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Chemical Laboratories

Metallizing paper for capacitors

The possibility of laying down a metal coating on paper by vaporizing in a vacuum has long been known. Paper thus coated could be rolled up into a capacitor, and so would supplement or even replace the existing technique of rolling two strips of metal foil between strips of paper. However, the older method was in satisfactory use and there was no great incentive, at least in the United States, to undertake the necessary development program.

During World War II, the Germans, as a military necessity, had developed a metallizing process, which was seen and reported by Bell System engineers and others during a post-war inspection tour. This quickened our interest, and development was started to see if the process could be refined and cheapened to a point where it would offer advantages to Western Electric production. Our resulting capacitor is now not only smaller in size for a given value

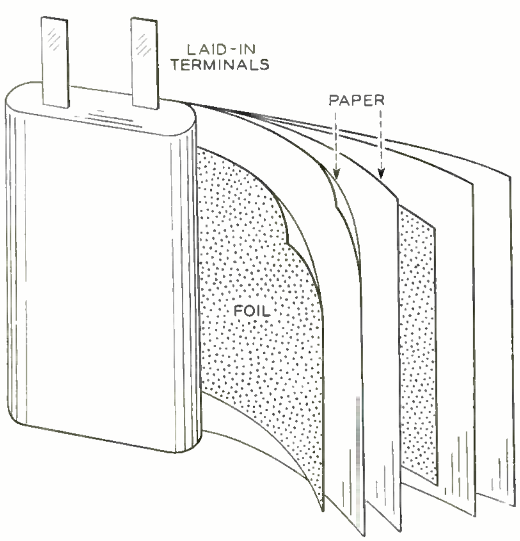
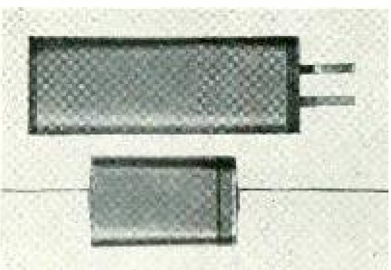


Fig. 1—A foil type capacitor above and a metallized paper capacitor of the same capacitance below. Method of constructing foil type capacitors is shown at the left



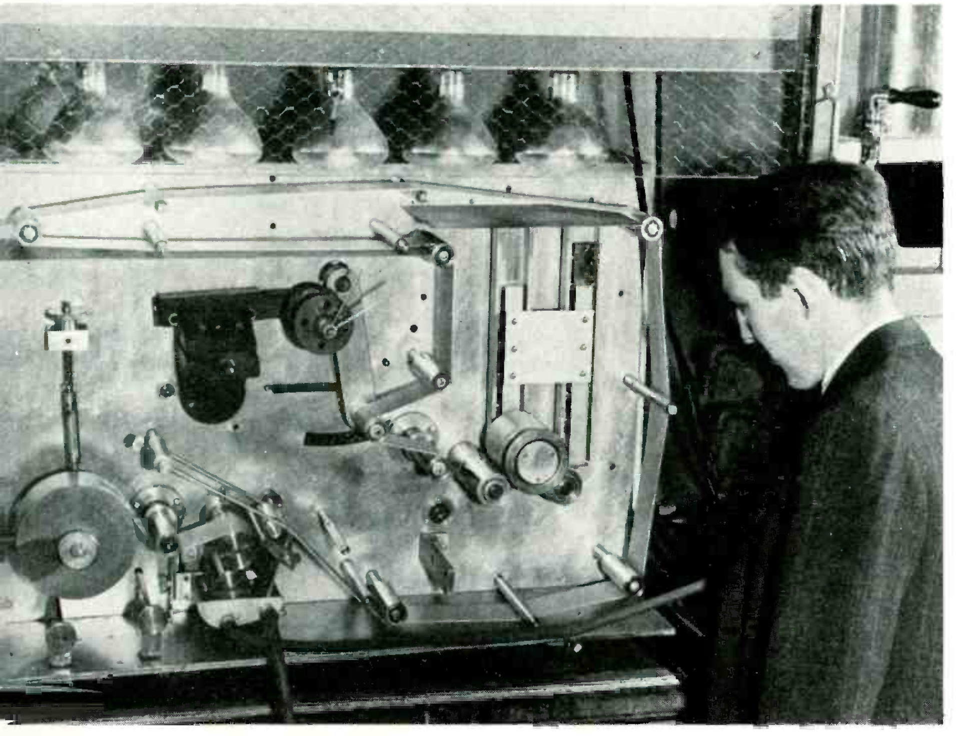


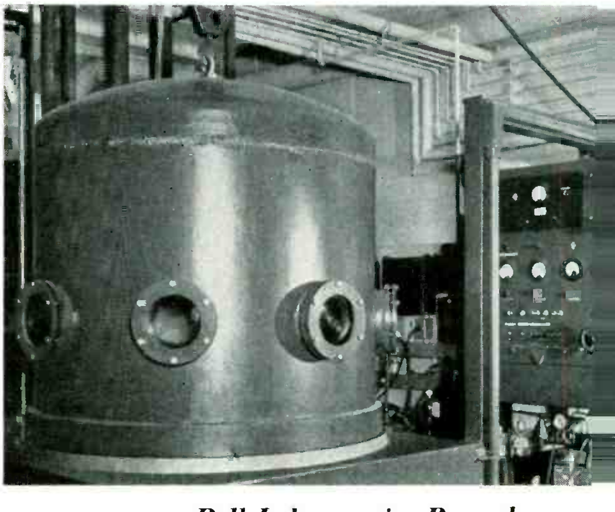
Fig. 2—Experimental coating arrangement to apply lacquer to capacitor paper prior to metallization. C. J. Frosch is observing the set-up

than its foil predecessor, but it also has the added advantage of self-healing of punctures through the insulation. The relative size of the old and new capacitors is shown at the right of Figure 1. A 2.0 mf metallized paper capacitor unit, below, has about one-third the volume for the same capacitance as the conventional capacitor above.

As is well known, the older types of foil capacitors* consist of two strips of aluminum separated by two sheets of chemically pure Kraft paper. The foil and paper are each about one-tenth as thick as ordinary writing paper. When the foil assembly is rolled up cylindrically, two additional sheets of paper are used as shown. The paper is wider than the foil and electrical contact with the foil is obtained through strips of heavier metal inserted into the wrapping during the winding process. The assembly is dried and then impregnated to improve dielectric strength and specific inductive capacity. Finally, it is potted in cans to keep out moisture.

In contrast, the newer metallized paper capacitors, while made with the same pure Kraft paper as that used in the aluminum foil type, have only two sheets instead of six. Each of these two sheets is lacquered, on one side, to improve dielectric strength by filling up the hollows and small holes and by covering over any conducting particles possibly present. The lacquered paper is dried and then it is metallized by directing on it metal vapor in vacuum. A controllable width of unplated margin is

Fig. 3—Vacuum vapor-plating machine for metallizing capacitor paper



*Record, *January*, 1943, *page* 123, and *March*, 1945, *page* 65.

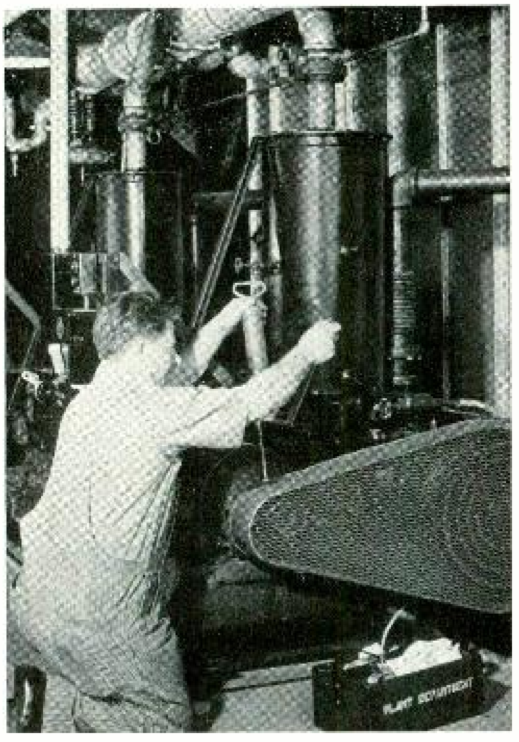


Fig. 4—These two mechanical vacuum pumps produce the main vacuum in the bell jar and, together with oil diffusion pumps in the base of the plating apparatus, create a vacuum of about 1/10,000 mm of mercury. Mechanic Ralph Coviello is operating the apparatus

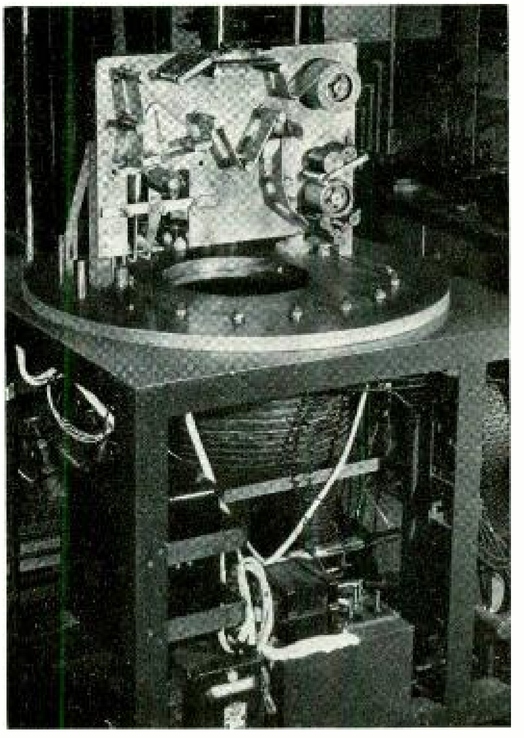


Fig. 5—Vacuum vapor-plating machine with bell jar and side panel removed. The plating occurs in the upper section normally covered with the evacuated bell jar. Below are located oil diffusion pumps, transformers, speed control and the water-cooling coils

left along the edge of one sheet of the metallized paper and its co-wound companion sheet has its own margin on the opposite edge. These two sheets of lacquered and metallized paper are then rolled together to form a capacitor. Terminals are provided by spraying a bridge of metal across the two opposite ends of the final assembly to provide a base for later soldering of lead wires. This is followed by a final drying and the usual impregnating and potting.

For the first step in laboratory manufacture of the metallized capacitor, that of lacquering the paper is illustrated in Figure 2, which shows the experimental apparatus located under a hood to remove inflammable solvents. As viewed, a supply roll of uncoated stock is at the lower left. The paper passes toward the lower right under an adjustable guide roll and then over one of two small lacquering rolls traveling at the same speed and direction as the paper. The amount of lacquer on the second roll is metered by a gap between the applicator and supply rolls; the latter has the same speed counterclockwise and revolves in a pool of lacquer of determinate viscosity in the trough below. The paper is held down on the lacquer-applying roll by a guide and also by a depresser bar, both adjustable. The depresser bar and a floating roll determine the angle at which the paper passes over a rotating drill rod. The rod revolves against the motion of the paper to smooth the lacquer, to remove any excess lacquer and to prevent accumulation of any foreign solid material which might score a streak in the wet coating.

By several guide rollers, the paper then passes up to drying lamps and thence past a tension indicating device to the center right wind-up roll. The lacquered side of the paper does not come in contact with any guide roll until it has been sufficiently dried en route. The paper tension is controlled by a spring-actuated brake on the paper supply roll shaft.

After the lacquering, the roll of paper is more thoroughly dried in a vacuum oven and is then ready for metallizing in the large metal bell jar with observation windows shown in Figure 3. The bell jar is evacuated by two mechanical pumps located elsewhere and shown in Figure 4. These mechanical pumps are assisted by oil vapor pumps located in the lower part of the main equipment, as in Figure 5, where the covering bell jar and the side panels in the base were removed to make apparent the construction of the whole apparatus.

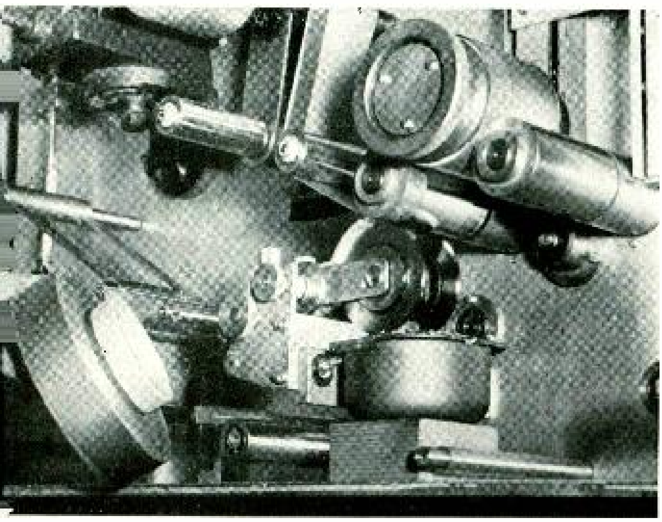


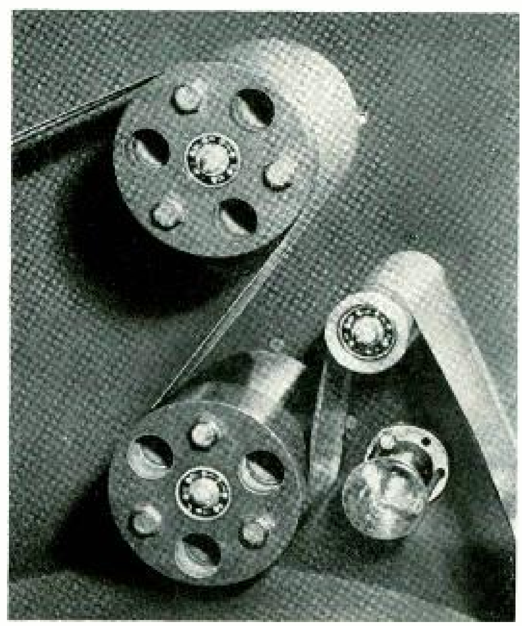
Fig. 6—The two lubricated cutting wheels press the paper against the hardened steel rolls, scoring the paper sufficiently to cause separation. A slit roll is held, left, with the unplated margin evident

Referring to Figure 5, the paper to be metallized is located on the supply reel in the upper right-hand corner of the upright panel. The paper runs leftward beneath an automatic tensioning device and continues beyond a tension indicating roller and thence to the zinc vapor applicator. The zinc is contained in a slotted resistance-wound crucible, and the vapor is directed upward from the slot onto the lower surface of the paper. The paper next passes over the three rolls forming a V in the center. Here the upper two rolls are insulated from the panel and the metal side of the paper is down against those two, so that the electrical resistance of the plating can be measured. Following the resistance-measuring rolls are two inspection lamps in oval housings which permit examination of the plating by both reflected and transmitted light. The paper is finally wound up on the supply roll in the lower right-hand corner of the panel. During actual metallization, of course, the bell jar is in place and evacuated. There is also a screen, over a large opening directly beneath the panel, through which gasses in the chamber are removed by the vacuum pumps.

Following metallizing, the paper is slit to a required width with a score slitter attachment on the lacquer machine, as shown in Figure 6. A completed roll is at the lower left.

Apparatus of the kind shown in Figure 7 tests the metallized paper for electrical weak spots on a sampling basis. The large insulated rolls shown are electrically charged to burn away the vaporized zinc electrode at any weak spots or conducting particles in the paper. This fuse-like action of the metal film is called "Self-Healing." The number of weak spots, or burnouts,

Fig. 7—Electrical burn-out testing of metallized capacitor paper is done on a sampling basis with this type of laboratory equipment



THE AUTHOR: H. G. WEHE received the A.B. degree from Washburn College in 1922 and the M.A. degree from the University of Kansas in 1925. In the meantime, he had taught Physics and Chemistry and had spent one summer in test board work with the Southwestern Bell Telephone Company. In 1926 he joined the E. of M. Department of the Western Electric Company, but in 1929 transferred to Bell Telephone Laboratories, where he became a member of the Technical Staff with the Research Department. His first work was in magnetics and on the deposition of carbon films on ceramic material. Since 1933, excepting a year during the war developing radar tubes, he has been engaged in studies of the vapor deposition of thin films either of semi-transparent or non-reflecting types or to serve as electrodes, resistors, semiconductors, photo and radiation sensitive elements. A considerable part of his work has been on metallized paper capacitors.

which occur are recorded on an independent automatic counter.

The metallized paper is then wound into individual capacitor units, one of which is shown at the lower right of Figure 1 on page 317. After drying, impregnating and potting, they are given a surge of high voltage to permit the self-healing property of the capacitors to reinsulate any internal low resistance paths between electrodes. After suitable inspections for quality and also performance, the metallized paper capacitors are then ready for use.

During these post-war developments, Western Electric engineers were designing machinery for commercial production. There were frequent meetings with our engineers, so that Western Electric might benefit from our work. Eventually, production was started at Hawthorne and metallized paper capacitors are now available for use in the new Bell System combined station set.

*RECORD, *May*, 1949, *page* 165.

Patents Issued to Members of the Laboratories by the United States Patent Office, April to June, Inclusive

H. H. Abbott
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Interoffice transfer of alarms in No. 5 crossbar

C. E. GERMANTON
Switching Development

Since it was expected that many No. 5 crossbar offices would be maintained by off-premises personnel at least part of the time, such as nights and week-ends, it was necessary to design suitable circuits to transfer alarms* in unattended offices to some center where a maintenance force was available. Such a system has been designed, and was first used with the No. 5 crossbar office in Media, Pa. It has since been adapted for use with the panel system and with the No. 1 crossbar system, and should it be found desirable, it could be arranged for use with the step-by-step, community dial, crossbar tandem, and panel sender tandem systems.

In a trial of the transfer of alarms from a No. 1 crossbar office, it was found that a considerable amount of information was desirable, and twelve cable conductors were used. In addition, it was found that it should be possible to enable the transfer circuit from the receiving end whenever transfer had been neglected at the sending end. It should also be possible to determine whether the transfer had been enabled even if no alarm conditions existed, and to release locked-in temporary alarms so as to determine whether or not the trouble condition was of a continuing nature.

Another requirement was that any failure in the transfer circuit should not result in a no-alarm signal, or should not signal an alarm of less importance than that existing at the time. If the cable conductors were opened or grounded, for example, if a fuse blew, if a contact failed due to dirt, or if a wire were broken off, an alarm should be sounded, while if an alarm were being transmitted, it should be changed to a more important class if possible but never to a less important one.

These requirements were all met by an alarm sending and an alarm receiving circuit connected by only two interoffice conductors. Over these two conductors may be transferred as many as seventy different types of alarm conditions. At the sending end of the system, positive or negative 130-volt battery or open circuit may be applied to each of the two transfer leads under control of relays. At the receiving end of the system, each transfer lead connects to one side of the winding of a three-position polarized relay; the other side of each winding is grounded. Since each relay has three positions, there are nine combinations of positions for the relays taken together. These relays control a circuit which causes a specific lamp to light and an audible signal to sound for each of eight

*Record, *August*, 1949, *page* 294.

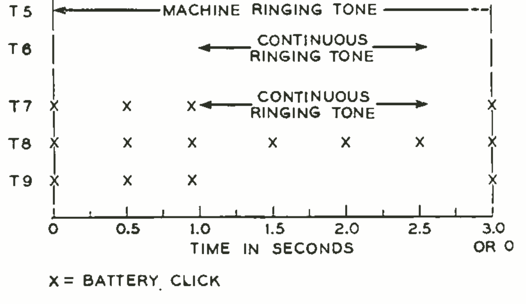


Fig. 1—Tone and click combinations

of the combinations. The ninth combination with no lamp or audible signal is used to indicate that the circuit is in good working order. One of the eight lamps and audible combinations is used to indicate a failure in the alarm circuit itself. This leaves seven indications to be associated with various types of trouble conditions that may arise in the particular office that is being supervised.

Besides these two relays, a telephone receiver is bridged across the circuit through a repeating coil, and at the sending end provisions are made for applying any of ten possible tone or click combinations, which may be superimposed on the d-c current through the transfer leads. These combinations are shown in Figure 1. For each of the seven alarm positions of the relays, therefore, there are ten possible tones. There are thus seventy possible trouble conditions that may be given in addition to the signals for transfer-circuit failure and for the all-clear condition.

A simplified schematic of this transfer arrangement is shown in Figure 2, where the relays are in the positions they assume when no alarms are being transferred. Relays FA, L, L1, and A are operated at the sending end, while at the receiving end polarized relay T is operated to its positive position and relay R to its negative position. Under these conditions, the d-c signal relays and the tone and click circuit are disabled, and thus alarms arising in the office are not transferred.

When the alarms are to be transferred to the distant point, the transfer key TR is operated, thus releasing the A relay. This supplies enabling battery to both the tone and d-c relay circuits and disables all audible alarms in the local office, but makes no other changes so long as there are no alarms to be transferred. Should a maintenance man now listen at the receiver at the maintenance center, he would hear a low tone, which in conjunction with the no-lamp condition would indicate that a transfer had been made, that the circuit was in good working condition, and that there were no alarms. When alarms occur, they operate relays in the d-c and tone sig-

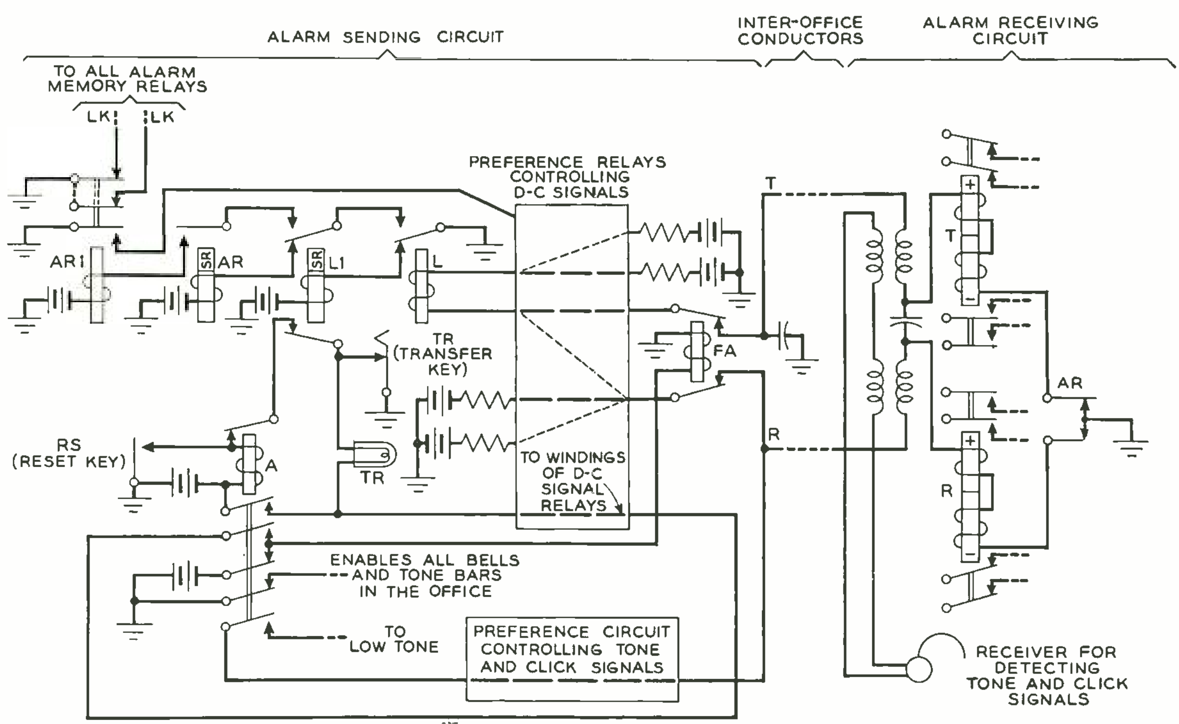


Fig. 2—Simplified sketch of the alarm sending and receiving circuits

LEAD	ALARM CONDITION								
	ALARM TRANSFER FAILURE	TROUBLE RECORDER SEIZURE		ALARM					NORMAL
		1 ST TRIAL	2 ND TRIAL	MAJOR POWER	MAJOR SWITCHING	PERMANENT SIGNAL	LOAD	MINOR	
T	OPEN	–	OPEN	–	OPEN	+	+	–	+
R	OPEN	OPEN	–	–	+	OPEN	+	+	–
	8	7	6	5	4	3	2	1	0

DECREASING SEVERITY ⟶

Fig. 3—D-c signal combinations

nal circuits to send the proper signals to indicate the type of trouble existing.

When the maintenance man returns to the unattended office, he releases key TR. This causes lamp TR to light. Then he momentarily operates the reset key RS. This operates relay A which locks itself in through the transfer key, extinguishes lamp TR, removes battery supply from the tone and d-c relay circuits, and enables the local audible alarms. The extinguishing of TR lamp is a check that relay A operated and remained locked after RS was released.

It is not sufficient, however, only to provide for sending the required alarms. Every possible contingency must be foreseen and provided for. One obvious one is that the maintenance man might neglect to operate the transfer key when he left the No. 5 office. Under such conditions, the transfer may be accomplished from the receiving circuit by operating the AR key at the extreme right of Figure 2. A maintenance man at this point would know that the transfer had not been made by absence of tone when he listened on the telephone receiver, and knowing from the schedule of nonattendance at the distant No. 5 office that transfer should have been accomplished, he would at once operate key AR. This opens the transfer circuit and thus releases relay L which in turn releases relay LI. The release of LI in turn releases relay A and thus effects the transfer.

When transfer has been accomplished in this manner from the receiving end, the TR lamp at the sending end will be lighted through a back contact of relay A and the TR key. When a maintenance man returns to the No. 5 office, therefore, this lighted TR lamp will show that transfer was made from the receiving end, and he will momentarily operate the RS key to reoperate relay A and thus enable the local alarms. When relay A operates, the TR lamp will be extinguished.

Key AR need be operated only momentarily, since once relay A has released, it will not be reoperated by closure of LI because normal connection to the winding of A is made through one of its front contacts. Once released, relay A can be reoperated only by operation of the reset key RS.

The primary function of key AR, however, is to open momentarily the locking paths for all memory relays—in this way determining whether some alarm received is of a temporary nature or whether it continues or recurs. Examples of the former are a trouble recorder seizure, momentary failure of the regular power service to the building, or an overload of the switching equipment such as may result from a flurry of calls in case of a fire in the neighborhood. The slow-release relays LI and AR in Figure 2 insure that the locking leads LK are not opened if relay L releases momentarily when the alarm signals change, and that these leads do not remain open continuously in case of a cable failure.

Since there is always the possibility of two or more alarms occurring simultaneously, and since only one alarm can be transferred at a time, it has been necessary to associate preference circuits in the tone and d-c signal circuits to select only one of possibly several alarms for transfer. Under such conditions, it is desirable to select the most important alarm, that is, one requiring the most prompt attention. The nine possible combinations of conditions that can occur on the transfer leads to the maintenance center are thus arranged in a preference sequence as shown in Figure 3, where the importance decreases from left to right. At the extreme right is the normal condition, indicating that the transfer circuit is normal and that no alarms are being transferred. At the extreme left, on the other hand, are the conditions that would exist if the power fuses on the alarm circuit had blown, or if the transfer leads were open. Since, under this condition, no alarms at all would be transferred, this is the worst condition possible. Between these two extremes are the seven conditions used for various classes of alarms.

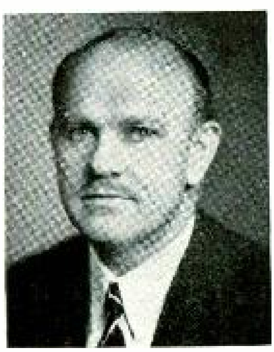
TABLE I—CHANGE IN ALARM GIVEN IF EITHER TRANSMITTING LEAD IS OPEN

	T	*R*
0	6	3
1	4	7
2	4	3
3	8	–
4	–	8
5	6	7
6	–	8
7	8	–
8	–	–

These seven alarm conditions have been so selected that should an open occur in either of the transfer leads, the resulting alarm indicated at the receiving office would be of a more serious nature than the alarm existing when the trouble occurred. This is shown in Table I. At the left are listed the various classes from zero to eight, corresponding to Figure 3. The next column to the right indicates the alarm class that would result were the tip lead opened, while the third column indicates the alarm that would result were the ring lead open. A dash indicates that no change occurs, since the battery signal has already been removed from that lead. It will be noticed that in all cases the importance of the alarm is either unchanged or increased, but is never decreased by the opening of the circuit. The absence of tone would give a clue if this trouble is caused by severance of a conductor. However, the trouble may be due to a dirty contact or a broken wire, in which case the tone may still be audible. A factor of safety resides in the fact that any alarm which is transmissible over one lead is severe enough, unless of short duration, to warrant dispatching a maintenance man to investigate its cause.

If while relay A is operated, a momentary break should occur that would release it, the transfer of alarms becomes enabled and the audible alarm devices in the building are disabled. This feature does not appear desirable at first glance but the alternative—to disable the transfer under a similar failure condition—would be dangerous, since the alarm signals would then not reach any maintenance people. The present arrangement insures that in case of such trouble, the alarms are transmitted

THE AUTHOR: C. E. GERMANTON was graduated magna cum laude from Lafayette College in 1926, receiving the B.S. degree in electrical engineering. He then joined the Technical Staff of these Laboratories where, as a member of the Systems Development Department, he has since been principally engaged in the development of panel and crossbar switching circuits. During World War II he contributed also to the design of the operational flight trainers, which were built by the Western Electric Company for the Navy. Since V-E Day he has been designing circuits for the No. 5 crossbar system.



to the distant point where maintenance personnel are always in attendance. In addition, the pilot lamps at the originating point will light, which, without the audibles, will be indication of an alarm sending circuit failure.

At the receiving end of the transfer arrangement, the lamp and audible signals remain locked-in, even if the received signal has been retired. If the signal should be changed before attention can be given, all lamps and audibles remain locked-in. In addition to the alarm release key already referred to, there is an audible cutoff key which, when operated, will silence the audible and extinguish the lamps unless an alarm signal is still in effect, in which case the corresponding lamp remains lighted. If the alarm signal is subsequently replaced by the normal signal, the lamp is extinguished and the circuit is again normal. If, however, the lamp signal is changed, the original lamp is extinguished, a new lamp lights, and the audible is sounded.

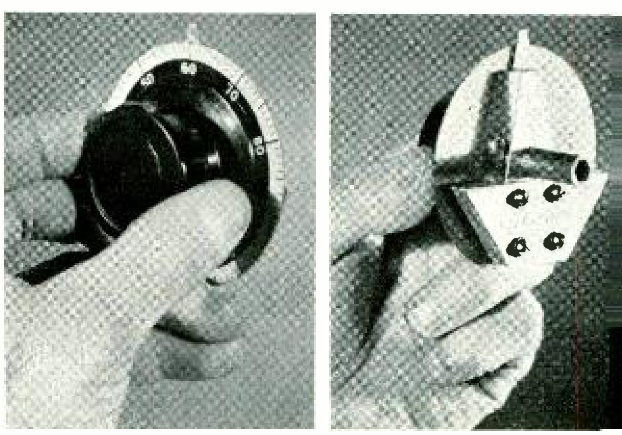
A portable dial for network adjustment

In the new 15-kc program channels,* it may be necessary at rare intervals to readjust a coil in a phase-shifting network of the modem unit. To avoid the expense of a graduated dial and index on each modem unit, and the greater likelihood of the adjustment's being changed by accidental movement of the dial, a portable self-indicating adjusting dial was developed by A. J. Wier and R. I. Game.

The coil of the modem unit is adjusted by turning its shaft, which is hexagonal at its outer end. The shaft on which the portable dial is mounted, evident in the illustration, has a hexagonal socket that fits over the shaft of the coil, and by slipping the dial shaft over the end of the coil shaft, the coil may be turned with the dial. Since there is no panel on which an index line could be marked to permit the exact position of the dial to be read, a self-adjusting index is provided on the dial itself. This consists of an index pointer—just above and behind the dial—that is free to turn in a slot in the dial shaft. A projection from the index below the shaft carries a relatively heavy counterweight that maintains the index pointer upward at all times. As the dial is turned, therefore, the index always remains upright, and the dial may be read beneath it.

The optimum setting of the coil to be adjusted differs somewhat for the two directions of transmission, but by setting the coil midway between the positions that give the best results for each direction, satisfactory operation is thus obtained for both directions.

When adjustment is required, therefore, either at the factory or in the field, the portable dial is slipped over the shaft of the coil, and with transmission in one direction, the dial is turned until optimum conditions are obtained. The reading under the index is then noted. Following this, the direction of transmission is reversed, and a second adjustment is made—the dial reading again being noted. The dial is then turned until the index is just midway between the two readings obtained, which is the optimum position for normal use. The scale on the dial, which runs from 0 to 100, is entirely arbitrary, and serves merely to permit the mid-point between two readings to be selected.



*Record, *July*, 1949, *page* 251.

A. L. MATTE
Telegraph Transmission

The 40AC1 carrier telegraph system

The great economies attainable on the longer hauls by carrier telegraphy, together with the operating advantages and improved transmission resulting from this method of operation, have led to its widespread use throughout the world. Although several carrier-telegraph systems have been incorporated in the Bell System plant, the 40C1 voice-frequency equipment is the most up to date and the most widely employed at the present time. This system was designed to meet the conditions generally encountered in the Bell System, and is particularly economical for large installations. It is not well adapted, however, to small installations in isolated locations where only a few channels are required and the battery facilities commonly present in Bell System offices are not available. The latter conditions are those that usually prevail with privately owned communication networks, such as those operated by the railroads.

Primarily to satisfy the rapidly growing needs for modern equipment of such outside customers of the Western Electric Company, a modified version of the 40C1 equipment, known as the 40AC1 system, was made available following the conclusion of World War II. A considerable number of these systems have since been purchased and placed in service with very satisfactory results.

Retaining the principal electrical features of the 40C1, the 40AC1 system is capable of substantially the same performance over similar facilities as far as signaling speed and high-quality transmission are concerned, and in addition is self-contained

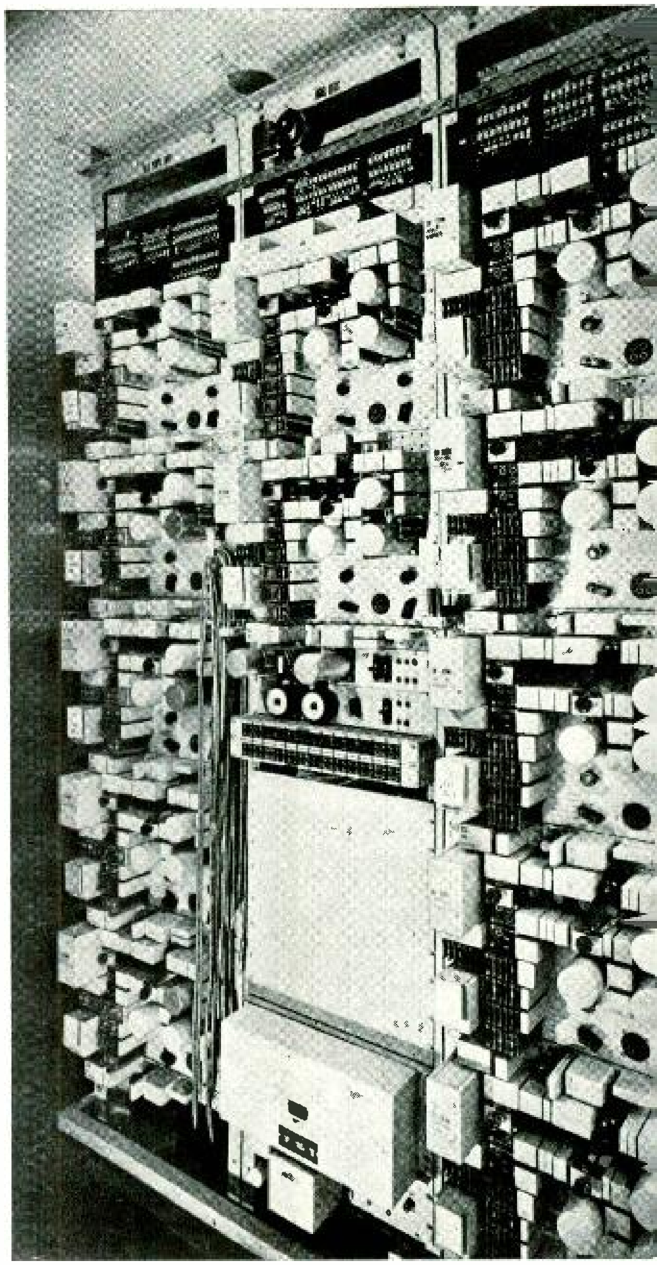


Fig. 1—A complete 40AC1 carrier telegraph terminal includes three bays of equipment

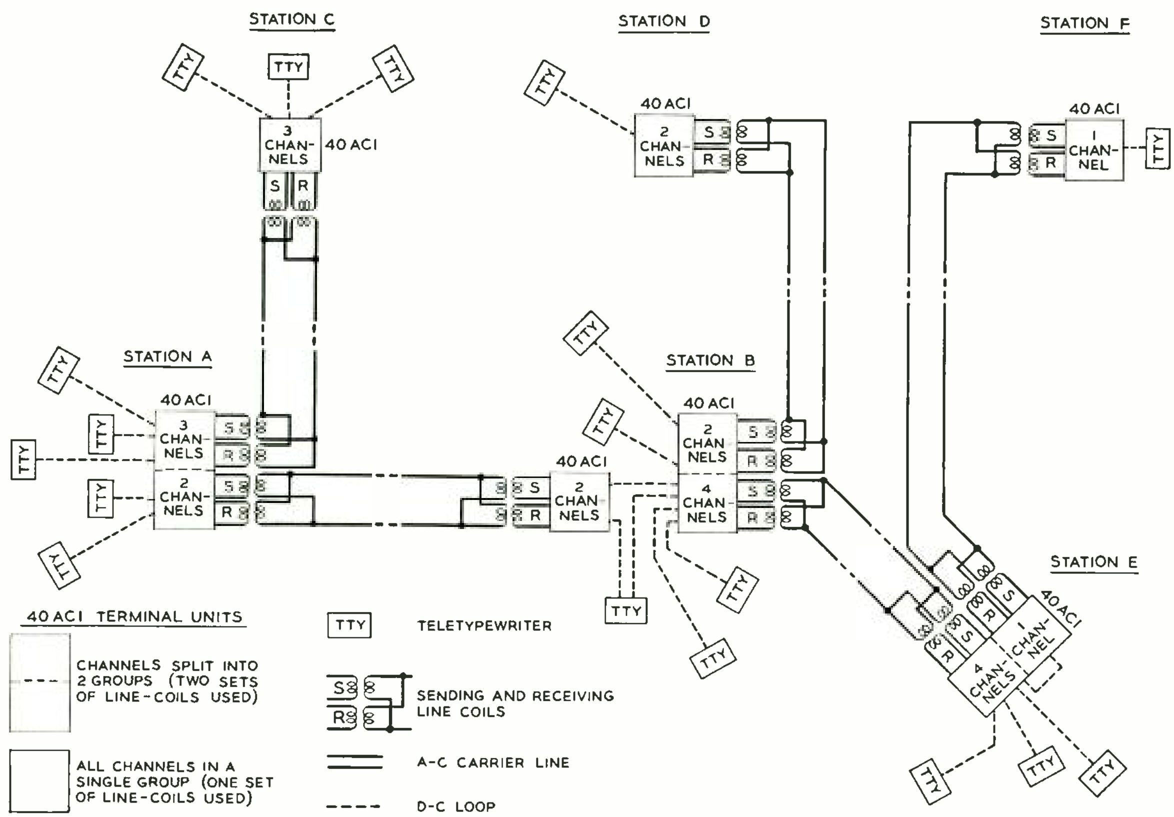


Fig. 2—Typical layout employing 40AC1 terminals

and more flexible in application. To make it adaptable to isolated locations, provision is made for its entire operation from commercial a-c power but, if preferred, the telegraph currents for the loops and even the plate current may be supplied from external d-c sources. Power to heat the vacuum tubes, however, must be derived from an a-c source. The testing equipment is an integral part of each system so that very little auxiliary equipment is needed.

A complete 40AC1 system provides from five to twelve full or half-duplex telegraph channels over circuits suitable for telephone transmission. The equipment is arranged, however, so that any number of channel terminals from one to twelve may be installed. If increasing traffic demands make it desirable, additional channels may be provided later merely by adding panels to existing bays or by adding new bays. A complete twelve-channel system includes an "originating" bay and two "supplementary" bays. The originating bay, which is always required, includes the common equipment, such as power supply, line coils, and jacks, plus the equipment for one or two channels. Each supplementary bay will mount up to five additional channels. Each channel terminal, complete except for the common equipment, consists of a fourteen-inch panel with a 1¾-inch oscillator panel beneath it, and thus may be added one or more at a time as needed. Standard nineteen-inch relay racks are employed; these are available in a number of heights, from eight feet eight inches to eleven feet six inches, to permit lining them up with any existing equipment. An originating and two supplementary bays of equipment are shown in Figure 1.

As in the 40C1 Bell System voice-frequency carrier telegraph system, the carriers are all multiples of 85 cycles and are spaced 170 cycles apart. Only twelve channel frequencies are used, extending from

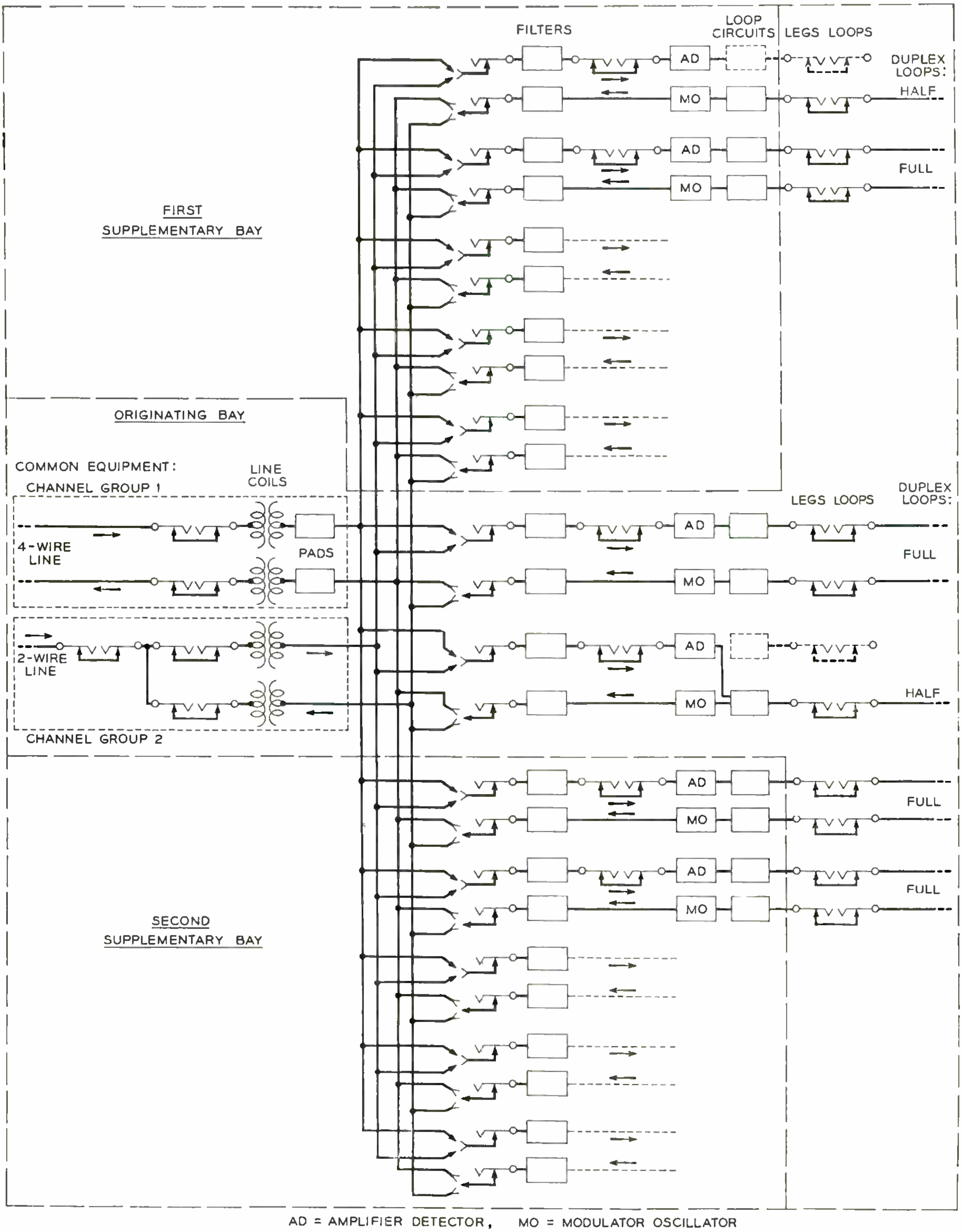


Fig. 3—Simplified diagram of the splitting arrangements of the 40AC1

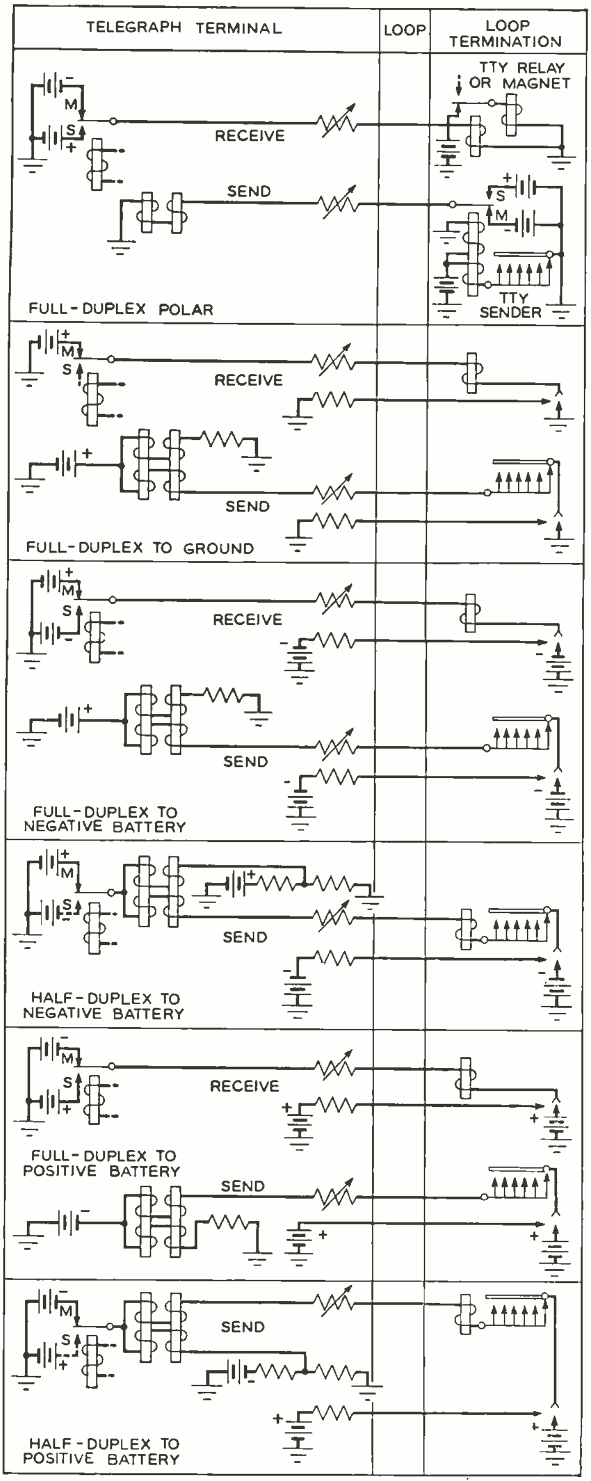


Fig. 4—The six possible loop connections that are possible with the 40AC1

425 to 2295 cycles, inclusive, which is six less than in the 40C1 system. Each channel terminal has its own carrier supply associated with it. For small installations, this is simpler and more economical than deriving all carriers from a common source, and the small deviations that may occur in the individual oscillators are not important for short hauls or point-to-point operation. Besides its oscillator, each channel includes sending and receiving filters, a sending relay that short circuits the oscillator during spacing intervals and permits carrier to flow over the line during marking intervals, a break relay used for half-duplex operation, and a receiving amplifier, detector, and receiving relay. The general circuit arrangement and method of operation has already been described in the Record.*

The equipment and wiring of the bays is arranged so that if desired the channels may be divided into two separate groups, each connected to a separate line. This permits a single 40AC1 system terminal to be used for telegraph communication with two different points over two different circuits. Where a large company, such as a railroad for example, is carrying on operations at a number of separated points, the optional splitting of a system terminal into two channel groups at any point in this manner permits a fairly complex telegraph intercommunicating system to be laid out with a minimum amount of equipment. Figure 2 illustrates the sort of system that may be constructed. Here 40AC1 systems, with different numbers of channels, are installed at six points, each with a number of d-c loops connecting to tributary stations. At A, the 40AC1 system consists of five channels arranged in two channel groups, which provide communication to stations B and C respectively. At B, there are two 40AC1 systems, one divided into two channel groups serving stations D and E, and one employing a single channel group of two channels connecting with station A. The two systems at B, however, may be connected together either directly or through a local teletypewriter, and thus station A may connect through B with station E as shown. By interconnecting one

*Record, *February,* 1948, *page* 58.

channel of each of the two groups at station E through their loops, through connection between A and F may be readily established.

Splitting into two channel groups is accomplished by bus bars and soldered connections as indicated in Figure 3, which also shows the distribution of the equipment on the originating and supplementary bays. Two separate lines entering through the line jacks located on the originating bay are connected to two buses, and the channels on the common and supplementary bays may be connected to either bus. There are thus no restrictions as far as the equipment is concerned as to which channels comprise each channel group.

Either four-wire or two-wire circuits may be used with the 40AC1 system, but not more than six two-way channels may be derived from a two-wire circuit. Four-wire circuits can handle twelve full or half-duplex channels. If repeatered, such circuits may be of any length, providing there is not more than about 25 db attenuation between vacuum-tube repeaters. Carrier-telegraph cable circuits of the latter type, when equipped with automatic attenuation regulators, have been operated successfully over more than 1500 miles. With open-wire lines, however, the length of the circuit is limited by noise and the regulation obtainable.

Any carrier-telephone system employing different carrier frequencies for the two directions of transmission is the equivalent of a four-wire circuit so far as telegraph transmission is concerned, and may thus serve as the line facility for a 40AC1 system. The Western Electric C* or, with minor modifications, H1† carrier systems, already in use by railroads, may thus be utilized. With an H1 system, however, certain restrictions must be observed. Operation over circuits incorporating more than three H1 line repeaters in tandem is not recommended, and because of the high attenuation of the H1 system at low frequencies, the 425-cycle channel should not be used. Only eleven channels are thus available over an H1 system under the most favorable circumstances, and if more than one repeater is used, or if the net loss is high, it is preferable to use different carrier telegraph frequencies for the two directions of transmission, thus permitting the operation of only five duplex channels.

With two-wire circuits, it is always necessary to use different frequencies for the two directions of transmission, hence,

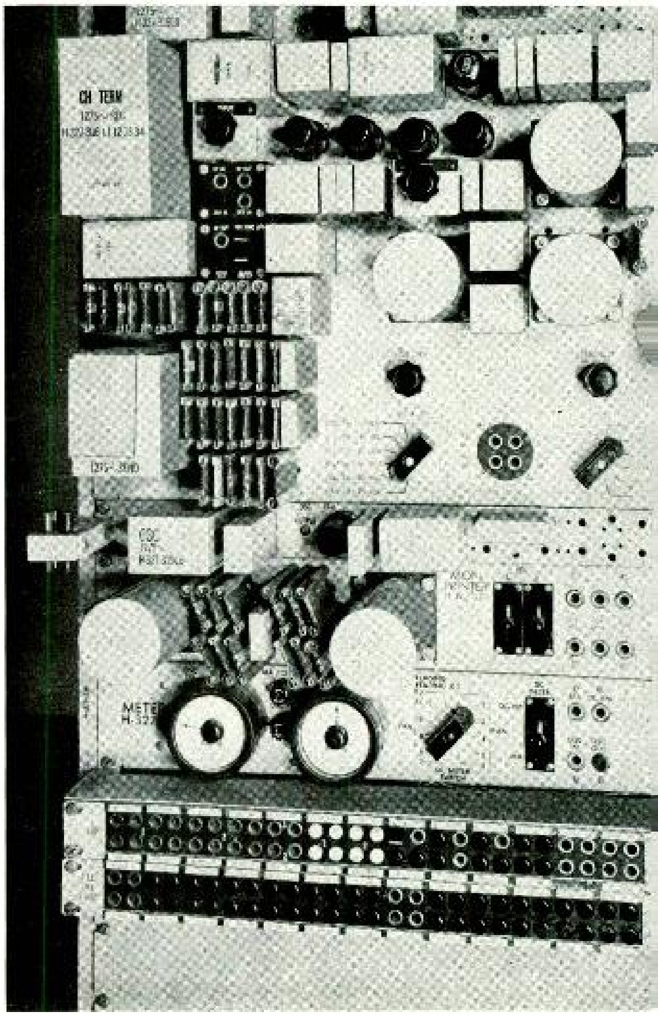


Fig. 5—One channel terminal with its oscillator and common monitoring and testing equipment

as noted above, only six duplex channels may be used. Furthermore, operation of such circuits is not recommended where more than two repeaters are required.

Because of the wide variety of conditions existing where the 40AC1 system may be

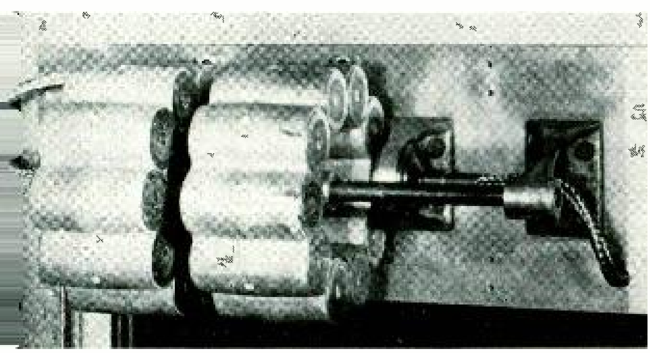
*RECORD, *February*, 1938, *page* 208.
†RECORD, *November*, 1937, *page* 76, and *November*, 1938, *page* 220.

THE AUTHOR: A. L. MATTE graduated from M.I.T. with the B.S. degree in 1909 and returned in 1912 to take graduate work during the winter of 1912 and 1913. In 1918, after five years with the Detroit United Railways, he joined the D & R of the A T & T—transferring to the Laboratories with the department in 1934. He has been chiefly concerned with the transmission aspects of telephone signaling systems, with carrier telegraph, with double modulation methods for increasing the frequency range of carrier telegraph in cables, with the coördination of the transmission characteristics of telephone and telegraph systems superimposed on the same circuit, and with laboratory and field testing and maintenance methods.

used, provisions are made for connecting to six different types of d-c loops. Correct operation for any of these types is secured by merely operating a six-way dial associated with each channel. The six possible loop connections are shown in Figure 4. Sixty milliamperes is the normal loop current, but the permissible length of loop depends on the type of conductors, the quality of maintenance, and the method of operation. In general, a distance of five miles should easily be obtainable with satisfactory results.

A rectifier is mounted on the originating bay to provide plate current. The heater current for all the vacuum tubes is supplied from a transformer. If desired, the terminals may also be equipped with one or two additional rectifiers to supply current for operating the loops. These rectifiers operate from either 115 or 230-volt circuits, 50 or 60 cycles and the d-c voltages are closely regulated.

Also on the originating bay are testing facilities capable of serving all the channels of one system, which may be seen in Figure 5. This equipment may be connected to any channel merely by turning a dial switch. Tests may be made on the individual channel equipment—other than the filters—without disturbing service on the other channels.



One of the coaxial attenuators developed by A. G. Jensen and patented during the early work on the coaxial system. Such attenuators found limited use at that time, since, except for very high frequencies, other forms were adequate and easier to build. Above 10 megacycles, however, they have become indispensable, and for the very high frequency communication system developed during and since the war, coaxial attenuators are now essential tools. The construction of these more modern attenuators was described in the RECORD *for June*

Radioactivity provides new tool for Laboratories' chemists

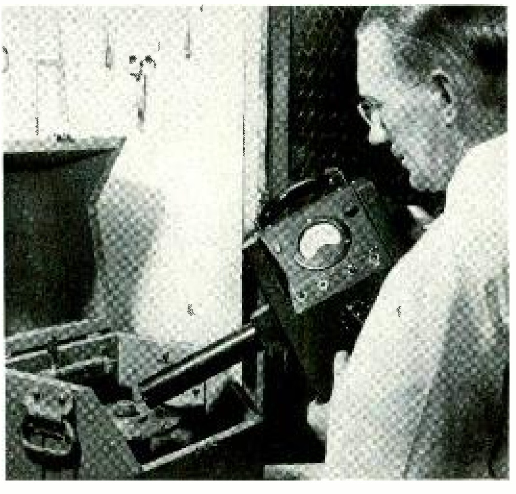
Bombarded by neutrons, the atomic nuclei of many normally stable chemical elements become unstable and give off radiation which may continue for years. For chemical purposes, these "radioactive isotopes" of an element behave exactly like the original element and have the advantage that they can be detected in minute amounts beyond the reach of ordinary chemical methods.

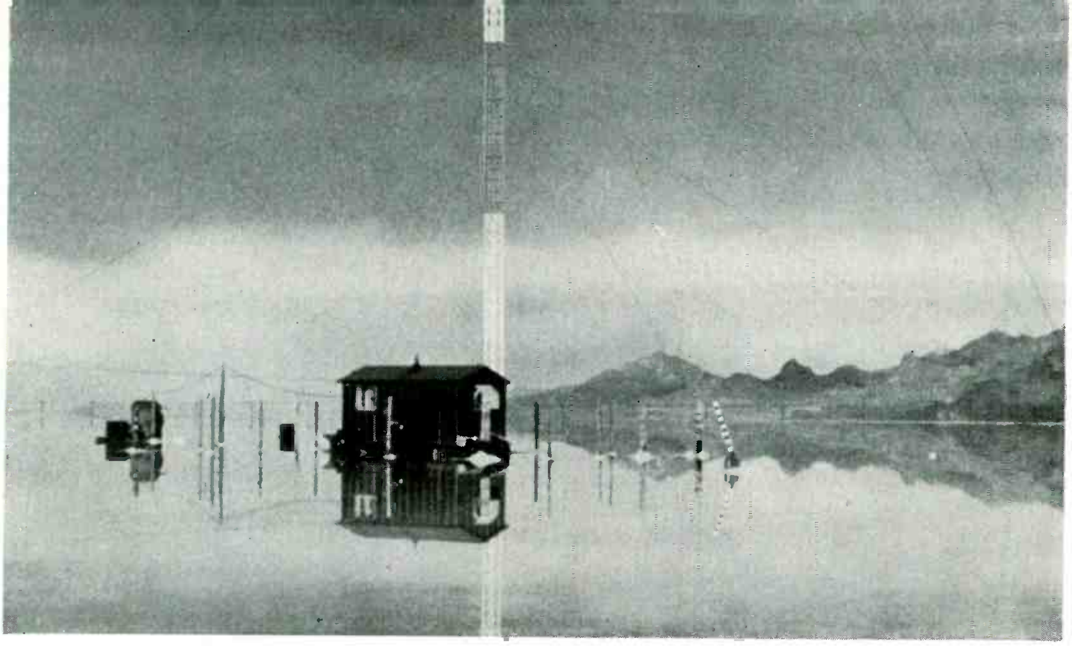
In medicine, radioactive isotopes are being used to trace the migration of chemicals through the human body. At the Murray Hill laboratory they are providing a highly sensitive means for tracing impurities in telephone materials.

The radioactive tracer technique is used to study impurity distribution in germanium ingots for Transistors. For example, radioactive antimony is melted with germanium to form an ingot which is then cut into slices about 100 mils thick. Registering intensity of radiation, a Geiger counter reveals the concentration of antimony in each slice, as little as one part in 100,000,000. Results help guide the production of chemically uniform germanium for Transistors.

J. D. Struthers is shown on the cover of this issue as he prepares a solution containing radioactive isotopes to be used in the study of telephone materials. He is aided by a mirror and protected by lead bricks.

Left—A Geiger counter reveals intensity of radiation of radioactive sample before its removal from the packing box and so the degree of care which must be exercised in handling. Right—J. D. Struthers removes an aluminum cylinder containing radioactive antimony from the lead box in which it was shipped from the Oak Ridge atomic energy plant where the antimony was rendered radioactive through several weeks of exposure in an atomic pile. For safety, the material is housed in the lead cylinder in foreground or handled with tongs behind a lead barrier





Microwave Propagation Tests

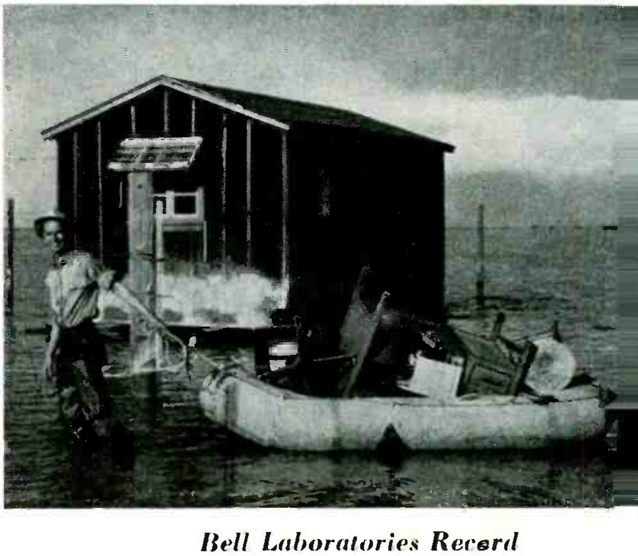
R. P. Booth, Transmission Engineering

In connection with the rapid expansion of radio relay systems, measurements of the transmission behavior of the centimeter waves involved have been made by the Laboratories and Associated Companies in a number of parts of the country under a wide range of terrain and atmospheric conditions. Laboratories' effort for the past year or so has been concentrated on studying transmission over flat terrain in locations which differ in the degree of smoothness and amount of vegetation.

During the period from June through December of 1948, continuous recordings of fading were made in Ohio on two paths which will be adjacent repeater sections on the New York-Chicago TD-2 system now under construction. This terrain consists of relatively flat farming country, with scattered trees in wood lots and along section roads. Beginning in August, 1948, and still continuing, similar measurements of fading have been in progress on the Bonneville Salt Flats of western Utah, over the extremely smooth and vegetationless terrain famous for its use as a track for setting motorcycle speed records.

The tests in the latter area have been of particular interest for several reasons. First, as in pioneering days, the Great Salt Lake Desert offers inducements as a short cut in a transcontinental route, and it is important to obtain reliable data on transmission variations to be expected in an area noted for climatic conditions which produce fantastic images at optical frequencies. Secondly, the location presents the smoothest large area of barren land surface in the United States, and is ideal for use in making measurements to check the theories of reflection and diffraction in the microwave range of frequencies. Thirdly, the continuation of the tests throughout the 1948-49 blizzards, in an area contiguous to that where snowbound herds of sheep and steers were fed by the well-publicized "Operation

Taking furniture in a rubber boat across the flooded Salt Flats to the test station at Bonneville. This station and the mast for the "dish" antenna is shown in the photograph at the top of the page

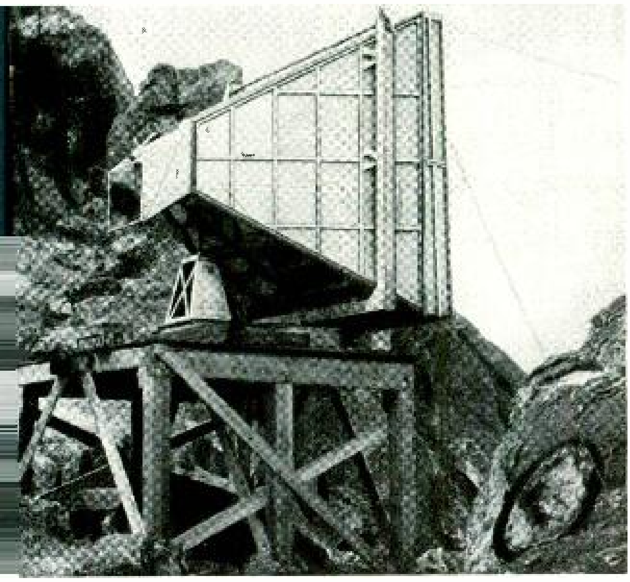


Haylift," has provided some Laboratories and Long Lines personnel with an adventurous experience in maintaining operations under extremely trying conditions (to put it mildly!).

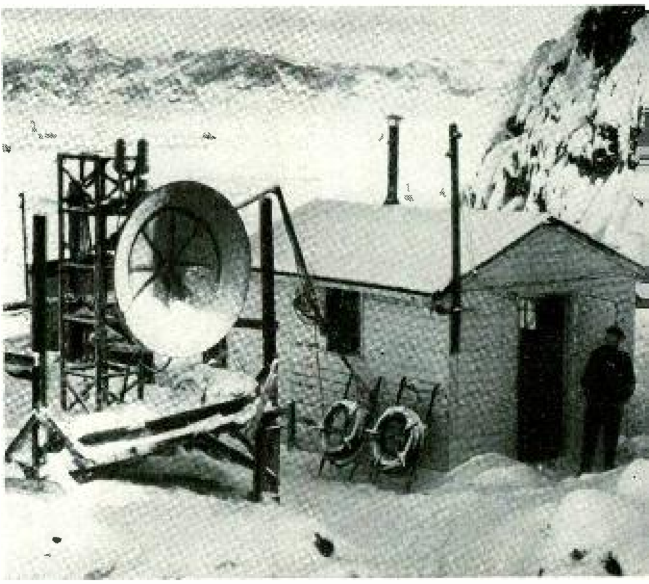
The radio equipment used in the measurements is the X-64607 path testing equipment,* modified to incorporate features for continuously recording variations in received signal day in and day out, month after month. These data have been of great assistance in evaluating the transmission paths across such terrain and in devising means for providing satisfactory performance.

In this desolate area, commercial power is not available, and it is necessary to supply power for the measuring equipment and tower lighting by means of gasoline engine generators at the various station sites. The desert surface at one of these locations is of fine silt underlaid by water and until a road was completed recently could not support even a light vehicle. Last summer it was necessary to roll numerous 55-gallon drums of gasoline across a third of a mile of slippery mud in order to supply fuel to the engine generator. During the winter snows, a sled was improvised to drag in supplies from the highway. The site on the side of a mountain just west of Wendover, Utah, is reached over a winding trail about a half a mile long. Fortunately, a highway construction gang used a nearby location for caching its dynamite supplies, so that this particular trail was kept plowed after a fashion during the winter. Nevertheless, the Laboratories' station wagon suffered at least one burned-out clutch bucking snowdrifts, and shovels were in order several times each day during routine station visits.

The Laboratories personnel who made the Ohio tests were H. C. Franke and R. L. Kaylor, assisted part of the time by 1948 summer student employees L. G. Abraham, Jr., and D. P. Kelly. Those involved initially in the Utah tests were G. H. Baker and H. G. Fisher in the late summer and fall of 1948. Those who held the fort there during the past "unusually severe" winter were G. H. Baker and D. K. Martin, and they have been joined recently by W. Strack, Jr. In both the Ohio and Utah tests, the Long Lines Department coöperated in site preparation, station maintenance, and personnel phases of the work.



The horn in place at Wendover



Wendover station in winter

Tests during the summer and fall of 1949 are being conducted over new paths in the Platte River valley in Nebraska, and in the sagebrush country of Nevada, in addition to the tests which continue on the Salt Flats. H. C. Franke is at the Nebraska location and R. L. Kaylor is in Nevada.

Organization Changes

E. G. Hilyard, who is absent because of illness, will upon his return to the Laboratories act as Consulting Engineer.

Effective August 8, C. Breen became Switching Maintenance Engineer in charge of Department 3130, succeeding Mr. Hilyard.

*Record, *January*, 1948, *page* 6.

Communications Training Program

The completion of the first academic year of Communications Development Training for thirty-five young engineers was marked by a dinner on June 29 at Murray Hill during which M. J. Kelly gave a talk on the School, outlining its objectives and the purpose of this integrated training program. After a brief talk by P. W. Blye representing the Program Committee, a number of the students, on invitation from Dr. Kelly, expressed their views of the program.

With the opening of the third semester of the School on September 6, the majority of the students will continue to take the complete training program. A small percentage of the original group together with other members of the Laboratories will take selected studies. Meanwhile, a new group of young engineers recruited this year will enter the School's first semester.

This semester's work includes: Probability and Statistics; Electronic Circuits; Fundamentals of Switching; Fundamental Circuit Theory; and Fundamentals of Television.

General view of the dinner-meeting held at Murray Hill at the completion of the first academic year of the Communications Development Training. In addition to the thirty-five students, there were present at the dinner M. J. Kelly, A. B. Clark, J. W. McRae, W. H. Martin, R. Bown, H. H. Lowry, F. D. Leamer, R. E. Poole, representing D. A. Quarles, R. K. Honaman, M. Sultzer, E. J. Thielen, and the Program Committee, P. W. Blye, A. G. Ganz, T. C. Henneberger, S. B. Ingram, John Meszar and F. F. Romanow

K. S. McHugh Elected President of New York Company

Carl Whitmore, who has been President of the New York Telephone Company for the past five years, has been elected Chairman of the Board of that company. Many Laboratories people will recall his active interest in the telephone exhibit at the New York World's Fair, which occurred during his vice-presidency in charge of the Long Island Area.

Keith S. McHugh, a vice-president of A T & T since 1938, has been elected President of the New York Company to succeed Mr. Whitmore. Mr. McHugh has been a member of our Board of Directors.

Institute of Radio Engineers

Members of the Laboratories who are serving on the *Board of Directors* of the I.R.E. are R. A. Heising and J. W. McRae. Serving on general committees are: *Board of Editors,* Ralph Bown, F. B. Llewellyn, J. W. McRae, L. A. Meacham, E. L. Nelson, W. C. Tinus, E. K. Van Tassel and E. C. Wente; *Awards,* J. W. McRae; *Education,* F. R. Stansel; *Con-*

A conference group of Laboratories, Western Electric and Government officials during a recent visit to the Sandia Laboratory of the Atomic Energy Commission near Albuquerque. Left to right: M. J. Kelly, G. A. Landry, Bennett Boskey, Brig. Gen. James McCormack, Jr., Col. R. T. Coiner, Jr., D. A. Quarles, Stanley Bracken, P. J. Larsen, F. R. Lack, Richard Smith and Rear Admiral G. P. Kraker (retired)

stitution and Laws, Professional Groups, and *Sections,* R. A. Heising; *Policy Development,* R. A. Heising and F. B. Llewellyn; *Nominations,* Ralph Bown; *Membership,* and *Finance,* F. B. Llewellyn; *Papers Review,* H. A. Affel, P. H. Betts, R. L. Dietzold, W. M. Goodall, F. W. Cunningham, A. R. D'heedene, J. G. Kreer, Jr., G. G. Muller, J. R. Nelson, A. F. Pomeroy and W. T. Wintringham; *Papers Procurement,* W. P. Mason, Pierre Mertz and W. E. Reichle; and *Editorial Administrative,* F. B. Llewellyn and H. S. Black.

Members on technical committees include: *Antennas and Wave Guides,* A. G. Fox, vice-chairman, W. E. Kock, S. A. Schelkunoff and J. C. Schelleng; *Audio Techniques,* R. A. Miller; *Circuits,* A. R. D'heedene and R. L. Dietzold and E. H. Perkins; *Electroacoustics,* Eginhard Dietze; *Electron Tubes and Solid State Devices,* C. E. Fay, S. B. Ingram, J. A. Morton and R. M. Ryder; *Facsimile,* Pierre Mertz; *Modulation Systems,* H. S. Black, chairman, J. G. Kreer, Jr., and L. A. Meacham; *Piezoelectric Crystals,* R. A. Sykes, vice-chairman, W. L. Bond and W. P. Mason; *Radio Transmitters,* A. E. Kerwein, vice-chairman; *Research,* Ralph Bown; *Standards,* A. G. Jensen, vice-chairman, H. S. Black and A. F. Pomeroy; *Symbols,* A. F. Pomeroy, chairman; *Television Systems,* A. G. Jensen, chairman, and M. W. Baldwin, Jr.; *Video Techniques,* A. G. Jensen and L. W. Morrison, Jr.; and *Wave Propagation,* A. B. Crawford and A. G. Fox.

Laboratories' members who are I.R.E. representatives on other bodies include: F. B. Llewellyn, *A.S.A. Electrical Standards Committee, Division of Engineering and Research of the National Research Council,* and *U. S. National Committee of the International Electrotechnical Commission;* A. G. Jensen, *A.S.A. Sectional Committee on Definitions of Electrical Terms;* J. C. Schelleng, *A.S.A. Subcommittee on Communications;* C. E. Fay, *A.S.A. Sectional Committee on Standardization of Electron Tubes;* S. A. Schelkunoff, *A.S.A. Sectional Committee on Electric and Magnetic Magnitudes and Units;* Eginhard Dietze, *A.S.A. Sectional Committee on Acoustical Measurements and Terminology;* and A. G. Jensen and J. C. Schelleng, *Joint I.R.E. and A.S.A. Definitions Coördinating Committee.*

First Commercial TE-2 Microwave System

A TE-2 radio system was placed in commercial operation on June 30 when The Bell Telephone Company of Pennsylvania initiated service from Philadelphia to Station WDEL-TV in Wilmington. This was the first commercial application of TE-2 equipment. The network connection originates at the Long Lines 900 Race Street coaxial terminal whence a 4,000-foot polyethylene pair circuit feeds the TE-2 transmitter atop the Pennsylvania Company's building at 17th and Arch Sts. The TE-2 receiver antenna 22 miles away is located at the 230-foot point on the broadcaster's tower outside Wilmington. Waveguide and coaxial cable are employed between the receiver antenna and radio frequency unit, the latter located in a building at the tower base.

BELL LABORATORIES CLUB REPRESENTATIVES

F. L. LANGHAMMER, JR. W. H. THATCHER, JR.

Representatives at Whippany

FRANK L. LANGHAMMER, JR., was graduated from Massachusetts Institute of Technology in 1941 and joined the Whippany Radio Laboratory later the same year. During the war he engaged in radar design and development, and since then has been concerned with mechanical design in connection with military projects. The Langhammers, originally New Englanders, now live in Morristown with Frank, III, who is five years old.

WILLARD H. THATCHER, JR., has long been active in Club activities, particularly bridge, bowling, softball and the Glee Club. He also sings with a quartet, *The Four Notes*, three of whom are Laboratories' members. Mr. Thatcher, who is a member of Military Electronics Department, lives in Florham Park with his family, including two daughters, Bobbie and Jackie.

ALFRED ZITZMANN is a supervisor in Systems Drafting at Graybar-Varick. Mr. Zitzmann was engaged by architects before he joined the Laboratories twenty-seven years ago. He is the father of twin daughters on the New York Area Staff. They have recently returned from the Poconos, where dad and mother vacationed at a house to their liking, and the twins, Shirley and Frances, at a livelier hotel for young people. Mr. Zitzmann's chief interests are bowling and bridge. He is past chairman of Bell Laboratories Bridge Club.

SAMUEL D. WHITE is a resident of Stelton, New Jersey, where he has just completed a term as president of the Stelton Improvement League. He also serves on the township's Educational Council, his interest being enhanced by the fact that his own youngsters, Robert, thirteen, and Marjorie, ten, attend the local schools. Mr. White, who was graduated from Rutgers University and came to the Laboratories directly in 1927, does design and development work in Switching Apparatus. With his family, he spent his vacation cruising from Maine to Perth Amboy on a friend's sailboat, stopping off at historical spots along the way, particularly around Cape Cod.

ALFRED ZITZMANN S. D. WHITE T. J. GRIESER E. A. PERPALL

Representatives in New York

J. G. WHYTOCK J. J. HARLEY G. H. REUBLE

Representatives at Murray Hill

THEODORE J. GRIESER has been a member of the Laboratories since 1930, the year he was graduated from the University of Idaho. His early work was on trial installations, and later the No. 1 crossbar. Since 1941 he has been in the microwave radio field and now in the transmission group supervises a phase of this work. Mr. Grieser's Club interests are table tennis and horseshoes; his outside interests salt water fishing. His home is in Mountainside, New Jersey, and he's the father of three growing girls, Carol, fifteen; Elaine, twelve; and Mildred, nine.

EDWARD A. PERPALL has had a more varied career than most since coming to the Laboratories. He has been a member of the Shops, Plant and Financial Departments and is now a Payroll Supervisor in General Accounting, where he administers for Benefit Plan, overtime, and night bonus payments. Mr. Perpall was graduated from Pace Institute. A Long Islander, his hobby is surf casting, striped bass being his specialty. He also likes to work around his home in Lindenhurst where his family of four children, two boys and two girls, gives him a lively time of it.

GEORGE H. REUBLE is Club Representative at Murray Hill for a second year. He was raised in Summit, attended its schools, still lives in the town and now has two daughters in school there. Mr. Reuble, a member of the Commercial and Service Staff group, renders general order service for sections 1A and 1B of Building I. He's happiest when he is working with mechanical or electrical gadgets, and is currently building furniture for his two little daughters.

JOHN G. WHYTOCK came to America by way of Australia from his birthplace in Scotland. He was fourteen when he landed in New York, where he attended high school, Cooper Union and Columbia. He came to the Laboratories by way of Western Electric, which he joined twenty-seven years ago, and is now engaged in the mechanical design of thermistors and varistors. Primarily a Long Islander, though he now lives in Chatham, New Jersey, Mr. Whytock is very much interested in salt water fishing, golf and bridge. The Whytocks have two daughters, Barbara, training at the Presbyterian Hospital, and Christina of grammar school age.

JOSEPH J. HARLEY, vice-president of the American Cinema League, is well known at the Laboratories for his movie making skills. However, he has another avocation even closer to his heart, camping and fishing at lower Saranac Lake, where since 1930 he has maintained, in an idyllic setting on Bluff Island, a camp site having outdoor sleeping facilities and a huge dining frame for the use of his family and guests. The Harleys can accommodate twelve comfortably, but week-ends have doubled and nearly trebled the number.

Seein' Things

Not a few of the Laboratories' video enthusiasts were startled one evening in July to see a model airplane, with recognizable Bell Laboratories' markings. It was being used by Arthur Godfrey during his program. They actually did see an authentic small scale reproduction of the tri-motored Ford used by the Laboratories back in the thirties.

It had happened that A. R. Brooks, who supervised the air group of the Hadley Airport field station, came by the replica which was eventually presented for display among models of all types of planes at the New York headquarters of the Institute of the Aeronautical Sciences. When Godfrey's story of air travel development lately called for a Ford tri-motor, the Bell Laboratories model was borrowed for the act.

RETIREMENTS

W. R. LUTHER R. M. SAMPLE

Recent retirements from the Laboratories include W. R. Luther with 44 years of service; R. M. Sample, 35 years; O. J. Finch, 33 years; John Kielin, 27 years; Frank McGlynn, 20 years; and W. J. Carey, 19 years.

WALTER R. LUTHER

Compared with motors and furnaces, telephone circuits consume little power, but an adequate power plant must be set up in each telephone building. To determine capacity, equipment men add up the "current drain" of each circuit, which brings them to W. R. Luther. For twenty-seven years, Mr. Luther has been making this kind of study of every new or revised circuit until now his first-glance guess is surprisingly close to his final estimate. Moreover, he has simplified the technique so that the group he joined in 1922 finally consisted only of himself.

Mr. Luther joined Western Electric at Clinton Street in 1902, then transferred to the telephone company as a student, installer and trouble shooter in Chicago. Later he had a similar job with the New York Company and meanwhile went to night school. In 1910 he transferred to Western Electric Installation Department and in 1914 was assigned to wiring and circuit laboratory work on dial systems at West Street. In 1919 he became a development engineer, and in 1922 took up his study of "current drain."

Retirement, Mr. Luther expects, will give him more time for his hobby—gardening around his house in Hempstead.

RALPH M. SAMPLE

In 1914, the telephone dial was an active problem of the Laboratories because of the imminence of dial systems. Ralph Sample's first job was drafting on the first dial to be designed here. Then—in 1916—he enlisted in the Engineers for the Mexican Border affair, during which he had charge of photographic work on the Army's first photo-reconnaissance job, done from high towers. Overseas from 1917 to 1919, he continued with photography and worked on engineering supplies.

After his return, Mr. Sample was for a time engaged in early crossbar switch development, then was in a panel dial laboratory and worked on coin collectors. During the Bell System's demonstration of television—at the Coolidge inauguration in 1925—Mr. Sample was one of the Washington group.

By that time, additional staff was needed in F. F. Lucas' microscopic laboratory. Mr. Sample was selected, and his next twenty years were full of accomplishment. His skill as a manipulator and his feeling for mechanical design were of great help. He assisted Dr. Lucas in formulating the requirements for an ultra-violet microscope to be built abroad, later set it up and operated it for many years on a great variety of telephone problems.

During the war, Mr. Sample worked on one of the atomic bomb problems which the Laboratories undertook for Columbia University. Since 1945 he has been a member of the Chemical Laboratory's microscopic service group, working on tungsten filaments, inspection of brazed joints, insulating materials, fatigue and creep of lead cable sheathing.

In retirement, which is at his own request, Mr. Sample will work in his own microscopic laboratory, and will collaborate with his sons in the manufacture of diamond cutting tools.

OSCAR J. FINCH

After the first Bell System patent application was filed for a magnetic alloy of nickel and iron, O. J. Finch supervised the melting, casting, rolling and heat treating of hundreds of specimens, containing varying proportions of the two metals. In the years to follow

JOHN KIELIN O. J. FINCH

he had charge of the processing of thousands of alloys of these and other metals. In fact, since his early days on iron dust cores for loading coils—that was in 1916—he has played an active part in the Laboratories' unfolding drama of magnetic materials—a drama which has produced such famous names as permalloy, permendur and vicalloy.

Graduating from University of Minnesota in 1906, Mr. Finch worked on the test floors of electrical manufacturers and for a power company. Since he liked to handle what he worked with, he was happiest in a laboratory, and on joining us he was assigned to the then "Physical Laboratory," on mercury arc rectifiers. Soon he shifted to loading coils and later to the processing of alloys. For some years he has been in direct charge of the group which melts and fabricates new alloys.

W. J. Carey and Frank McGlynn, formerly utility men in Building Service at West Street, have retired to their native County Donegal, Eire, the one to Ballyharry, the other to Ballyboffey

Mr. Finch claimed "commuting" as a hobby; he preached it vigorously for several years on the Brooklyn-Murray Hill route.

John Kielin

If you've ever wondered who keeps the Club Lounge and the Medical Department so clean, here's your answer—John Kielin. After twenty-seven years as a night cleaner, Mr. Kielin retired at the end of August.

Reporting for work at six o'clock, Mr. Kielin would get his box, truck, pails, mops, etc., in Basement B and go to 5H where he first emptied all waste baskets. Then he scattered sweeping compound, and swept it across all linoleum into his dust pan. Carpets or rugs got a vacuum cleaning. He dusted the desks, window sills and chairs, and then went over the floor area with a damp mop. Finally he mopped the washrooms with a detergent solution. After 5H came 4H and 1H, and by 2:30 a.m., his work finished, he started for home. That must be a happy place for there he expects to spend some of his retirement—helping Mrs. Kielin with the cleaning!

Television Engineers Visit Murray Hill

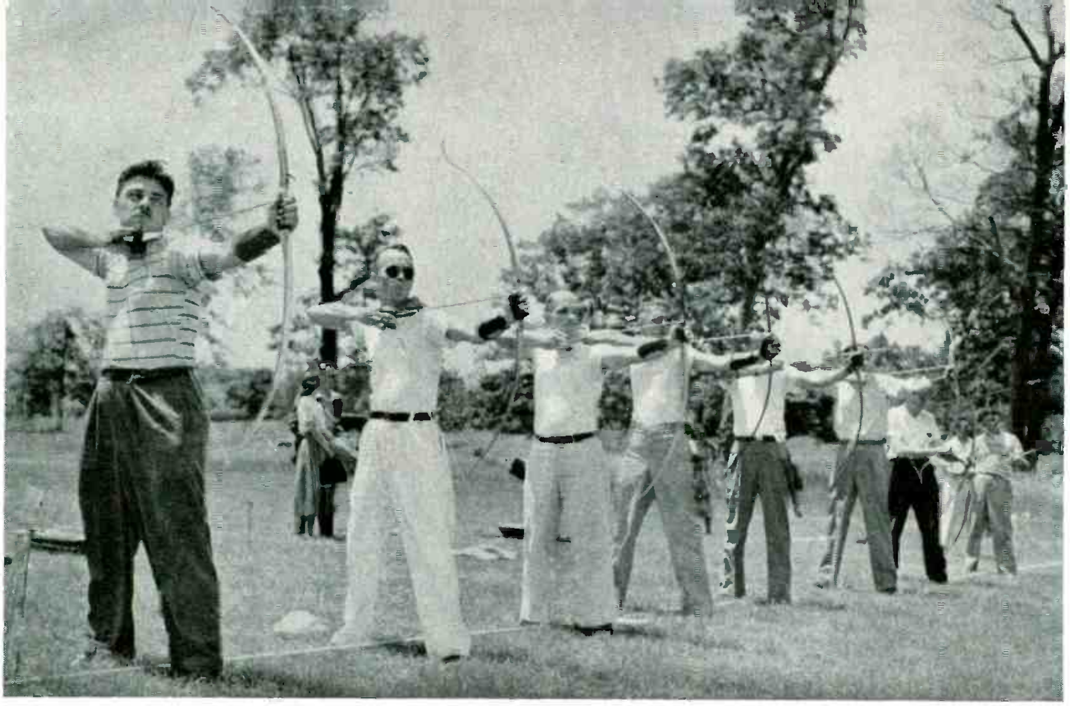
Twenty-five television engineers, members of the Television Systems Committee of the Radio Manufacturers Association, recently visited the Murray Hill Laboratory at the invitation of A. G. Jensen, P. Mertz and W. T. Wintringham. Most of the morning was spent at a business session in the Arnold Auditorium and after a tour of the laboratories, the group assembled for lunch, where they were joined by Ralph Bown and the department heads of the Research Department. After lunch, Dr. Bown gave a brief talk on the Bell System's interest in television and on the Laboratories' work on the fundamental problems underlying satisfactory transmission of television signals. The afternoon was spent with members of the Television Research Department, where the group inspected a television film scanner, a four-color optical projector, a photoelectric lens bench, and other special equipment presently being used in our television research work. W. M. Goodall of the Radio Research Department gave a demonstration of television by pulse code modulation. The day ended with a general discussion of some of the problems common to the Laboratories and the television industry as a whole.

Legion Post Summer Dance

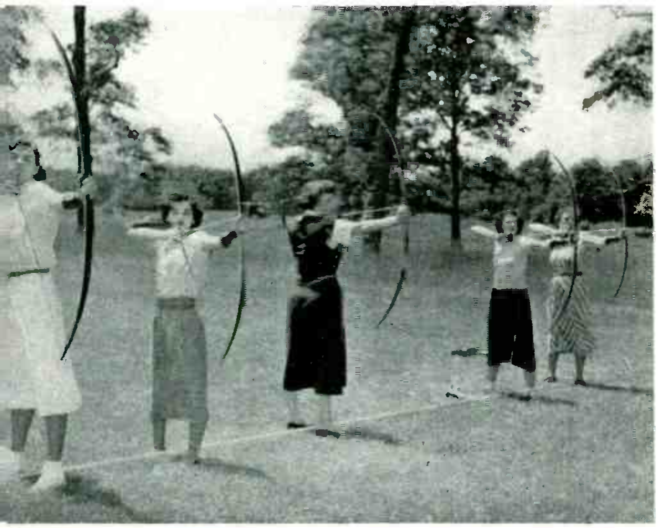
Three hundred guests, many of them Laboratories' members and their families, attended the summer dance sponsored by the Laboratories Hospital Visiting Committee of the Bell Telephone Post No. 497 of the American Legion. The dance was held in the garden of Dee Old Homestead in Brooklyn.

Dr. Shull Speaks at Murray Hill

Dr. Clifford G. Shull of the Physics Division, Oak Ridge National Laboratory, visited Murray Hill on July 29 and spoke in the Arnold Auditorium on *Studies of Neutron Diffraction.* He reviewed some of the general principles of the subject and then took up some of the applications. These included (a) applications to nuclear physics studies, (b) neutron diffraction as a supplement to X-ray and electron diffraction in crystallographic studies, and (c) the studies of the various paramagnetic and antiferromagnetic structures.



ARCHERY TOURNAMENT AT MURRAY HILL



Championship meet at Murray Hill of teams from that location, Whippany and New York. Winners of the tournament were Alice Jastram, first, Herma Procopiadi, second, and Helen Cruger, third, in the women's group; and W. J. Cernik, first, H. A. Bredehoft, second, and I. H. Baker third, in the men's group.

Above—Men's team, left to right: A. Albanese, H. A. Bredehoft, W. E. Whidden, I. H. Baker, W. D. Goodale, Jr., D. H. King, J. F. Jessich and W. J. Cernik

Left—Women's team, left to right: Alice Jastram, Jerry Garguilo, Janet Bullock, Herma Procopiadi and Helen Cruger

Left, below—Picnic luncheon during the tournament, left to right: Helen Cruger, a guest, W. J. Cernik and Alice Jastram

Below—H. A. Bredehoft spotting hits on the target as C. N. Hickman looks on

Rural Telephone Service

The Telephone Companies throughout the Nation are now in their fourth consecutive year of record-breaking rural telephone construction to meet the unprecedented demand for service which has sprung up during and since the war.

The companies are pushing new telephone lines into remote ranch and farm sections. Regions where few, if any, farmers ever wanted telephone service are now anxious to get it as soon as it is possible.

So great has been this surge in the applications for rural telephone service that it demanded the building of literally tens of thousands of miles of new pole line and the stringing of about a million miles of wire—to say nothing of many new buildings and vast quantities of switchboards and other equipment.

The great strides being made in the expansion of telephone service in Bell System rural areas are familiar to all of us. Less well known, perhaps, are the important efforts of the Bell companies to lend a hand wherever they can to farmers outside their territories who want telephone service.

The folks in the little crossroads community of Anton, Colorado, for example, banded together recently and went into the telephone business. There were slightly more than 100 farmers in that vicinity and the nearest telephone exchange was 30 miles away, in Akron, Colorado. The farmers and the Mountain States Company people talked things over. The outcome was that the farmers formed the Airline Telephone Association, then went to work and built a telephone system in the isolated community. Meanwhile, the Bell company provided two toll circuits from Anton to its office in Akron, using radio equipment developed primarily for mobile services. These were the first switchboard-to-switchboard radio-telephone links to be placed between a Bell System telephone exchange and a connecting company.

With the advice and assistance of the Mountain States Company, the farmers in the Anton coöperative strung thirty-five tons of wire and set 2,200 poles. Where they lacked equipment, they improvised it. The rear end of an abandoned truck, a few pieces from an old threshing machine and a little welding produced a post-hole digger on the front of a farm tractor. Hay stackers were used to elevate the amateur linemen to crossarm level to tie the telephone wire.

By the time they were finished with the construction, the switchboard was in and the radio circuits into Akron were in working order. Everybody agreed it was a mighty nice combination of wire and radio service.

Murray Hill Chorus

The Murray Hill Chorus held its annual meeting on June 10 at which the executive chairman, Phyllis Taylor, read the annual report, including a summary of the work done during 1948-49, and also several recommendations for the coming season. J. G. Walker, Spring Concert chairman, summarized the activities connected with the concert and F. J. Black, treasurer, gave the financial report for the year.

The following officers for 1949-50 were elected: executive chairman, Brockway McMillan; vice-executive chairman, William Vierling; secretary, Myra Norris; treasurer, Paul Weaver; and librarian, Clarice Lovell.

The Murray Hill Rhythm Trio in the Arnold Auditorium, left to right: Ray Biazzo, bassist; John DeFeo guitarist; and Harry Geetlein, pianist

During the coming season, the chorus will be directed by Leo W. Collins, Teaching Fellow of the Juilliard School of Music. For the past two years Mr. Collins has studied at Juilliard under Robert Shaw, majoring in conducting. At present he teaches choral conducting and sight singing at Juilliard and is director of the Guild Choir at The Riverside Church, New York City.

September Service Anniversaries of Members of the Laboratories

50 years
Mary Douglas

40 years
W. C. Dorgan
J. J. Kuhn

35 years
R. B. Simon

30 years
H. B. Arnold
J. W. Corwin
J. T. Delaney
Howard Flammer
N. R. French
J. J. Gilbert
E. K. Jaycox
J. L. Mathison
Ludwig Pedersen
H. S. Price
George Roberts
S. J. Stranahan
B. S. Swezey
E. S. Wolek

25 years
David Anderson
J. A. Becker
C. F. Bischoff
J. J. Heil
A. F. Kane
W. Koenig, Jr.
Mary Maxwell
R. L. Peek, Jr.
Frank Steiner

20 years
A. J. Ahearn
Ernest Babcock
Robert Black, Jr.
J. R. Boettler
E. J. Buckley
M. S. Burgess
Vincent Burns
L. P. Carter
J. P. Cherney
T. R. D. Collins
W. J. Darlington
F. P. Drechsler
Thelma Gradwell
O. C. Haas
W. F. Halloran
M. S. Hawley
C. H. Heller
J. W. Hoek
J. F. Hurley
C. W. Irby
O. H. Kimmel
Joseph Kleiber
W. J. Lally
G. W. Lees, Jr.
H. C. Montgomery
R. J. Morris, Jr.
James Murray
J. W. Nalencz
E. W. O'Hara
Richard Olsen
Patrick O'Neill
T. J. O'Neill
W. K. Oser
F. J. Osolinik
N. J. Pierce
H. J. Reinwald
R. O. Rippere
R. W. Sears
W. F. Sefcik
P. J. Sheehan
J. O. Smethurst
B. F. Stoddard
R. L. Towne
L. M. Towsley
A. W. Treptow
A. H. Van Bree
F. B. Vreeland
G. H. Williams, Jr.

15 years
John MacKay
J. A. Watters

10 years
W. E. Balph
B. C. Bellows, Jr.
Dorothy Mendelsohn
B. M. Oliver
J. N. Shive
A. P. Winnicky

West Street Choral Group

Under the direction of R. P. Yeaton, the West Street Choral Group will hold its first meeting of the season on September 7 at 5:30 p.m. in the auditorium at West Street. At the meeting, the newly elected officers, namely, R. W. Westberg, chairman; C. L. Beckham, treasurer; Eleanor Ebeling, librarian; and Catherine Graham, secretary, will be on hand to welcome new and old members.

News Notes

M. J. Kelly attended a meeting of the Navigation Committee of the Research and Development Board. He also visited the Collins Radio Company at Cedar Rapids, Iowa.

William Fondiller has been elected a member of the Board of Managers of the Columbia University Engineering Alumni Association.

The Physical Review, June 1, 1949, contains the following article: *The Optical Constants of Germanium in the Infra-Red and Visible,* by W. H. Brattain and H. B. Briggs, and the following Letters to the Editor: *New Ferroelectric Crystals,* by B. T. Matthias, and *Pressure Change of Resistance of Tellurium,* by J. Bardeen.

The Journal of the Acoustical Society of America, July, 1949, contains articles by R. Bown, *Acoustics in Communication;* Charles Kittel, *The High Frequency Region of the Acoustic Spectrum in Relation to Thermal Conductivity at Low Temperatures;* F. M. Wiener, *The Diffraction of Sound by Rigid Disks and Rigid Square Plates;* G. W. Willard, *Focusing Ultrasonic Radiators;* and C. T. Molloy, *The Lined Tube as an Element of Acoustic Circuits.*

N. B. Hannay, D. MacNair and A. H. White are authors of the article *Semi-Conducting Properties in Oxide Cathodes* in the July issue of the *Journal of Applied Physics.*

At Hawthorne, J. P. Guerard discussed specifications for metals; P. P. Cioffi, magnetic materials applications; D. H. Gleason and C. C. Barber, the current production and the new developments on crossbar switches; D. G. Blattner and R. C. Hecht, terminals, plugs, cord weights, meters and keys for combined sets; H. M. Knapp, wire spring relay program; W. G. Laskey, message register problems; A. A. Burgess, J. G. Ferguson and W. B. Graupner, crossbar and AMA equipment; W. Whitney, manufacturing costs; and K. G. Compton and R. C. Platow, adhesives and finishes.

H. A. Birdsall attended the Gordon Research Conference Series on Textiles at New London, New Hampshire.

H. M. Cleveland and F. J. Biondi conferred at the Research Laboratories of Electronics at M.I.T. on metal-ceramic sealing problems. Mr. Biondi has been appointed a member of Subcommittee VIII, Metallic Materials for Radio Tubes and Incandescent Lamps, of Committee B-4, A.S.T.M.

W. O. Baker attended meetings of the Panel on Physical Chemistry of the Office of Naval Research in Washington. He also participated in the A.A.A.S. Conference on High Polymers at New London, New Hampshire.

During the A.S.T.M. convention in Atlantic City, E. R. Morton and G. R. Gohn presented a paper on *A New High Speed Sheet Metal Fatigue Testing Machine.*

LABORATORIES SWIM CLUB DEMONSTRATES FOR RED CROSS

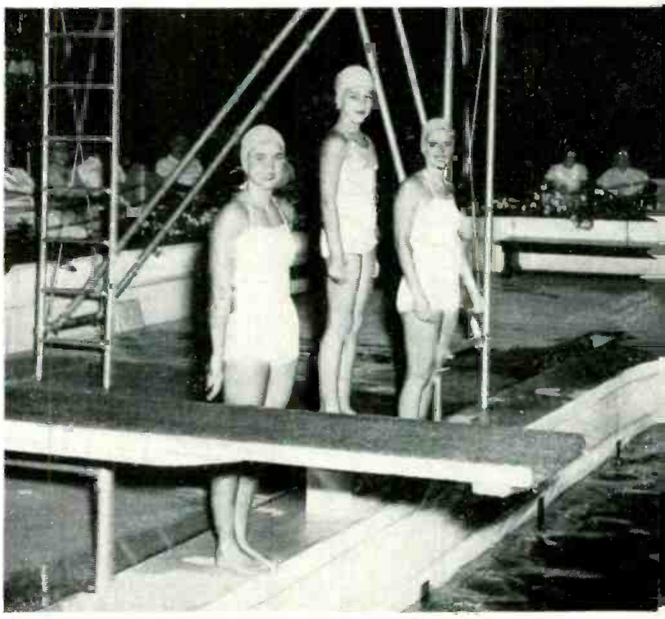
When the Canoe Brook Country Club of Summit invited the Summit Chapter of the American Red Cross to demonstrate life saving and water safety techniques to their members, that organization called upon the Instructors of the Murray Hill Swim Club, all of whom hold Red Cross certificates. The accompanying photographs show some of the skills demonstrated by the Swim Club. Those taking part in the demonstrations were Marjorie Boyle, W. C. Buckland, J. B. DeCoste, Thelma Gradwell, R. W. Hull, G. G. Lavery, Elizabeth Merrell, J. J. Pauer, Priscilla Pecon, Mildred Read and G. B. Ruble. Mr. Lavery is Water Safety Chairman of the Summit Red Cross.

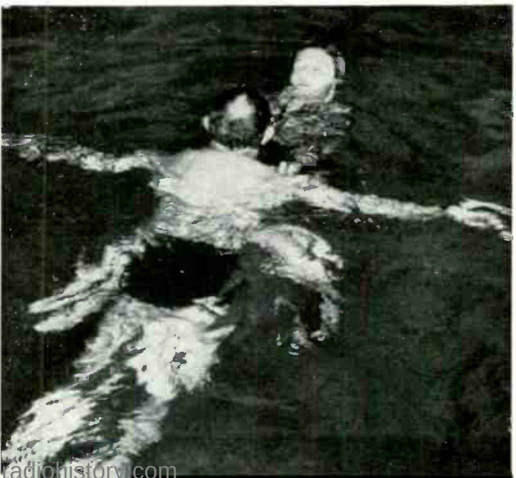
Above—Elizabeth Merrell and J. B. DeCoste show the proper way to reënter a canoe

Right—"Bunny" Michel and Jill Harms of the Red Cross and Doris Michel of the BTL

Below—left, G. G. Lavery leveling off a victim, Priscilla Pecon, prior to a swimming carry

Below—right, W. C. Buckland bringing in a tired swimmer





News Notes

K. G. Compton attended the Gordon Research Conferences on Corrosion at Colby Junior College, New London, N. H.

J. P. Griffin visited W. D. George of the National Bureau of Standards for the purpose of discussing the improvement of crystal units for frequency standards.

V. E. Legg attended Committee A-6 on magnetic materials at an A.S.T.M. meeting in Atlantic City.

R. G. McCoy of Switching Apparatus Development has received the M.S. degree from Columbia University.

R. E. Coleman attended conferences at the General Electric Company, West Lynn, Massachusetts, to discuss specifications for photoelectric cells.

R. A. Miller, H. W. Augustadt and W. R. Goehner visited American Time Products Company on a regulated frequency supply. Mr. Miller and L. B. Cooke attended a meeting of Audio Facilities of RMA.

V. T. Callahan visited Morrisville, Vermont; Hudson, New York; Harrisburg, Pennsylvania; and Boston to discuss diesel engine installation problems.

H. M. Spicer went to Boston and Schenectady. In Boston he visited A. & J. M. Anderson Manufacturing Company to talk over emergency cell switches, and in Schenectady he discussed with the General Electric Company motor control.

W. L. Betts made tests on charging generators at the General Electric Service Shop in Chicago.

R. F. Massoneau, G. A. Hurst and W. H. Seckler were in Towson, Maryland, to study pre-cutover tests of the No. 5 crossbar office.

J. H. Waddell visited Eastman Kodak Company and the Wollensak Optical Company in Rochester in reference to recording photography and high-speed photography.

F. W. Anderson was at the New England Telephone and Telegraph Company in Boston making noise tests.

L. A. Leatherman observed performance requirement tests on the power plant in the Orchard Office, Philadelphia.

R. N. Sweetland visited Power Equipment Company in Detroit to make type tests on rectifiers.

N. V. Mansuetto visited Milwaukee and Madison, Wisconsin, in connection with N1 carrier equipment.

W. L. Black attended a subcommittee meeting of the Institute of Radio Engineers on audio frequency.

A. M. Zillian supervised modifications of the Laboratories' trial installation of signaling equipment at Philadelphia and Richmond.

R. M. Bozorth is the author of an article, *Advances in the Theory of Ferromagnetism*, and C. A. Dahlbom, A. W. Horton and D. L. Moody, *Multifrequency Pulsing in Switching*, in the June issue of *Electrical Engineering*.

A. C. Walker visited Watertown Arsenal in Massachusetts to discuss problems related to a large-sized stainless steel autoclave being made by the Signal Corps for our use in the growing of quartz crystals.

V. T. Callahan and E. J. Hawes of Hawthorne discussed diesel engine controls with the General Motors Corporation at Detroit. Mr. Callahan also conferred with engineers of the Hercules Motors Corporation at Canton, Ohio, and the Duplex Truck Company at Lansing, Michigan, upon new diesel engines.

L. B. Cooke discussed questions relating to noise in accounting offices at The Bell Telephone Company of Pennsylvania.

E. J. Donohue, H. A. Miloche and P. W. Sheatsley inspected new No. 1 crossbar equipment now being installed in Lansdowne, Pennsylvania.

E. A. Kuenzler and O. H. Maurer were at Freeport, Long Island, in connection with No. 5 crossbar equipment.

H. J. Keefer and C. W. Matson visited Pittsburgh for several days in connection with dust studies being made at that location.

Mary Pilliod's visit to the AMA accounting center at Philadelphia for two weeks was in connection with accuracy tests of AMA at the Clearbrook-Madison Office.

C. F. Seibel, H. C. Green, D. H. Pennoyer and W. I. McCullagh conferred at Lansdowne on the initial installation of AMA in the No. 1 crossbar office.

L. A. Weber and F. S. Farkas made field trials of signaling on N1 carrier system at Milwaukee and Madison, Wisconsin.

R. H. Ricker, T. A. Jones and W. A. Phelps were in Washington during early August in connection with a field evaluation test of communication equipment for the Army.

R. S. Caruthers and L. Pedersen with W. E. Burke and C. Cuthbertson of Western Electric conferred at Haverhill in connection with the development of the N1 carrier telephone system.

A. H. Wagner and L. Pedersen, with W. R. Scherb of Western Electric, discussed die-casting designs for the N1 carrier telephone system at the die-casting plant of the Doehler-Jarvis Corporation at Pottstown, Pennsylvania.

W. I. McCullagh attended the cutover at Glenolden, Pennsylvania, and R. C. Pfarrer and H. D. MacPherson the cutover of No. 4 toll at Cleveland.

R. H. Nichols selected *Television* as the topic of his talk before the Rotary Club of Holland, Michigan, his home town.

A. H. Schirmer and H. B. Brehm investigated lightning troubles on station protection apparatus at Hamlin, Pennsylvania.

D. W. Bodle made a field inspection in the western division of the New England Telephone and Telegraph Company on exchange cable protection.

R. C. Eggleston and C. R. Brearty visited Atlanta and Live Oak, Florida, with representatives of the Western Electric in connection with the application of new specification requirements on wood crossarms.

L. R. Snoke attended a conference and demonstration of chemical underbrush control at Norfolk, Connecticut.

The Laboratories were represented in interference proceedings at the Patent Office by F. Mohr and C. Baraff before the Primary Examiner.

J. E. Cassidy and W. W. Werring were at the Patent Office in Washington relative to patent matters.

F. Mohr was in Washington recently in connection with patent matters.

F. D. Leamer and H. W. Gillette attended the Industrial Conference at Silver Bay, July 20-23, where Mr. Leamer was chairman of a seminar on the subject *Why People Work.*

A. K. Bohren, C. A. Warren and R. G. Stephenson went to the Naval Research Laboratory Field Station in Boston and Raytheon Manufacturing Company in Waltham in connection with components for military projects.

N. W. Bryant and G. F. Swanson visited the Bureau of Ships Design Group in Washington to discuss modifications of electronic equipment designed at Whippany.

J. W. Smith and F. E. Nimmcke participated in a conference in Washington with Navy personnel.

S. C. Hight, A. A. Lundstrom and P. H. Thayer conferred on aeronautical problems with Cornell Aeronautical Laboratory engineers in Buffalo. Mr. Hight, E. L. Nelson, Mr. Lundstrom and J. H. Felker attended Bureau of Ordnance conferences in the Navy Department on the development of naval equipment in Washington.

F. B. Combs visited Winston-Salem in connection with mobile radio telephones.

Engagements

*Eleanor Boyd—Thomas G. Higgins
*Harriett Hein—Ernest Hommer
*Jean Karch—*Jack Sagarese
Dorothy Musaus—*Richard K. Evenson
*Margaret Ryan—William H. Miehe
*Dorothea Seibert—Alfred H. Corwin
*Shirley Zitzmann—*William J. Rauchle

Weddings

Jeanne Barbier—*Owen L. Williams
*Alice Carpino—Harry R. Franke
*Rose Chambers—*Clifford E. Underhill
*Catherine Cheevers—William Kondrat
*Anita Garcia—*Joseph Kotaski
*Muriel Greenhagen—Martin A. Pawelko
Mary Harnedy—*John J. Turley
*Marilyn Miller—*James A. Donlevy
*Kristine Mortensen—Harold Hotaling

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

J. F. Sweeney and W. L. Cowperthwait have returned from Macon, Georgia, where they took part in flight tests of Air Force equipment being developed by the Laboratories. H. H. Bailey is supervising the tests which are continuing with the assistance of F. E. De Motte, E. H. Sharkey and F. A. Goss.

R. C. Shaw and W. C. Hunter, with R. E. Johnson of A T & T, spent July 18 and 19 in Washington assisting the Chesapeake and Potomac Telephone Company Engineering Department in connection with a mobile radiotelephone land station transmitter installation.

H. L. Rosier observed demonstration of aircraft communication equipment at the Naval Air Test Center, Patuxent River, Maryland.

"The Telephone Hour"

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

September 5	*John Charles Thomas*
September 12	*Barbara Gibson*
September 19	*Pia Tassinari and Ferruccio Tagliavini*
September 26	*Lily Pons*
October 3	*Gladys Swarthout*
October 10	*Guiomar Novaes*
October 17	*Ezio Pinza*
October 24	*Jascha Heifetz*
October 31	*Bidu Sayão*

B. H. Simons visited Winston-Salem on July 5 to 7 and July 13 to 15 for the purpose of inspecting the first five amplifiers factory produced at that location.

H. A. White discussed edge-lighted plastic control panels at the Bureau of Aeronautics, and R. C. Newhouse, aircraft problems.

J. H. Hershey inspected fire control equipment at the Philadelphia Navy Yard.

T. W. Winternitz and S. C. Hight made a visit to Watson Laboratories, where Mr. Hight spoke on *Naval Defense Systems*.

A. A. Lundstrom, W. H. MacWilliams and P. H. Thayer visited the Navy Department in Washington.

A. K. Bohren and J. B. Bishop conferred with the Bausch and Lomb Company in Rochester on an optical device.

P. S. Darnell, R. J. Phair, M. D. Rigterink, A. C. Norwine, E. H. Jones, F. J. Given and H. H. Schneckloth spoke at a conference on printed circuit techniques on June 6 in the Arnold Auditorium.

C. F. Seibel, H. D. Cahill, W. H. T. Holden and W. I. McCullagh visited Glenolden and Lansdowne for consultations on automatic message accounting.

This Month's Ad

Nearest installation of the B-1 control and alarm system being in Dallas, M. Brotherton of Publication enlisted the coöperation of Western Electric's Bert Bonnell at Kearny. Their photographer took the picture and S. Pavelchak, an electrical tester, obligingly posed as a testboardman. A definitive story on this interesting system is in preparation for a forthcoming issue of the Record.