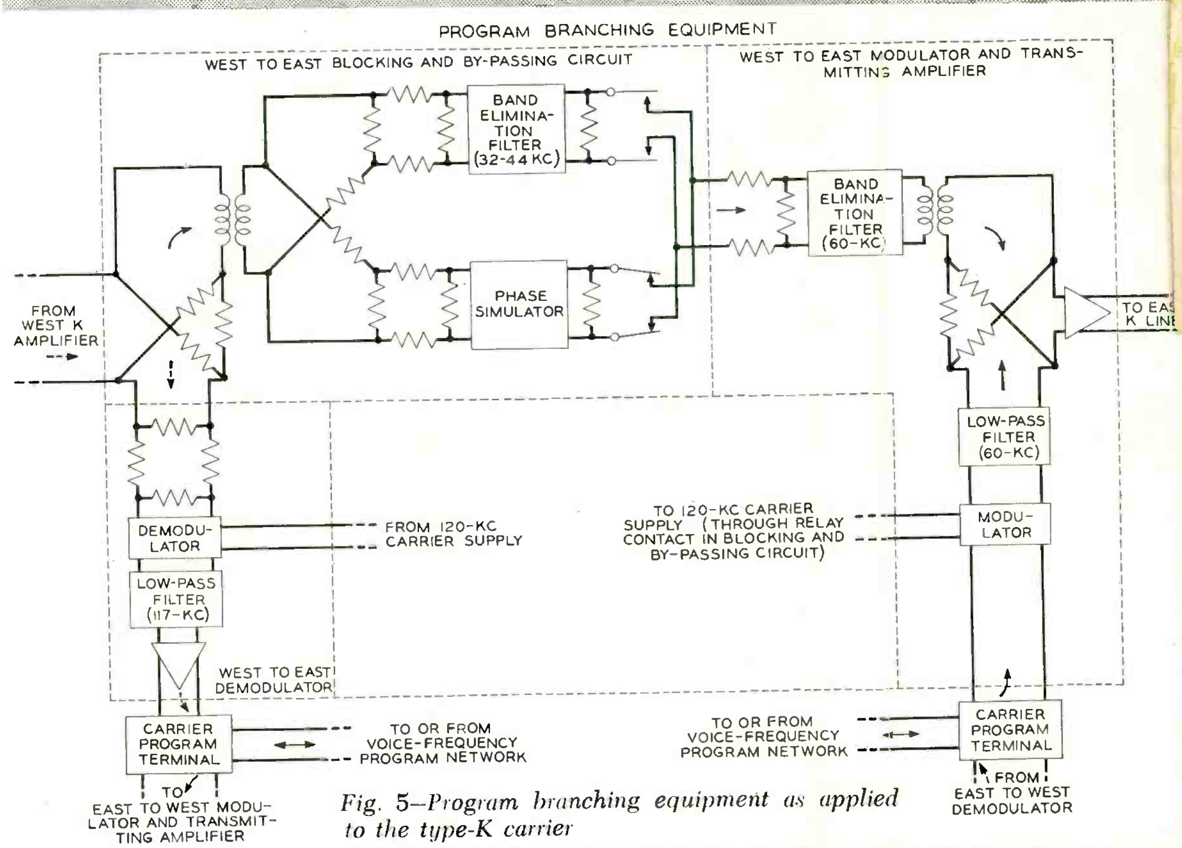


Fig. 5—Program branching equipment as applied to the type-K carrier

network at any number of points desired.* With carrier systems, however, two band filters are brought in each time a voice-frequency circuit is derived. If a nation-wide circuit were built up of short links – changing from carrier to voice frequencies and back again at each point where the program circuit might be split – the program might have to pass through from 50 to 60 program band filters and thus suffer more than allowable distortion. To avoid this without decreasing the desired flexibility, program branching equipment has been provided which permits the program to pass through the switching point at the carrier frequencies when a break is not required at that point. One of these branching equipments is inserted in the east-west carrier circuit at that point and one in the west-east carrier circuit, and two program terminals are connected to them as shown in Figure 4.

The branching equipment includes a blocking and by-passing circuit, a modulator and transmitting amplifier circuit, and a demodulator. The arrangements for application to a type-K carrier circuit are as indicated in Figure 5. At such a branching point, the program normally goes through at carrier frequencies without distortion, and a program terminal, to receive at this point, is merely bridged across the through circuit. When, however, the program network is to be broken at this point so as to connect one program circuit to the eastward line and another to the westward line, a band elimination filter is inserted in the K line. This attenuates to a high degree the program frequencies which are in the 32 to 44-kc range, thus blocking the program signal and the 42-kc control tone, but passing freely all the nine channels used for telephone messages or voice-frequency telegraph. A different program signal can then be introduced on the other side of the blocking filter. It will be noticed from Figure 5 that the by-passing path, which lets the program carrier signal go through when the blocking filter is not used, includes a phase simulating network to simulate the phase shift in the filter fairly closely for the frequencies corresponding to channels 1 to 4 and 10 to 12. This permits switching the blocking filter in and out without disturbing transmission of voice-frequency telegraph signals on these channels. The left bay in Figure 1 contains the branching equipment.

Although the branching point arrangements have been described for type-K systems, similar arrangements have been developed for coaxial systems, and it is now possible to make use of the rapidly expanding cable carrier and coaxial networks for program transmission. Since these networks cover regions which, a few years ago, were spanned only by open-wire lines, they will allow for the first time coast-to-coast transmission over cable facilities, either ordinary cable or coaxial, with their greater reliability.

*Record, *August*, 1932, *page* 430.

THE AUTHOR: R. W. Chesnut received his A.B. degree summa cum laude in 1916 (as of 1917)

from Harvard and, after a year as a Traveling Fellow in Europe, spent two years on acoustic developments with the French and American Armies in France. In 1920 he joined the Publication Department, but soon went into carrier development where he participated in the first transcontinental carrier telegraph trial in 1921. Later he became identified with carrier telephone development, and since 1922, has supervised many developments in this field such as Type C, J, K and L terminals, and has participated in many special development projects such as the first trans-atlantic radio telephone in 1926-28, the Key West-Havana submarine cable of 1930 and of 1941, the demonstration of orchestral music reproduced in auditory perspective in 1933, and radar and radar testing during World War II.

The Directors of The Southern New England Telephone Company were recent visitors at the Murray Hill Laboratory. Left to right: R. A. Haislip, G. H. Anthony, H. B. Curtis, L. S. Rowe, F. R. Hoadley (rear), E. E. Wilson (rear), D. S. Berger, G. W. Berger and V. M. Tyler

M. J. Kelly in Europe

M. J. Kelly sailed for Europe on July 29 for a tour of universities and industrial laboratories in England and on the continent. First stop in his itinerary was Stockholm and from there he plans to go by air to Copenhagen, Amsterdam, Zurich, Brussels, Paris and London. Dr. Kelly expects to return aboard the *Nieuw Amsterdam* leaving October 5 from Southhampton.

Dr. Buckley to Advise on Atomic Energy

On August 1, O. E. Buckley was appointed by President Truman to a six-year term as member of the General Advisory Committee of the Atomic Energy Commission. Members of the committee, which is headed by Dr. J. Robert Oppenheimer, Director of the Institute for Advanced Study, Princeton, N. J., serve as advisors to the Commission on scientific and technical matters relating to materials, production and research and development.

Others serving on the committee are James B. Conant, President of Harvard University; Lee A. DuBridge, President of California Institute of Technology; Enrico Fermi, Professor of Physics at the Institute for Nuclear Studies, University of Chicago; I. I. Rabi, Chairman of the Department of Physics, Columbia University; Hartley Rowe, Vice President and Chief Engineer, United Fruit Company; Glenn T. Seaborg, Professor of Chemistry, University of California; Cyril S. Smith, Director of the Institute for the Study of Metals, University of Chicago; and Hood Worthington, Carothers Research Laboratory, E. I. du Pont de Nemours and Company, Incorporated.

FCC Delegation Visits Murray Hill

Paul A. Walker, R. H. Hyde, E. M. Webster and G. E. Sterling, members of the Federal Communications Commission, visited Murray Hill on August 2. They were accompanied by L. W. Spillane, H. C. Looney, J. A. Willoughby, J. E. Barr, C. M. Braum, W. C. Boese and W. K. Roberts of the Commission Staff. The group inspected various research and development projects in progress at the laboratories. The program included a demonstration of the Transistor.

Franklin Institute Honors C. A. Lovell and D. B. Parkinson

Clarence A. Lovell and David B. Parkinson of the Laboratories have been named corecipients of the 1948 Potts Medal of the Franklin Institute. The citation that accompanies the medal indicates that it is awarded "in consideration of their combined contributions both to the theoretical and practical design of the Electrical Gun Director, one of the outstanding pieces of equipment developed

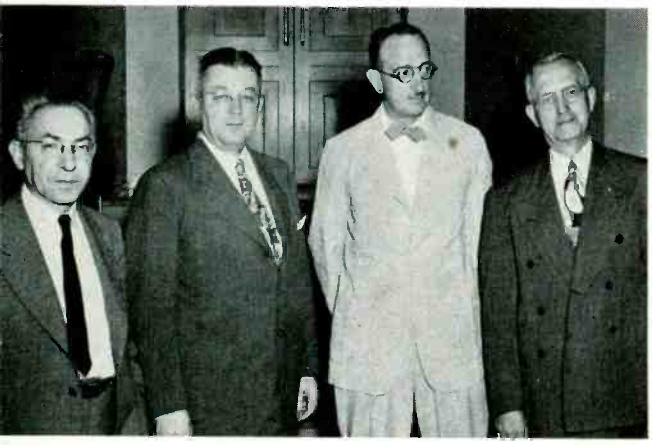
On July 20 nearly 300 of the nation's leading radio and electronic engineers visited Murray Hill where they witnessed the Transistor demonstration and heard it described by Ralph Bown, Director of Research. The audience was composed of members of the Radio Manufacturers Association, college and university investigators, representatives of the Army and Navy, and scientists from various government laboratories

during the war period, which development has further contributed largely to the theory and practical application of servo mechanisms and smoothing filters in general."

The Potts Medal will be awarded to Drs. Lovell and Parkinson by Richard T. Nalle, president of the Franklin Institute, at traditional Medal Day ceremonies to be held October 20.

Synthetic Crystals of Quartz

Clear, sparkling crystals of real quartz, identical in every way to those produced only by the process of nature, are now being grown inside bomb-like, steel "test tubes" at Bell Telephone Laboratories. The accomplishment was described on August 2 in a paper by Ernest Buehler and Albert C. Walker, presented at a meeting of the International Union of Crystallography at Harvard University, Cambridge, Mass. Recent experiments have been so successful that commercial manufacture of the useful mineral seems possible for the near future. Such crystals are not a substitute; they are the real thing, with a composition identical to the quartz crystals found in nature. The only difference is that they are synthetically produced. Due to the controlled uniformity of such production, the synthetically produced crystals are superior to natural ones.



At the Transistor demonstration on July 20 at Murray Hill. Left to right: I. I. Rabi, nuclear scientist of Columbia, R. K. Honaman, Director of Publication, Ralph Bown, and Max F. Balcom, president of the Radio Manufacturers Association

One of the first effective approaches to the problem of growing quartz was made shortly after the turn of the century by Giorgio Spezia, in Italy, who obtained crystal growth rates of about a half-inch in six months. During World War II, a German geologist, Prof. Richard Nacken, succeeded in obtaining somewhat higher rates. At these Laboratories and other research centers in this country, studies of the Nacken process have revealed serious limitation of his method, but at the same time, uncovered new approaches. Further investigations along these lines resulted in the technique now announced.

The basic methods used are in many respects like those developed in the Laboratories for growing the water-soluble EDT crystals. The growth rates, even those obtained early in the research, have been higher than those established for EDT. The standard growth rate described in the paper is four times that of any previously reported. Much greater growth rates have been obtained in the Laboratories but not by methods which it is believed can be successfully duplicated under controlled conditions.

The material from which the quartz crystals are grown is a finely powdered form of silica, which is placed in the bottom of the steel bomb and an aqueous alkaline solution is added. The seed plate, a thin wafer of quartz, is suspended at the top of the bomb; the bomb is then sealed and placed in a furnace. Under pressures exceeding 15,000 pounds per square inch and at temperatures of about 750 degrees F, the silica dissolves. In its dissolved state, it rises to the cooler part of the bomb and is deposited on the seed plate, molecule upon molecule, in perfectly regular order until all of it is in the form of a single clear crystal.

F. J. Scudder Retires

Among those who have made great contributions to the success of dial switching systems, F. J. Scudder will always be remembered. Starting with the New York Telephone Company in 1910, he was one of the first observers assigned by that Company to follow the development activity in the Laboratories on switching systems. He was transferred to the Laboratories in 1917, and played a prominent part in the semi-mechanical system then under test in Newark. Work on Metropolitan toll tandem, installed in 1919, and the first full automatic panel dial system, placed in service in 1921, followed.

Mr. Scudder was responsible for the development of the first common control dial system, which resulted in the No. 1 crossbar system being made standard for large city dial offices. He followed this work with the application of crossbar switches to toll dialing systems, and the No. 5 crossbar system. His direction of the development of these systems was an outstanding contribution to the art.

In August, 1945, he was made Director of Switching Development, in charge of all switching development, and continued in this post until his retirement.

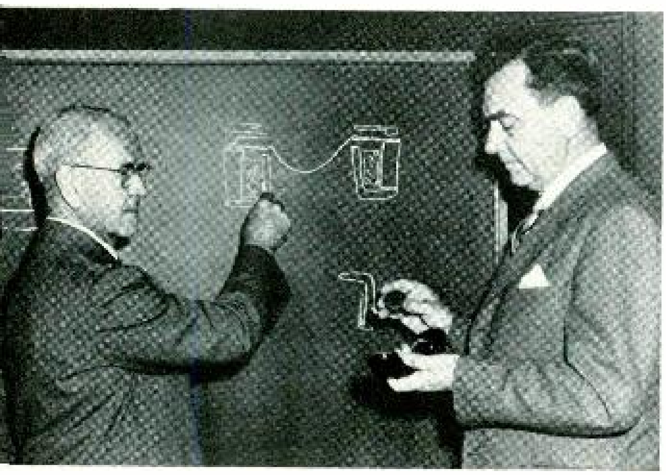
His associates admired Mr. Scudder for his broad background knowledge of telephone systems, and for his fair and considerate relations with all of the engineers with whom he came in contact. His friends in the Bell System wish him many happy years in retirement.

F. J. Scudder

A. J. Busch

A. J. Busch Appointed Director of Switching Development

A. J. Busch joined the Laboratories in 1922 immediately upon receiving an E.E. degree (cum laude) from the Polytechnic Institute of Brooklyn. After completing the student course, he was engaged in laboratory testing and analysis of both manual and panel telephone circuits for two years. An equal period was spent in designing manual circuits and from 1926 to 1933, he engaged in new developments for the panel system. From 1933 to 1941 he was assigned to the development of local and No. 4 toll crossbar systems. From 1941 to 1945, he was in charge of various development groups concerned with telephone switching as well as war projects until he succeeded Mr. Scudder as Switching Develop-



W. H. Martin (left), following a talk on July 22 to about 200 people at the headquarters office of The Pacific Telephone and Telegraph Company in San Francisco, discussed various developments of the Laboratories with J. M. Black, who is vice president of that company

ment Engineer in 1945. From 1945 until June 1, 1948 when he became Assistant Director of Switching Development, he was in charge of the development of common control switching systems including the latest switching system known as the No. 5 crossbar system. On August 1, Mr. Busch succeeded Mr. Scudder as Director of Switching Development in Systems.

Sound Added to Film on Mortar Bandage Joints

By the time a movie drama is seventeen years old, its showings are confined to the small theatres which specialize in "revivals." Not so, however, with that hardy veteran of the Laboratories, *Making and Using Mortar Bandage Joints in Underground Conduit Construction.* Filmed in 1931 by the Laboratories' sound picture group under F. L. Hunt, the script was written and spoken by C. D. Hocker, (now retired). The principal actors were S. M. Sutton and J. M. Hardesty. Thousands of Bell System plant construction men have learned from it how to fold up cement mortar in a cheesecloth bandage and wrap it around the joint between two underground conduit tiles.

Celebrating its eighteenth year, the film has recently come out in a new 16 mm sound-on-film version.

R. B. Hearn Honored

A Certificate of Appreciation has been awarded to R. B. Hearn by Secretary of the Army Kenneth C. Royall, in recognition of his outstanding service to the Army. General Courtney H. Hodges, First Army Commander, made the presentation at his Headquarters on Governors Island July 15. Mr. Hearn was cited for "outstanding patriotic service to the Signal Corps while serving as a technical observer in the European Theater from September, 1944, to June, 1945. As a result of his observations and recommendations more efficient channels of communication were provided for the Armed Forces. Despite material shortages, technical difficulties and lack of trained personnel he efficiently directed rebuilding, modifying and use of foreign equipment."

R. B. Hearn (left) receives the Certificate of Appreciation from General Courtney H. Hodges

Legion Post 497 Becomes Bell Telephone Post 497

The American Legion granted a charter to the Bell Telephone Post 497, originally the Western Electric Post 497, on June 1, 1948, under the seal of the National Commander in Indianapolis. Change of name was brought up for discussion in the Post last March by members who felt that because of the emphasis on Western Electric the Post was losing many of the 7,000 veterans in the metropolitan area who are members of the Bell System and eligible to join but who belong to parts of the System other than Western. It is hoped that the new all-inclusive name, Bell Telephone Post, will encourage many more to become Legionnaires. Commander of the Post is H. Bongard, 395 Hudson Street; first, second and third vice commanders, respectively, are R. C. Kenney of 195 Broadway, J. Landi of Brooklyn and D. H. MacPherson of these Laboratories; adjutant, W. J. Hogan, Dey Street; assistant adjutant, R. C. Nance, and finance officer, H. S. Hopkins, both of the Laboratories; service officer E. N. Emmons, Kearny; chaplain, A. Draper, 395 Hudson Street; and sergeant-at-arms, J. M. Marko of BTL.

Murray Hill Symphony Orchestra

The Murray Hill Symphony Orchestra began rehearsals on September 6 at five-fifteen in the Auditorium and plans to continue rehearsals at that time each Tuesday until next June. P. B. Oncley, conductor, is anxious to have as many musicians as possible join the orchestra, particularly in the violin, oboe and bassoon sections. Officers for the 1948-49 season are R. R. Galbreath, chairman; Joseph Domaleski, vice-chairman; Caroline Douglas, secretary; and R. A. Chegwidden, treasurer.

The New Telephone Directory

A new telephone directory, the first since March 1, 1947, has been distributed at the Laboratories. Its preparation is the responsibility of Ruth Vieweger of the General Methods Department, assisted by Mildred Beckner, in conjunction with a committee of representatives of each department, who this year selected the new type for the names and numbers in the directory.

The book was printed by Franklin Printing Company who also do the RECORD. Normally it takes three months to produce a new directory; this time the job took six months because of labor difficulties in the printing trade which have also delayed the RECORD.

Changes in Organization

Effective August 2, R. A. Miller was transferred from the Station Apparatus Development Department to the Systems Engineering Department, reporting to M. H. Cook, Director of Systems Engineering.

The organization now reporting to Mr. Cook is as follows: W. L. Heard, Special Assignments; J. W. Woodard, Systems Standards and Drafting Engineer; E. J. Johnson, Special Equipment Engineer; C. H. Achenbach, Power Development Engineer; C. G. Miller, Systems Practices Engineer; and R. A. Miller, Audio Facilities Engineer.

Waves and Raindrops

When you stand in a doorway and look off through a rainstorm you are probably making a guess as to how wet you are likely to get in terms of how much some distant object is obscured by the falling drops. This is a good practical use to make of the fact that light—

During the Months of April, May and June, the United States Patent Office Issued Patents on Applications Filed by the Following Members of the Laboratories

A. J. Aikens
M. L. Almquist
E. G. Andrews
E. J. Armstrong
H. I. Beardsley
J. A. Becker (2)
C. A. Bieling
J. R. Boettler
L. J. Bowne
J. T. L. Brown
R. Burns
T. C. Campbell
O. Cesareo
C. J.Christensen
P. P. Cioffi
S. Darlington (2)
W. L. Dawson
R. C. Dehmel
T. L. Dimond (2)
J. M. Eglin
W. C. Ellis
I. E. Fair
L. Ferguson
A. G. Fox
W. W. Fritschi (2)
E. M. Fry
C. S. Fuller (2)
J. S. Garvin
M. C. Goddard
W. M. Goodall
T. R. Griffith
C. W. Harrison
H. Havstad
R. A. Hecht
A. L. Hopper
L. W. Hussey
R. J. Kent
J. H. King
W. Koenig, Jr.
H. J. Kostkos
H. K. Krantz
G. A. Locke
C. A. Lovell
R. F. Mallina
W. A. Marrison
W. P. Mason (5)
B. K. McAlpine
S. J. McDermott
W. McMahon
E. E. Mott
E. A. Nesbitt (2)
R. S. Ohl (3)
D. B. Parkinson
R. L. Peek, Jr.
D. H. Pennoyer
L. C. Peterson
K. W. Pfleger
J. A. Potter (2)
E. Praizner
G. E. Reitter
J. B. Retallack
J. W. Rieke
R. R. Riesz
S. D. Robertson
V. L. Ronci
J. C. Schelleng
R. J. Shank (2)
O. A. Shann
J. N. Shive
L. J. Sivian
G. R. Stibitz
K. H. Storks
G. K. Teal
C. H. Townes (2)
F. W. Treptow
L. E. Van Damme
A. Weaver
E. C. Wente
G. W. Willard
D. E. Wooldridge

wavelength, 50 millionths of a centimeter—is absorbed and scattered by raindrops. Multiply the wavelength by a hundred thousand, and you have microwaves which are becoming very important to the Bell System. What happens when rain sweeps across their path?

Sloan Robertson and Archie King have given an answer for waves in the one and three centimeter region. They set up a transmitter and a receiver a few hundred feet apart at the Holmdel Laboratory with a rain-gauge in between. Whenever rain threatened, they were johnnies-on-the-spot, recording the rainfall and the transmission impairment every few minutes.

As might be expected the 3 cm waves suffered the least; in a heavy rainfall transmission went down less than a decibel—that's a 20% reduction in received power—a mile. But the little 1 cm fellows really took a beating—a heavy rain set them back from 4 to 10 decibels a mile and a cloudburst knocked them for 35 decibels.

For the still shorter wavelengths, G. E. Mueller found a falling-off in the rate of increase in attenuation due to rainfall. Heavy rains and cloudbursts produced losses for his six-millimeter waves only a few db greater than Robertson and King had observed.

Upshot of it all is that the men who engineer the Bell System's microwave paths have something pretty definite to go on when they space relay stations and design power amplifiers.

News Notes

Ralph Bown has accepted the appointment as a member of the Joint Technical Advisory Committee which was created by the Institute of Radio Engineers and the Radio Manufacturers Association for the purpose of advising government agencies and professional and industrial groups on technical aspects of radio, television and electronics. The JTAC replaces the Radio Technical Planning Board which has been dissolved.

D. A. Quarles went to Burlington and Winston-Salem and during the visit addressed the Engineers Club of Greensboro on *The Bell Laboratories' Place in the Bell System.*

Letters to the editor in the July 5 issue of the *Physical Review* included *The Transistor, a Semi-Conductor Triode* by J. Bardeen and W. H. Brattain; *Nature of the Forward Current in Germanium Point Contacts* by W. H. Brattain and J. Bardeen; and *Modulation of Conductance of Thin Films of Semi-Conductors by Surface Charges* by W. Shockley and G. L. Pearson.

The laboratories were represented in interference proceedings at the Patent Office by G. F. Heuerman and D. MacKenzie before the Primary Examiner and by H. S. Wertz before the Examiner of Interferences.

J. A. Hornbeck and J. P. Molnar presented a joint invited paper *Cathode Emission Processes in Townsend Discharges* before the American Physical Society meeting which was held in Madison, Wisconsin.

H. W. Heimbach, J. G. Ferguson, R. L. Lunsford and O. J. Morzenti, at Hawthorne, discussed manufacturing schedules concerning No. 5 crossbar office equipment.

An anniversary celebration, honoring six men of the Systems Engineering on attaining thirty years and in one case thirty-five years of service during the month of July, was marked by a luncheon at the Fifth Avenue Hotel on July 21 attended by twenty-seven friends and associates. The guests of honor from left to right are E. T. Herwig, H. B. Nienstedt, A. B. Kvaal, F. T. Meyer, H. O. Wood and C. E. Sunderland. Mr. Meyer is the member of the group who has completed thirty-five years of service

BELL LABORATORIES CLUB OFFICERS FOR THE 1948-1949 SEASON

MILDRED READ
Second Vice-President

E. K. EBERHART
President

J. C. KENNELTY
First Vice-President

UPON ACCEPTING the presidency of Bell Laboratories Club for the 1948-49 term, E. K. Eberhart launched a more active program than has been undertaken by a president in many years. His experience in Club activities is of long standing, he having been the first chairman of the Greater New York Fund drive after the Club assumed responsibility for it. He has participated in the campaign for funds every year since, held office in the bowling league and stamp clubs, and served as departmental representative twice. Mr. Eberhart is a member of the A. O. honorary engineering fraternity, the I.R.E. and the New York Electrical Society.

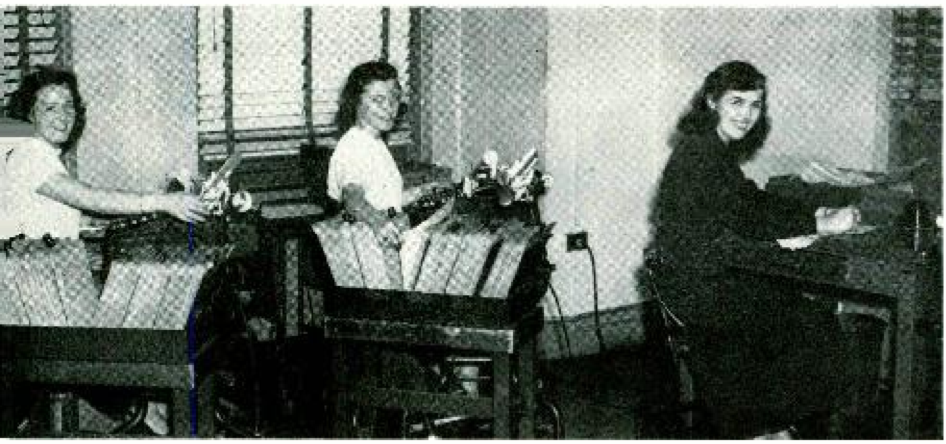
A graduate of the University of Pittsburgh in 1924 with a B.S. degree in Mechanical Engineering, he is now engaged in the design of order wire and alarm equipment for the New York-Chicago radio relay system. During the war he designed a portable repeater for Signal Corps use and worked on counter measure and radar test equipments, and the AN/TRC-6 microwave radio relay project.

Residents of Summit, the Eberharts have a nine-year old son, Stephen, whose interests vacillate between his dad's engineering bent and his mother's interest in the arts.

FIRST VICE-PRESIDENT of the Club for the coming year is J. C. Kennelty who has been active in Club and Legion activities for many years. He has served as club representative for the Commercial Relations Department and chairman of the golf club. Mr. Kennelty is a charter member and former Post Commander of Bell Telephone Post 497 of the American Legion. His Laboratories service dates back to 1917 when he joined the General Service Department. After serving as lieutenant in the Infantry, he transferred to the Purchasing Department where he organized the first personal purchase group. In 1922 he transferred to Commercial Relations where until recent organization changes, he was concerned with costs and cost estimates. Mr. Kennelty is now a member of the new Commercial and Staff Services group where his work has to do with general service, particularly with the preparation of estimates requested by Western Electric.

THE SECOND VICE-PRESIDENCY of the Bell Laboratories Club, customarily held by a woman, was accorded to Mildred Read of Murray Hill for 1948-49. Mrs. Read brings to the post a wide experience in the field of organization, having been president of the junior women's league of Summit and organizer of Y.M.C.A. young adult courses. She has been active in the tennis, swimming and Appalachian Mountain clubs.

A recent bride, Mrs. Read is the wife of W. Thornton Read of the Physical Research Department. Born in Portand, Oregon, she was graduated from the University of Nebraska in 1943 with a B.A. in chemistry. Her early work at the Laboratories was in the Electroplate Shop but for several years she has been engaged in spectrochemical analysis.



All smiles for the camera are Ann Babio, Louise Costella and Thelma Condon, members of the Stock Control group of the Purchasing Department. Miss Babio and Miss Costella tabulate the records; Miss Condon does clerical work in connection with the stock records

News Notes

E. R. CASEY, J. W. FALK, K. W. MILLER, MARTHA PUGH, S. N. TURNER and D. H. WILSON, JR. of the Patent Department have recently registered to practice before the United States Patent Office as Patent Agents.

J. W. SCHMIED lectured on July 6 before the Practicing Law Institute on selected phases of Patent Interference Practice; this was a repetition of a similar lecture given before the same Institute last April.

C. H. TOWNES, F. R. MERRITT and B. D. WRIGHT have written on *The Pure Rational Spectrum of I Cl* and W. P. MASON on *Piezoelectric or Electrostrictive Effect in Barium Titanate Ceramics* in the Letters to the Editor section of June 1, 1948, *The Physical Review.*

S. A. SCHELKUNOFF, as Visiting Professor of Engineering, instructed in two courses on electromagnetic theory in the University of California Off-Campus Graduate Program at San Diego this summer. During his visit he also served as special consultant in mathematics at the U. S. Navy Electronics Laboratory in that city. Dr. Schelkunoff spoke on *The Transmission of Electromagnetic Energy in Dissipative Media* on July 13 before the San Diego section of the Institute of Radio Engineers and on July 23 at the University of California, before the Departments of Engineering and Physics in cooperation with the I.R.E. and the A.I.E.E. At U.C.L.A. he also participated in a Symposium on *Modern Calculating Machinery and Numerical Methods.*

H. W. BODE has accepted an appointment to the Mathematics Advisory Committee of the United States Army.

J. BARDEEN attended the Gordon Research Conference in New London, N. H., where he addressed the conference on the *Theory of Surface Reactions.*

September Service Anniversaries of Members of the Laboratories

35 *years*

Robert Nordenswan

30 *years*

S. J. Fulton
G. A. Ritchie

25 *years*

Edward Alenius
A. E. Bowen
R. M. Bozorth
F. S. Corso
G. W. Cowley
E. F. Dearborn
V. R. Gabson
E. H. Gilson
K. H. Guerard
C. C. Kingsley
G. T. Kohman
G. J. MacDonald
J. J. McDermott
Bayman McWhan
K. W. Pfleger
E. H. Quoos
H. H. Spencer
L. F. Staehler
R. S. Tucker
E. P. Williams
Sylvester Young

20 *years*

Helen Adams
E. J. Becker
D. T. Bell
W. K. Caughey
E. T. Creaven
Catherine Cronin
A. F. Duerr
L. A. Fay
W. T. Gebhard
C. A. Goble
B. C. Griffith
Daniel Mahoney
H. E. Mendenhall
J. S. Parsons
W. C. Pfrommer
Thomas Powers
Margaret Remmelman
P. H. Richardson
George Ripepi
W. F. Ruede, Jr.
J. F. Schneider
K. S. Southard
C. E. Stone
E. K. Van Tassel
Michael Walsh
L. H. Whitman

15 *years*

Kenneth Durham
William Ryan

10 *years*

A. J. Irwin
T. A. Maras
Louise Norback
J. L. Politzer

C. KITTEL, who sailed for Europe on the *Nieuw Amsterdam* on July 2, spoke on the subject *Determination of Surface Energy of Block Walls in Iron* at the International Conference on the Physics of Metals in Holland.

L. H. GERMER attended the First Congress of the International Union of Crystallography from July 28 to August 2 at Harvard University, Cambridge.

C. E. SHANNON spoke on *The Theory of the Transmission of Information* and S. O. RICE on *Reflections from Bends and Corners in Electromagnetic Wave Guides* before the Second Symposium on Applied Mathematics at Massachusetts Institute of Technology.

B. MCMILLAN presented a paper *Recent Computer Developments at Bell Telephone Laboratories* before the Symposium on Numerical Methods held at the University of California, Los Angeles.

A. J. WIER visited the Long Lines Division at Chicago and Washington early in July to discuss with them and Western Electric installers various problems concerning the initial installations of 15-kc carrier program terminal equipment. This same procedure was followed by R. I. GAME at New York where two terminals are located for connection to Chicago and Washington.

A. H. WHITE, K. G. MCKAY and A. J. AHEARN attended a conference on fast counters at the University of Rochester during which Mr. Ahearn presented a paper on *Alpha Particle Bombardment in Diamond and Zinc Sulfide* and Mr. McKay a paper on *Electron Bombardment Conductivity in Diamond.*

R. R. RIESZ, R. L. WEGEL and O. J. ZOBEL were among the recipients of alumni citations during the Second Century Celebration of Ripon College. William Orvis was elected a member of the Board of Directors of the newly organized Ripon College Parents' Association.

H. T. KING spent several days in Watertown, Wisconsin, in connection with N1 carrier trial between Milwaukee and Madison. M. T. Dow, who had been making noise tests there with R. M. HAWEKOTTE, has returned to the Laboratories and been replaced in the field by ELIZABETH GARROW and D. D. SAGASER.

J. G. FERGUSON, W. H. LICHTENBERGER and W. WAGENSEIL were at Duluth in connection with No. 5 crossbar equipment.

WERNER HARTMAN and BETTY E. PRESCOTT'S article on *The Quantitative Spectrochemical Determination of Barium, Strontium and Calcium* was published in the June, 1948, *Journal of the Optical Society of America.*

W. SHOCKLEY participated in *Self Survey—A Review of the Curriculum in Physics* at Case Institute of Technology, Cleveland.

P. P. DEBYE attended the Polymer Research Conference in New London, New Hampshire, of the American Association for the Advancement of Science, on July 15-16 and the meeting of the International Crystallographic Union in Boston on July 28.

Members of the Murray Hill Plant Department, picnicking at Swartswood State Park, enjoy a hearty meal prepared in the open by chefs, in white caps, F. E. Dorlon, seated left, and P. V. Brunck, standing left

P. T. HAURY conferred at Leeds and Northrup Company regarding the design of a carrying case for maintenance tools for use on K carrier pilot wire controllers.

G. H. HUBER, N. J. EICH, H. W. HERRINGTON and L. PEDERSEN visited Squier Laboratory at Ft. Monmouth on printed circuit techniques.

R. M. BOZORTH, who spoke before the International Union of Pure and Applied Physics in Amsterdam, Holland, on July 15, selected *Ferromagnetic Domains* as his subject.

H. C. FLEMING was in Chicago, W. D. MISCHLER in Washington and C. A. GRIERSON at 32 Avenue of the Americas for the initial installation and demonstration of the new 15-kc (B-1) carrier program terminal for broad-band systems.

G. K. TEAL, M. D. RIGTERINK and C. J. FROSCH were the authors of a paper, *Attenuator Materials for Microwaves,* published in the August issue of *Electrical Engineering*.

R. A. CHEGWIDDEN, A. G. GANZ, J. A. ASHWORTH and V. E. LEGG were at Hawthorne on magnetic materials problems.

D. E. CAVENAUGH, H. A. VAIDEN and T. A. FILCE inspected facilities for constructing models of transformer apparatus at Air Design, Incorporated, Upper Darby, Pa.

It Isn't Done With Mirrors

Now that everyone at Murray Hill knows about the O'Keeffe triplets, left to right, Jane, Joan and Jean, of the Mailing Department, it's all quite clear but for a while they had people worried. An engineer who first called the RECORD's attention to them met a girl in the Restaurant as he was leaving to cross to the Acoustics Building. Seeing what he thought was the same girl in the Auditorium, he began worrying about his sight and when he found her at his desk upon reaching his laboratory he knew something was amiss with him or with the girl. So much alike are they that when pass pictures were taken, two of the three negatives were destroyed because the Photograph Department thought it needed only the best negative for file.

News Notes

T. G. BLANCHARD, L. W. KIRKWOOD and A. B. HAINES, with representatives of the Western and the Air Material Command, visited Squier Signal Laboratories, Fort Monmouth, regarding power transformers for government applications. Mr. Haines attended meetings at Chicago of RMA Committee 10-C on Receiver Power Transformers and of Subcommittee TR 9.4 on Power and Audio Transformers and Reactors for Transmitters. Mr. Blanchard and Mr. Haines visited the Sperry Gyroscope Company at Great Neck, New York, regarding manufacturing problems on transformers being made for Winston-Salem.

W. B. GRAUPNER visited Media on the trial installation of the No. 5 crossbar office.

G. E. BAILEY was in Boston on studies concerning 3-C switchboards.

G. A. BENSON studied schedules at Hawthorne for No. 4 crossbar toll office equipment.

O. MOHR, O. CESAREO and F. A. BONOMI were at Hawthorne from July 5 to July 9, in connection with polarized relay problems.

HENRY KOSTKOS was in Cleveland with the Ohio Bell Telephone Company to discuss the manufacture of display mechanisms developed by the Laboratories for the associated telephone companies.

W. J. JANSSEN discussed problems connected with the manufacture of ceramic bushings at the Stupakoff Ceramic and Manufacturing Company, Latrobe, Pa.

J. H. HERSHEY tested fire control equipment aboard the *U.S.S. Mississippi* at Norfolk.

A. D. THOMAS discussed with Western Electric engineers at Hawthorne equipment problems concerning community dial offices.

B. E. STEVENS visited Western Electric at Haverhill in connection with manufacturing problems on voltage regulators.

J. R. BARDSLEY studied loading coil case design problems at Hawthorne.

S. G. HALE visited Hawthorne in connection with problems of loading coil case finishes.

F. B. MONELL and A. R. D'HEEDENE discussed plans for the manufacture at Haverhill of filters for the type-N carrier system.

P. E. GILMER and C. M. HEBBERT attended a symposium on Electromagnetic Theory at Massachusetts Institute of Technology.

H. H. ABBOTT, at Pittsburgh, discussed PBX problems with the engineers of the Bell Telephone Company of Pennsylvania.

I. C. OSTEN-SACKEN visited San Francisco and Los Angeles to discuss development problems related to automatic ticketing, announcement systems and coin service.

A. J. ENGELBERG, G. A. HURST and S. P. SHACKLETON spent several weeks on field tests to determine the performance of the No. 5 crossbar system.

R. I. WILKINSON conferred with Colonel Bessel, head of the Mathematics Department, and the instructing staff in mathematical statistics at the United States Military Academy at West Point on June 2, on problems of curricula in probability and engineering statistics. In the evening, Mr. Wilkinson addressed 250 cadets from the Class of 1950 on the subject *Applications of Statistics in the Jungle Air Force from the Solomons to Japan.*

←*Talking with relatives on his ranch over* 2,000 *miles away, C. F. Blackwelder, of Cheyenne Wells, Colorado, tried out the mobile radio-telephone equipment in a test car during his recent visit to the Laboratories headquarters in New York. Mr. Blackwelder, who in* 1946 *participated in the first regular telephone call over a subscriber radio link, brought his family east and met the engineers whose efforts helped make his rural service possible. They were taken on an extensive tour, viewing the West Street and Murray Hill installations and A T & T and Long Lines buildings. With Mr. Blackwelder is R. V. Crawford, of Transmission Engineering*

New Page Turner Given Hospital by Legion

A veteran of World War I, this patient at Manhattan Beach Hospital has been lying in hospitals for years, unable to move his body or head, unable to read the things that interested him, until Bell Telephone Post 497 of the American Legion presented the hospital with this new improved page turner invented by Frank Reck of the Laboratories. The patient, A. M. Rodgers, a metallurgical engineer and a graduate of Harvard, no longer needs a Gray Lady to read to him; he has taken a new interest in life and in the scientific fields in which he formerly specialized. Shown above standing are Mr. Reck, inventor of the page turner, Mrs. Hopkins, who is actively interested in the work of the Committee and H. S. Hopkins of the Hospital Visiting Committee, who as paymaster is known to many at West Street.

News Notes

J. W. GIBSON is conducting a comprehensive series of traffic tests on the No. 5 crossbar exchange. Mr. Gibson, a member of the Bell Telephone Company of Pennsylvania, is temporarily assigned to the Laboratories.

C. F. BISCHOFF is making a field traffic study on the same system.

O. C. ELIASON and G. H. DOWNES initiated a trial of a new type of dehydrator for controlling atmospheric moisture at the St. James, L. I., community dial office. Mr. Downes consulted with the Post Engineer at Fort Monmouth on air conditioning problems.

A. R. KEMP   MINNIE MARCUS

RETIREMENTS

Recent retirements from the Laboratories include Minnie Marcus and A. R. Kemp.

A. R. KEMP

When A. R. Kemp entered the Laboratories in 1918 he held the B.S. and M.S. degrees in chemistry from California Institute of Technology, and had done further graduate work. After some work on wartime chemical problems, he was given charge of research on methods of chemical analysis and in 1919 took up the insulation research that was to be his lifework. At that time Western Electric had undertaken to make its first rubber insulated cables, to be used between the mainland and Catalina Island. Mr. Kemp worked closely with Western engineers at Hawthorne on that project.

In the early 1920's the Bell System had been purchasing its requirements of rubber-covered wires from several outside suppliers. Mr. Kemp guided the development of a compression test for wire insulation which soon became standard in the industry. When it was decided that Western Electric should begin to make drop wire, Mr. Kemp and his group worked closely with Point Breeze engineers on their new method of continuous vulcanization. Mr. Kemp suggested an accelerator which made the process a revolutionary step in the art. He collaborated with other suppliers in their use of accelerators and antioxidants; partly as a result, the Bell System was able to secure an improved product at a lower price.

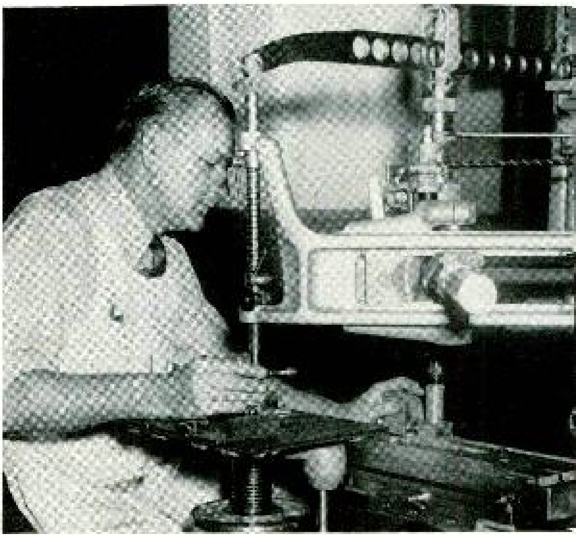
Extensive studies of plastic insulations under Mr. Kemp's direction resulted in the invention of paragutta,† a mixture of carefully purified gutta-percha and rubber. A cable insulated with this new material was to be made in Germany and Mr. Kemp went abroad to supervise the work. As an incidental but vital contribution, he aided in the development of a special technique of splicing the one-mile lengths, and trained the workmen. This cable, laid between Havana and Key West in 1931, was the first such cable to be operated at carrier frequencies.

From 1930 to 1943 Mr. Kemp supervised part of our organic chemical research. Here he made important contributions to knowledge of rubber insulation in the presence of moisture; one Bell System application was underground wire. From England in 1938, he brought home the first sample of polymerized ethylene; its dielectric properties at high frequencies were so good that a ton was imported and made into insulators for coaxial cable.

During World War II the shutting off of rubber imports posed a grave problem, which was met by the development and use of substitutes. Under Mr. Kemp's leadership, the Laboratories played a prominent role in the changeover to less critical materials. Advent of high frequencies, as in spiral-4 systems and of special applications, – for example, high voltage cables for airplane radar – brought other problems which were successfully solved. This work became so pressing that in 1943 Mr. Kemp relinquished all but the organic insulation work. Earlier in 1948 he became a consultant in the Chemical Laboratories.

Mr. Kemp is a member of the American Chemical Society; while chairman of its Rubber Division he was its special representative

†RECORD, *May* 1931, *page* 422.



Martin O. Kastner of the Development Shops Department duplicates a detail from a master on the new Gorton three-dimensional pantograph machine at West Street. Mr. Kastner guides the pantograph laterally and has a clear, unobstructed view of the work at all times at a conference in London. He was later chosen by the Chicago Section of the Society as one of ten leading rubber chemists. He is an "active" member of the American Institute of Chemical Engineers and a fellow of the (British) Institution of the Rubber Industry. Jointly and individually he is author of 48 publications and appears as an inventor on 34 patents.

Since his retirement Mr. Kemp has taken up residence in Southern California.

of production batteries go to Miss Marcus who arranges to have them put on test, later tabulates and graphs their performance. Rivalry between suppliers, stimulated by her objective comparisons, has been an important factor in the steady improvement in the batteries purchased by the Bell System.

During World War II Miss Marcus added to her duties high-voltage tests on cables for high-altitude radar. After retirement she expects to live on her farm near Albany.

Playing off in the horseshoe tournament, rear of Building T, with several tied for top honors, resulted in J. A. Laite, J. J. Reif and R. Olsen placing first, second, and third, respectively, in Class "A". Mr. Olson won third place on percentage points, having tied with G. Rampone and G. McDermott. In Class "B", T. Bodkin and T. J. Dolly tied for first place, with Bodkin winning the playoff, and M. J. Goodwin taking third place

Minnie Marcus

When Minnie Marcus joined the Laboratories in 1917, all Western Electric vacuum tubes were produced here, and her first assignment was work on assembly and pumping. Later she transferred to testing of switchboard lamps, and in 1920 to the group responsible for the development work on primary batteries and later was given charge of the testing work.

Dry cells are made by a number of outside suppliers to meet specifications based on performance requirements for the Bell System which may differ from requirements for other uses. For instance John Q. Public's flashlight is used infrequently and for short periods; long "shelf-life" of its cells makes a satisfied customer. A telephone repairman uses his flashlight a good deal and for minutes at a time; plenty of output is more important than shelf-life. Samples both of development and

News Notes

A. A. Hansen was in Chicago in connection with the testing and placing in service of single-frequency signaling and multi-frequency keying facilities in the Chicago toll office. With these facilities, direct dialing of New York City subscribers by the Chicago toll operators was initiated. Mr. Hansen also went to Philadelphia and Richmond to study field tests of the single-frequency signaling equipment.

H. C. Franke and R. L. Kaylor are in Wauseon, Ohio, engaged in statistical studies of fading in two sections of the projected New York-Chicago microwave radio relay route. This work will continue through the Fall of 1948. G. H. Baker and R. P. Booth also were in Wauseon in connection with this project. Mr. Baker recently visited Denver to discuss plans for microwave propagation tests in the Salt Flats of Utah.

J. J. MARTIN conferred with engineers at Archer Avenue and Hawthorne on non-metallic materials. En route he attended A.S.T.M. meetings in Detroit of Committee D-9 on electrical insulating materials.

J. E. CASSIDY was at the Patent Office in Washington during July relative to patents.

R. D. HEIDENREICH and C. J. CALBICK attended the meeting of the International Crystallographic Union in Cambridge at which Mr. Calbick presented a paper entitled *Electron Micrographic Study of the External Form of Crystals of Carbonyl-Nickel.*

Radiators by C. T. MOLLOY; *Acoustic Impedance Measurement of Very Porous Screen* by C. M. HARRIS; and a Letter to the Editor by A. R. RIENSTRA on *Electronic Musical Instruments.*

W. O. BAKER was chairman of the Chemical Conference of the American Association for the Advancement of Science on High Polymers held for a week at Colby Junior College, New London, N. H.

W. ORVIS and R. A. HECHT consulted the Specialty Insulation Manufacturing Company, Hoosick Falls, N. Y., on molding problems.

Shown above is one of fourteen girls in the Whippany stenographic group—Fanny Nobile—taking dictation from P. H. Smith, who invented the famous Cloverleaf antenna. Mr. Smith, who is well known in the field of broadcast and microwave antennas, is the author of numerous technical papers

Since the inception of Murray Hill Project II, Grace Hansen (shown above) has been responsible for the architectural and occupancy drawings in connection with the new building. On drawings received from the architect for study and check of designs, she has routed and followed through to approval, while on drawings of the Laboratories giving detailed plans of rooms for occupancy she has done the ordering of prints, distributing them to those concerned, keeping detailed records of distribution and issue numbers

J. D. STRUTHERS attended the first course in the Radioisotope Training Program conducted by the Oak Ridge Institute of Nuclear Physics.

The July issue of *The Journal of the Acoustical Society of America* contains articles on *Absorbing Media for Underwater Sound Measuring Tanks and Baffles* by W. P. MASON and F. H. HIBBARD; *Time Integral Basic to Optimum Reverberation Time* by J. P. MAXFIELD (retired); *Theoretical Analysis of the Mercury Delay Line* by H. J. MCSKIMIN; *Representation of Vowels and their Movements* by R. K. POTTER and G. E. PETERSON; *Calculation of the Directivity Index for Various Types of*

J. R. FISHER and J. G. WHYTOCK performed tests of pressing ceramic materials at the Denison Engineering Company, Columbus.

W. A. MUNSON participated in a meeting of the Naval Advisory Panel for Psychophysiology at the University of Pennsylvania.

H. V. WADLOW made chemical tests on specialty equipment at Winston-Salem.

E. E. SCHUMACHER attended a meeting in Washington of the federal government's Metallurgy Panel of which he is a member. He also was at Hawthorne, the University of Illinois and Detroit in connection with metallurgical problems. Mr. Schumacher and I. V. WILLIAMS went to Winston-Salem regarding materials specifications and standardization.

F. M. WIENER's paper *Notes on Sound Diffraction by Rigid Circular Cones* appeared in the July issue of *Journal of the Acoustical Society of America.*

T. AAMODT visited Allentown to discuss vacuum tube techniques.

F. A. BROOKS witnessed a trial in Atlanta of a method of reducing interference patterns in telephotograph signals transmitted over K-2 systems.

F. B. ANDERSON, G. P. WENNEMER and I. M. KERNEY were in Atlanta and Mobile on the trial installation of 8-kc program equipment on J-carrier telephone system between those two stations.

W. L. TUFFNELL, at Archer Avenue, discussed the handset coin collector.

F. F. ROMANOW and M. S. HAWLEY consulted with Dr. Cook of the Bureau of Standards in Washington on problems dealing with acoustic standardization.

W. KALIN visited the Brush Development Company in Cleveland in connection with crystals for hearing aid transmitters.

W. R. NEISSER visited the Archer Avenue plant in regard to new developments in subscribers' equipment.

H. E. VAIDEN studied transformers for the 50B recorder connector at Haverhill, Mass.

J. L. GARRISON visited the General Electric Company at Schenectady regarding plastic encasement of apparatus.

J. F. MORRION visited Winston-Salem and Burlington on matters related to the design of radio broadcasting equipment.

A. K. BOHREN and C. A. WARREN conferred in Washington at the Bureau of Ordnance on a government project.

A. A. LUNDSTROM selected *Air Maneuvers* as his subject when he spoke at Watson Laboratories before the Air Defense Group.

C. R. TAFT went to Minneapolis on the design of submarine equipment.

J. B. D'ALBORA and J. H. HERSHEY inspected the operation of fire-control equipment at the Naval Research Laboratory Annex, North Beach, Maryland.

S. J. STOCKFLETH and R. R. HOUGH discussed optical systems at the Eastman-Kodak Company, Rochester.

R. F. LANE participated in testing of aircraft radio equipment at Wright Field.

H. L. ROSIER and A. M. GARBLIK spent the month of July at the Patuxent Naval Air Station in connection with the testing of aircraft radio equipment.

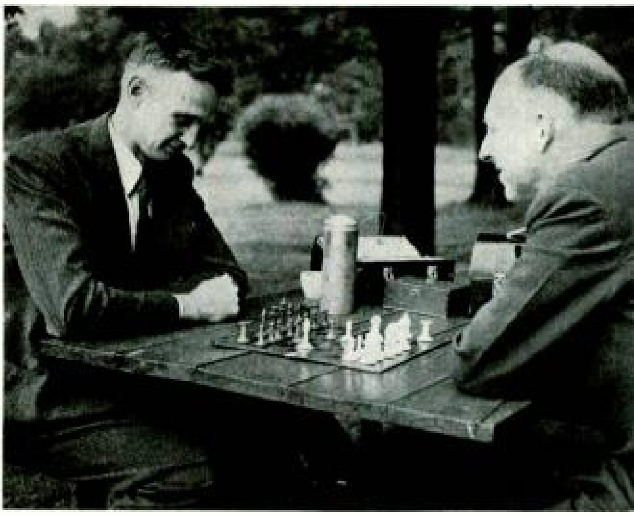
AT WINSTON-SALEM recently were E. L. NELSON, R. F. LANE, F. C. WARD, J. J. SCANLON, R. C. NEWHOUSE, R. H. MATTINGLY and F. A. GOSS.

R. H. KREIDER and J. H. COOK have returned from a visit to the Douglas Aircraft Company in Santa Monica.

H. C. RUBLY discussed inside wire stapling problems with telephone engineers at Columbus and Chicago, and modifications in staplers with engineers of the Heller Company at Cleveland.

J. F. WENTZ and E. T. MOTTRAM have returned from a visit to Dayton.

T. A. DURKIN inspected a trial shipment of drop wire at the Western Electric Distributing House, Boston.



Lunch eaten, William Lightbowne and J. C. Crowley relax at a game of chess at Whippany where bench and table units provide the opportunity of enjoying lunch and hobbies in the open

Obituaries

THOMAS SOLAN
1888-1948

JOSEPH BELL
1905-1948

WM. MULDOON, JR.
1891-1948

THOMAS SOLAN, July 23

Thomas Solan died suddenly while on vacation with his family in Canada. Mr. Solan joined the Western Electric Company as a painter in 1918. His skill as a wood finisher and painter gave him the opportunity for advancement to supervisor in 1927. Since then, Mr. Solan had been in charge of the group of painters in the Building Shop who handle the outside as well as inside maintenance painting of the Laboratories' building.

JOSEPH BELL, August 2

Mr. Bell had been a member of the Laboratories since 1921 and with the exception of about two years has been associated with the physical research group interested in electronic projects. His work was connected with the construction of electron tubes and vacuum apparatus. He worked on such projects as the first historic two-way television demonstration in 1927, color-television involving use of gas filled tubes, and the high quality cathode ray tubes used to transmit the first television signals over coaxial cable. More recently he had been engaged in the development and construction of metal vacuum systems used for vaporizing metal and then depositing it in thin films to be used as electrodes on the surfaces of many materials, particularly quartz crystals which were used for military purposes during the last war.

Mr. Bell was long interested in amateur radio, having operated station W2GHQ from his home for the past twenty years; he was a member of the Army Amateur Relay League and the United States Power Squadron.

WILLIAM MULDOON, JR., July 29

Mr. Muldoon joined the Development Shop in 1918 working first on production and later in obtaining materials for work being done in the Shop. After several years he transferred to the Commercial Relations Department where he was concerned with expediting model production on commercial products. During World War II, Mr. Muldoon worked on vital war projects particularly those for the Naval Ordnance Laboratory, and since then has been engaged in the procurement and expediting of government material as well as Research Department material.

WALTER CLARNER, July 18

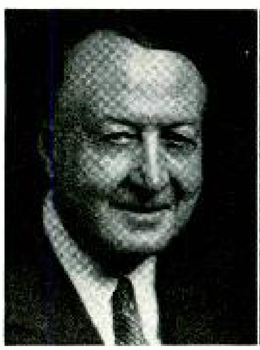
Mr. Clarner, who retired in April, 1947, after twenty-six years of service, started working at West Street as a millwright in the Building Shop. In later years he became a uniformed watchman in the Building Service group of the Plant Department.

JULIUS NACHTIGALL, August 3

A member of the physical electronics group of the Research Department at Murray Hill, Mr. Nachtigall came to the Laboratories in 1927 as a glassblower and had since been continuously engaged in that capacity. As he had served apprenticeship in his native Germany and had been engaged elsewhere at his trade in this country, he was particularly skilled in creating glass apparatus for Laboratories' analytic work and for general use.

LT. STANLEY W. ERICKSON, December 27, 1944

Lieutenant Erickson, a member of the Development Shops Department at the time of



WALTER CLARNER
1882-1948

JULIUS NACHTIGALL
1893-1948

his enlistment in 1943, was buried on July 21 with military honors in the Long Island National Cemetery, Pinelawn. Holder of the Air Medal with three oak leaf clusters, Lt. Erickson was killed in England on December 27, 1944, when his flack-riddled Flying Fortress crashed after a bombing raid over Germany.

LT. THOMAS M. PEPE, March 9, 1945

Double military funeral services were held on August 7 at the Long Island National Cemetery, Farmingdale, for Lt. Thomas M. Pepe of the Systems Drafting Department and his brother Joseph M. Pepe of the Navy who was killed in 1943 aboard the *Savannah* off Salerno. Their bodies were returned in August, Thomas' from the Philippine Islands, Joseph's from Europe.

Lt. Thomas Pepe, a dive bomber pilot in Squadron 243 of the Marine Air Corps, was killed in Luzon, P. I., during an attack. He was awarded the Distinguished Flying Cross, the Air Medal and the Gold Star, in lieu of a second and third Air Medal citations. The surviving Pepe brother, Matteo, is serving with the Marine Corps at Cherry Point, N. C.

News Notes

A TRAINING COURSE for shop stewards was given recently by the Extension Division, New York School of Industrial and Labor Relations of Cornell University. The following members of the Laboratories were among those who completed the course: F. N. MAGUIRE, L. MCNEILL, J. DORIAN, L. NEWBY, MAE CRAIG, E. WELLS, S. MARKOCKI, H. ULRICH, W. HIPPSCHEN, J. PICARD, R. DRYDEN, MRS. GWENDOLYN SHARPE, STEPHEN HAYES, R. SCHUSTER, D. SHEEHAN, D. LOWNY, E. MCCARTHY, T. HICKEY, F. THOMASSER, J. NIEDZWEICKIE, T. DIAB, L. MUNCH, O. CLARK, STELLA FIKA, R. MOLITOR and F. MORAN.

C. C. WILLHITE and R. V. LOHMILLER of Burlington visited Whippany in July. Mr. Willhite transferred to Whippany in August.

H. A. DOLL of Specifications and Change Order Department, Burlington, visited in Whippany the first week of August.

S. A. SCHELKUNOFF wrote the editorial page entitled *The End Is in Sight* in the July, 1948, *Proceedings of the I.R.E.* In the same issue is *Waves and Electrons Sections,* an article by W. RAE YOUNG entitled *Interference Between Very High Frequency Radio Communication Circuits.*

F. E. DORLON attended the annual convention and exposition meeting in Cleveland of the National Restaurant Association and made a tour of inspection of Eastman-Kodak restaurants and lounge facilities at Rochester.

VIRGINIA MOWRY interviewed and selected "Miss Ideal Secretary" for the Alpha Iota, national honorary business sorority, and spoke briefly on her selection and on qualifications for women in business before its eleventh international convention.

F. W. ANDERSON and R. W. PRINCE observed the power equipment at the No. 5 crossbar office in Media, Pa., and at the AMA Center in Philadelphia.

Lillian Chadwick of Transcription posed for this photograph in the Personnel Department in connection with a proposed booklet on business opportunities

DURING THE Democratic National Convention, L. G. ABRAHAM, K. E. GOULD, D. K. GANNETT, L. W. MORRISON and J. R. BRADY visited the Long Lines Offices in Philadelphia, Baltimore and Washington, to observe the operation of the facilities provided for television. This included a visit to the Convention Hall in Philadelphia.

A. H. LINCE visited Tennessee Aircraft at Nashville in connection with the manufacture of models of a delay lens antenna for the TD-2 microwave radio relay system.

"The Telephone Hour"

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

September 6	*Bidu Sayao*
September 13	*John Charles Thomas*
September 20	*Ferruccio Tagliavini*
September 27	*Lily Pons*
October 4	*Fritz Kreisler*

Murray Hill Glass Washing "Laundry"

By C. A. Charity
General Service Department

Many of the Laboratories' personnel do not know that there is a Glass Washing "Laundry" at Murray Hill operated by the General Service Department. The equipment in this room is used for cleaning chemical glassware used by the Technical Departments. Prior to Murray Hill No. I, glassware was cleaned in the individual Chemical laboratories at West Street. This was entirely a hand washing operation and the operator was obliged to have his various cleaning solutions in each laboratory.

In the process of our research and development work, considerable glassware of various shapes and sizes is used, primarily by the Chemical Research Department. We clean from 8,000 to 10,000 various pieces of glassware per month.

Daily collections and deliveries are made and soiled glassware collected in wire mesh baskets is transported to and from the washing room by means of a portable tray truck. A tag showing the room number is attached to each basket. This is important because there is always the chance that some impurity will stick to the glass and if sent to another laboratory room might cause trouble. For the same reason the glassware from each laboratory is usually washed at one time to avoid mixing and to insure the return of the proper glassware.

If the soil, such as paint, rubber, wax, plastic, is difficult to remove, the use of acids, solvents, and heating usually frees the soil so that the article can be immersed in the cleaning solution without interfering with the action or effectiveness of the solution. The glassware is placed in wire mesh baskets which are submerged by the use of hand-operated electric hoists into different heated solutions, according to the nature of the soil.

A nichrome wire basket is used in connection with the duriron tank containing sulphuric acid-sodium dichromate cleaning solution, and galvanized wire baskets with stainless steel tanks containing sodium hydroxide and tri-sodium phosphate solutions.

The glassware is inspected, hand washed if necessary, rinsed in hot water (distilled, if necessary), replaced in baskets and placed in a steam heated drying oven. The majority of the glassware handled can be cleaned by this method, but special and delicate articles, such as condensers, pipettes and burettes, must be hand washed. In most cases, glassware collected one day is delivered cleaned to the laboratories the following day.

Caesar Garcia wears safety goggles, rubber gloves and apron as protection against the acids and solvents he uses to clean glassware in the Murray Hill Glass Washing Laundry