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Conductivity measurements at microwave frequencies

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Among the design problems in microwave systems is that of limiting energy losses in coaxials and wave guides. For this purpose there must be quantitative information as to conductivity at microwave frequencies. Since little such information was available, the special measuring equipment shown in Figure 1 was set up at Holmdel to obtain it.

At microwave frequencies, currents do not penetrate a conductor but travel in a surface layer only a fraction of a mil thick, so, as the tests bring out, the nature and condition of the surface exercise a controlling influence on the losses. For example, a layer of silver

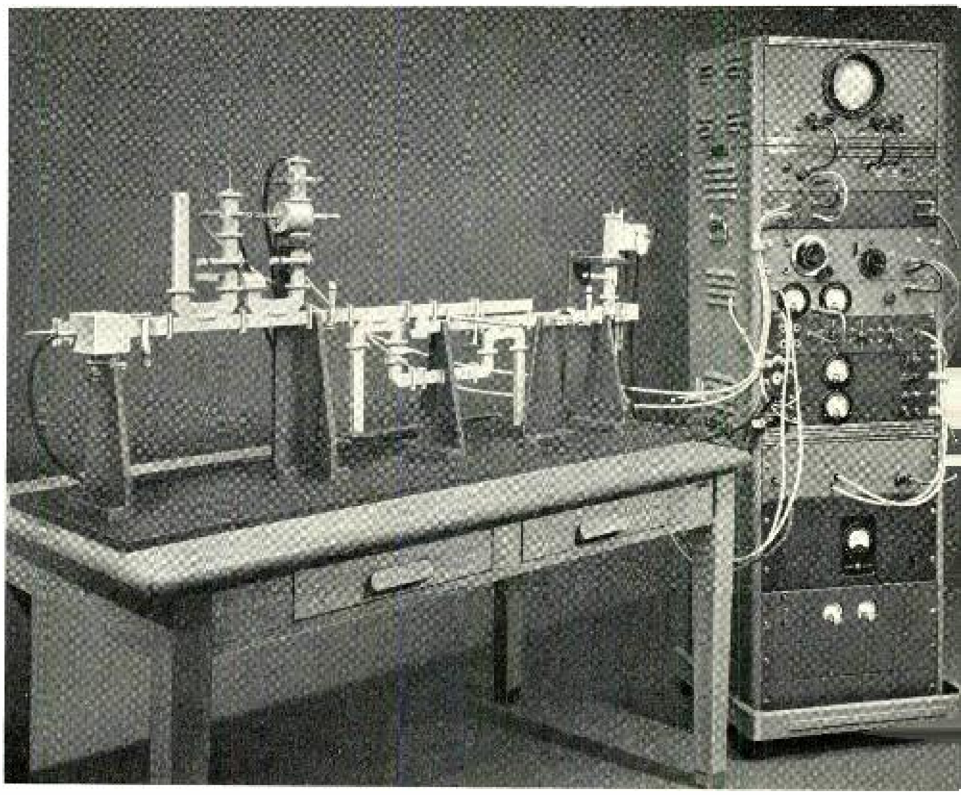

Fig. 1 — Test equipment for measuring the microwave conductivity of wire specimens at 9000 megacycles.

plating, which appears smooth to the eye, may be rough and porous enough to increase the loss of electropolished copper by 220 per cent. The loss of electropolished copper left outdoors for several months was found to increase by 40 per cent. Protected by lacquer, a conductor retains its initial high conductivity for many months.

A feature of the test method is that it utilizes a test specimen which can be easily made: a few inches of 20-mil wire having the surface finish to be studied. The wire specimen is supported by polyfoam beads in a tube of coin silver forming with it an open-circuited coaxial line which is resonant at multiples of a half wavelength. As shown in Figure 2, the tube, or "specimen holder," containing the wire specimen is coupled to wave guides through two orifices located centrally in the tube walls. Arriving from the wave guide on the left, energy from a signal generator enters the tube through the top orifice, exciting the coaxial line to resonance. Through the lower orifice, the signal passes out along the right-hand wave guide to a receiver and oscilloscope.

The desired conductivity of the wire is a function of the unknown "Q" of the resonant line. Commonly, "Q" is expressed as the ratio of reactance to effective resistance. More convenient for this type of measurement is another expression for "Q" based on the resonance curve (like the peaked curve in Figure 4) obtained by plotting, versus frequency, the power transmitted through the orifices. The power transmitted reaches a maximum at resonance. It may be shown that "Q" is equal to the ratio of the resonance frequency to the half-power bandwidth, that is, the width of the resonance curve where half the maximum power is transmitted.

To determine the resonance frequency and the half-power bandwidth, the specimen holder and associated wave guides are connected to the test circuit shown diagrammatically in Figure 3. The generator at extreme left produces a signal which sweeps, at a 60-cycle per second rate, to and fro through the resonance frequency of the specimen, over a frequency range from about 8950 mc to 9050 mc. Essentially, the test circuit comprises three branches over which signals from the generator are routed. Automatic relays A and B make the proper connections to record information on the oscilloscope screen.

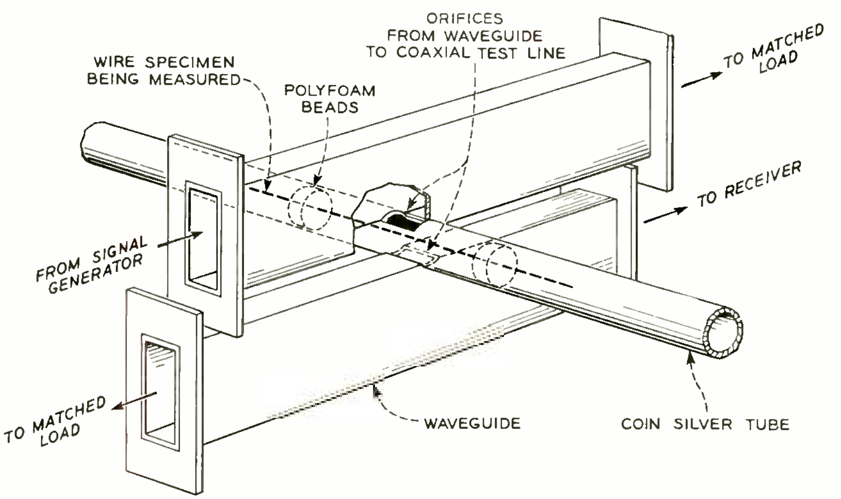

Fig. 2 – Wire-specimen holder and connecting wave guides.

First, with the top contact of relay A closed, part of the signal passes directly over the monitoring branch to the oscilloscope, plotting the generator's output characteristic, curve 1. During this sweep, relay B remains closed, connecting in the signal from the marker branch which contains the barrel-shaped cavity wavemeter. The wavemeter presents an open circuit to the signal until the sweeping frequency reaches the value at which the wavemeter is set. Then, a very small amount of energy escapes through the wavemeter to the oscilloscope; it interrupts the electron beam, making, in the generator's curve, a blank spot which acts as a frequency marker. By twisting the micrometer dial on the wavemeter, the frequency marker is readily moved back and forth along the generator's curve.

During a subsequent frequency sweep, with relay B open and the lower contact of relay A closed, the signal goes through the specimen holder to the oscilloscope, plotting the desired resonance characteristic as curve

To make a measurement, a wire is inserted in the specimen holder and the signal generator is adjusted to the frequency required to obtain a resonance curve on the oscilloscope. Then the two wave guide shorting-switches, shown under the specimen holder, are reversed so that the signal is detoured through the wave guide by-pass branch below; the receiver is then accurately tuned so that its oscilloscope curve is superimposed on that of the signal generator, making the response of these two branches identical.

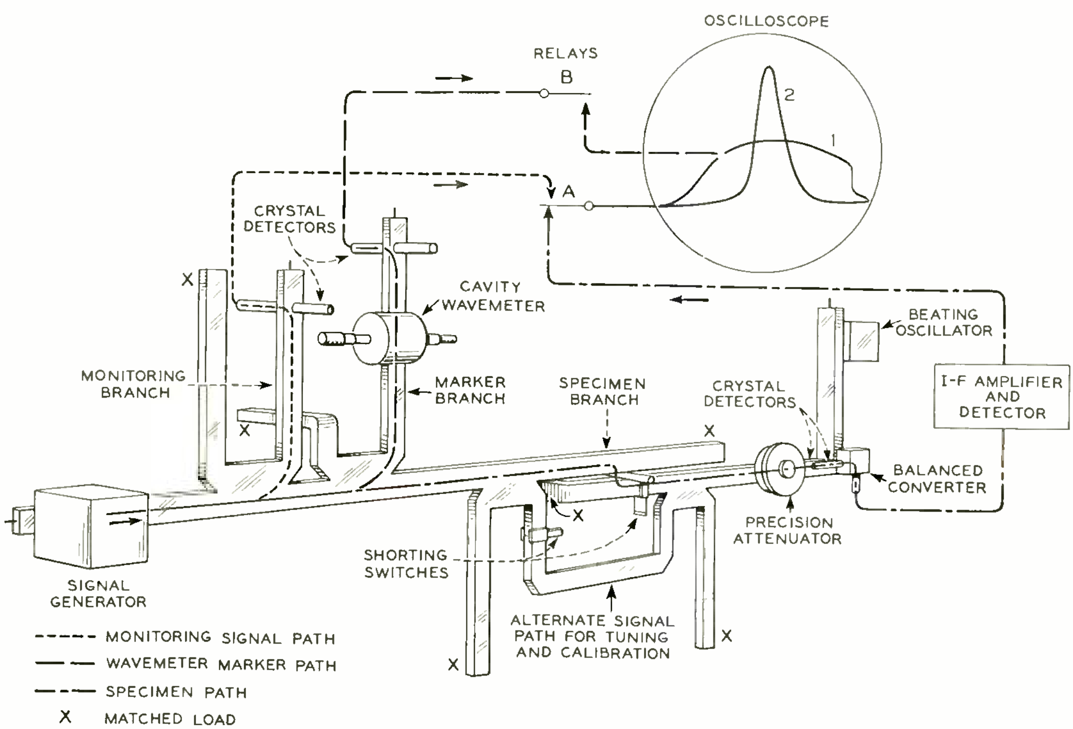

Fig. 3—Diagram showing transmission paths over test circuit to oscilloscope.

2. Due to persistence of vision, curves 1 and 2 appear to be displayed simultaneously on the screen.

Since the output from the specimen holder is relatively weak, it must be strongly amplified. For this purpose the signal passes from the specimen holder to a balanced converter where it is heterodyned with a beating oscillator which sweeps in synchronism with the generator. The output of the converter, which is nearly constant in frequency, at about 65 mc, is then amplified and detected on its way to the oscilloscope.

With the wave guide switches again reversed, the resonance curve of the specimen is shown on the oscilloscope and its peak frequency is then measured by moving the frequency marker to coincide with the resonance peak.

At this stage of the test, the resonance curve is aligned with the generator curve as shown in Figure 4(a). Subsequently the precision attenuator shown at the right of the specimen, or a precision attenuator in the IF system of the receiver, is adjusted to increase the gain 3.01 db, giving the display

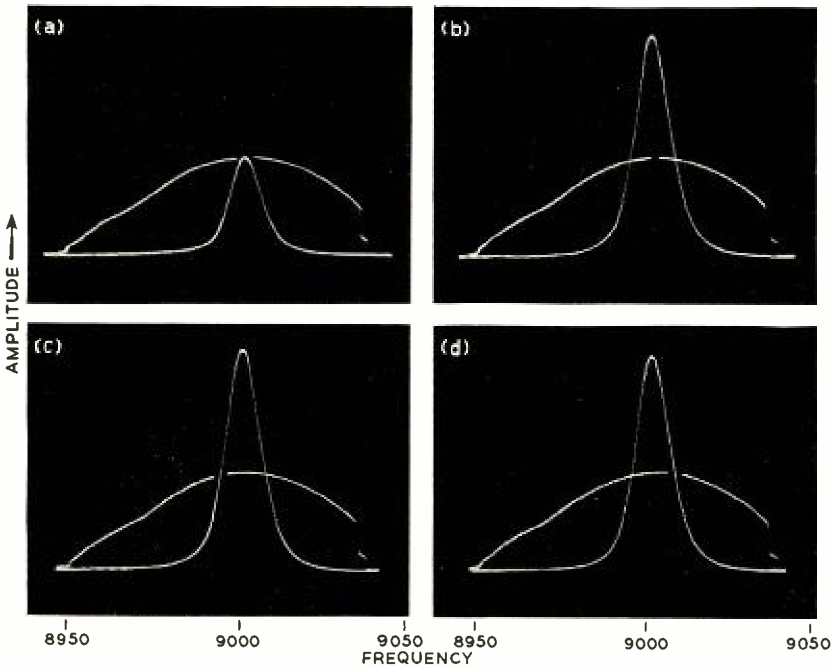

Fig. 4—Photographs of oscilloscope traces illustrating use of frequency marker in determining the resonance frequency and half-power bandwidth.

shown in Figure 4(b). The signal generator's curve now intersects the resonance curve of the specimen at the half-power points. The half-power bandwidth is then measured with the frequency-control dial of the cavity wavemeter as its marker is successively placed at these intersections as illustrated in Figures 4(c) and 4(d).

The ratio of the peak frequency to the half-power bandwidth gives the loaded Q value of the coaxial line. This value is corrected for the loss through the orifices in the tube walls, the correction being derived from a measurement of the power transmission ratio through the specimen holder at resonance. The Q value is also corrected for the loss in the tube, this loss being determined by measurement of a wire specimen made of the silver material used in the tube. Losses in the polyfoam supports are negligible. A complete test involves measurements of several lengths of the specimen wire, each one successively one-half wavelength shorter than the previous one. Then, for each specimen length, the quantity $n\lambda/2Q$ (where λ denotes the wavelength and n, the number of half-wavelengths) is plotted against $n\lambda/2$. The slope of the resulting straight line drawn through the points yields the value of Q with measurement errors averaged and the end effects of the wire eliminated.

The corrected, measured Q of the specimen wire, determined in this way, is inversely proportional to the loss of a coaxial line, or a wave guide, using the same material in the same surface condition. The data can be used to determine comparative losses in a microwave system with different materials or surface treatments. In order to calculate the losses of microwave components, the effective conductivity for any measured material is calculated from its Q, and then used, by means of the usual formulas, to compute the desired attenuations.

As a check, values obtained with this method were compared with Q values calculated from measurements of direct current resistance. These formulas are derived on the basis that the surface of a specimen is perfectly continuous and smooth. As expected, therefore, the measured Q values agree most closely with calculated values where the specimen has been made smooth. For very smooth, and, in some cases, electropolished, specimens of platinum, phosphor bronze, brass, molybdenum, gold, and copper, the measured and calculated values agree to within two per cent.

Unsmoothed commercial wires of high

conductivity—silver, copper, gold and aluminum—have from 5 to 20 per cent more loss than that calculated from measurements of direct current resistance. For commercial wires of lower conductivity – molybdenum, platinum, brass and phosphor bronze—in which the current penetrates more deeply into the material so that the surface is less important, the loss is 2 to 10 per cent higher than the direct current measurements predict for smooth surfaces.

The importance of ensuring surface smoothness as a practical measure in microwave systems is very strongly brought out by the measurements. For example, for smooth copper wires rubbed lengthwise with fine emery cloth, the loss increased about 25 per cent, and still more loss was observed when the wires were rubbed with coarse cloth. Rolled between ground steel plates to produce circumferential grooves about 3 microns deep, smooth wires had about 60 per cent more loss, and about two and a half times as much loss was measured after a wire was run through a die in a jeweler's lathe producing 220 threads per inch.

The results also bring out the importance of protecting wave guide surfaces from oxidation and corrosion. Smooth electropolished copper wires, initially having good conductivity, show a 10 to 15 per cent increase in loss after a few months aging indoors, and about a 40 per cent increase when left outdoors for the same length of time. A coat of clear lacquer protects surfaces, while increasing the loss only very slightly.

As expected, plated specimens exhibited rather poor conductivity, since plated metal is rougher and more porous than solid metal. The loss of an electropolished copper wire increases about 25 per cent when copper plated, and remains about 5 per cent higher even when re-electropolished. Silver plating on electropolished copper samples results in a 30 to 220 per cent increase in loss, with the largest values being obtained for rough porous surfaces plated at high current densities.

The information obtained with this measuring equipment has been found useful in the design and treatment of microwave components of all types where loss is a factor of importance.

THE AUTHOR: A. C. Beck received the E. E. degree from Rensselaer Polytechnic Institute in 1927. After two summers in the test department of the New York Edison Company and a year as instructor in mathematics at Rensselaer, he joined the Technical Staff of these Laboratories in 1928. With the Radio Research Department he has since been engaged in the development and design of short-wave and microwave antennas and related equipment. During the war he was chiefly concerned with radar antennas and the associated waveguide structures and components. At the present time he is working on microwave transmission developments for broadband communication by means of radio relay and circular electric waveguide systems.

A cathode-ray rapid-record oscillograph

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Switching Apparatus Development

For the past quarter century the rapid-record string oscillograph* developed by A. M. Curtis and I. E. Cole has been one of our principal laboratory tools for the measurement of time in milliseconds. The facts that the design has proven adequate without replacement or major modification for such a period, and that all the units prepared for laboratory departments are still in active service, attest the merit of the design. Recent needs for additional equipment of this type suggested that a study be made of applying new apparatus and techniques to determine the possibility of securing a modernized instrument giving improved operating characteristics at a cost less than the present cost of reproducing the early design. Such a study has resulted in the design of a new cathode-ray rapid-record oscillograph shown in Figure 1.

As indicated in Figure 2 the cathode-ray rapid-record oscillograph comprises three three-inch cathode tubes mounted vertically in an enclosure above the camera mechanism, which provides a supply magazine for recording paper and the drive mechanism for moving the paper out of the magazine past the recording "gate," and into the automatic developer. The cathode-ray tube assembly and the camera appear on the face of a cabinet-enclosed nineteen-inch relay rack. The associated circuit chassis for the operation of cathode-ray tubes shown on Figure 3, appears in the cabinet at the rear of the same rack, together with the camera driving motors and associated magnetic controls for the camera mechanism. The exposed paper discharges from the left end of the camera housing into the first of three developer trays which extend in a horizontal line across a second bay, which is somewhat more than nineteen inches in width. The paper first enters a developer tray and discharges from that into a hypo or fixer tray, both of these trays being equipped with motor driven belt conveyer systems. These first two trays and the discharge from the camera are necessarily light-tight; but the conveyers discharge from the fixer tray to the third tray which is open. The record can thus be read as the paper discharges, record side up, from the power driven fixer tray. The time the paper remains in the motor driven fixer tray is not sufficient in all cases to provide complete fixation; and if permanent records are desired they may be left in the open hypo tray for as long as desired.

The dimensions and appearance of the design are controlled by the three principal components appearing on the face of the cabinet: the cathode-ray tube assembly, the camera, and the automatic developer. Since it is necessary to monitor the recording by "peep hole" observation of the cathode-ray beams on the paper, the camera height is set at a convenient average eye level of a standing operator. The peep hole is evident in Figure 1 in the lower middle of the cover of the cathode-ray cabinet. Above the camera level thus established, appears the cathode-ray tube assembly. The three-inch tube is the smallest available having the proper control characteristics for focus and writing speed requirements. The length of these tubes with associated apparatus requires a height of approximately twenty inches above the camera.

Since the paper may be driven past the recording beams at a maximum rate of 150 inches per second, and since the time required for photographic development permits a paper exit speed from the camera of only about two inches per second, it is necessary to provide a storage cavity in the camera

*Record, *August* 1930, *page* 580.

where the excess of record length can await its slow removal by the automatic developer. For this purpose, a box approximately twenty inches square is mounted below the camera into which a loop of paper may be driven by the camera at high speed while the starting end of the loop is slowly pulled through the developer. The required immersion time of the paper limits the minimum dimension of the developer tray, and also of the fixer tray. While the horizontal length of the automatic developer system has been somewhat reduced in the new design, it contributes about thirty inches of the fifty-inch over-all length of the assembly.

The over-all height of the complete assembly on casters is six feet two inches, clearing a standard door frame. Inside depth of cabinet is approximately twenty inches, and the disposition of heavy components is low enough to provide good stability. The total weight of the assembly is approximately 1000 pounds.

The three identical recording channels have an input impedance of 10,000 ohms, a frequency response of $\pm$ 0.5 db from 2 to 10,000 cycles per second, a voltage amplification of 50 db, and a sensitivity of one inch peak-to-peak of photo trace for 1 volt rms. Amplitude distortion is limited to less than five per cent for ⅝ inch peak-to-peak amplitude of record, and the effects of crosstalk, voltage variation, and noise are individually limited to a maximum of approximately 0.005 inch effect on the trace amplitude. Cathode-ray tube circuits withstand an overload equivalent to six inches of beam deflection without producing undesirable effects.

Time lines are recorded by illumination through the slits of a drum driven by a synchronous motor operating on 50-cycle supply incorporated in the oscillograph. The shutter drum has forty slits, and thus with the motor running at twenty-five revolutions per second provides 1000 exposures or time lines per second. Every fifth and tenth line is wider than the intermediate ones to make the time scale easier to read. The record is a "positive"—black lines on a white background.

In operation, the cathode-ray tubes are convenient to adjust and are free from damage due to inadvertent overloads, which may be encountered in examining unfamiliar circuit conditions. The cathode-ray beams are readily visible for inspection through a monitoring peephole which gives access to the darkened interior of the camera. The beam intensity is sufficient to permit inspection by reflection from the light-colored emulsion surface of the paper, and the distinct blue color of the beam makes the trace readily distinguished from the Mazda light projected through the time-line slits. It is possible, therefore, to obtain perfect mutual alignment between the individual beams

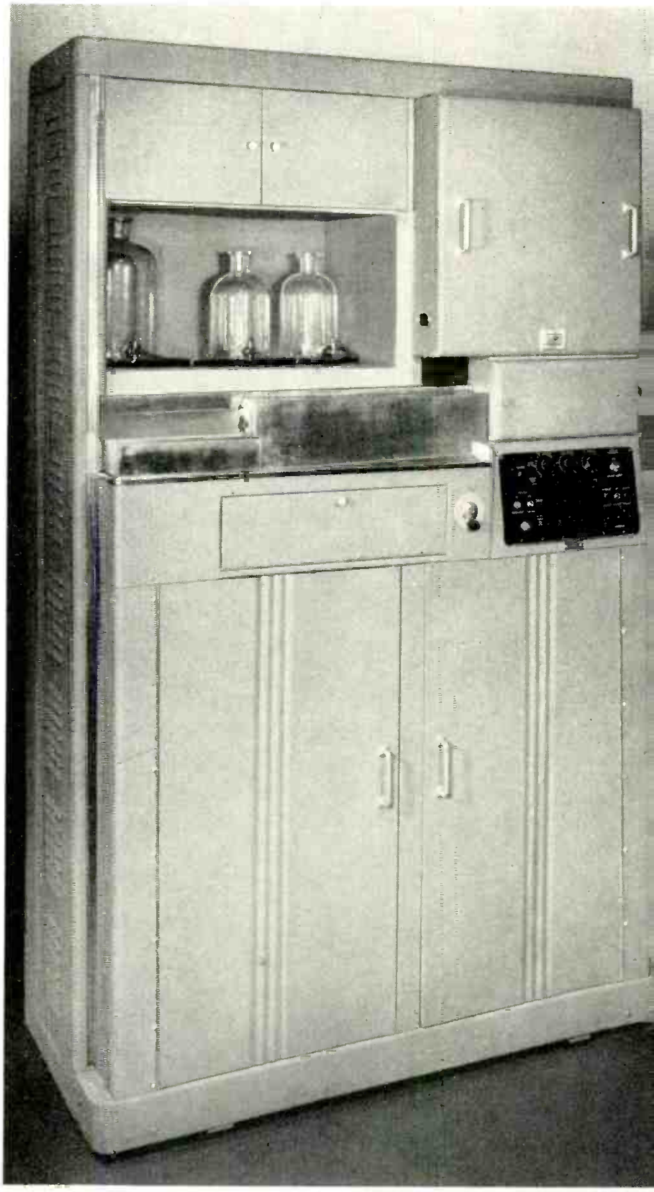

Fig. 1—Front view of new rapid-record oscillograph.

and the time line by bringing the blue line of the beam into coincidence with the whiter light of the time line. The potentiometer controls for positioning, focusing, and adjusting the amplitude of beam traces are conveniently concentrated on one small panel. The time-line motor is self-starting.

The paper handling mechanism of the original rapid-record string oscillograph has been substantially reproduced. A 60-cycle induction motor is connected to the drive roller through a variable speed transmission, and the size of drive units is sufficient to accelerate the paper from standstill to the maximum 150 inches per second and substantially constant speed within approximately ten inches of paper, or about 0.1 second of elapsed time. The paper driving

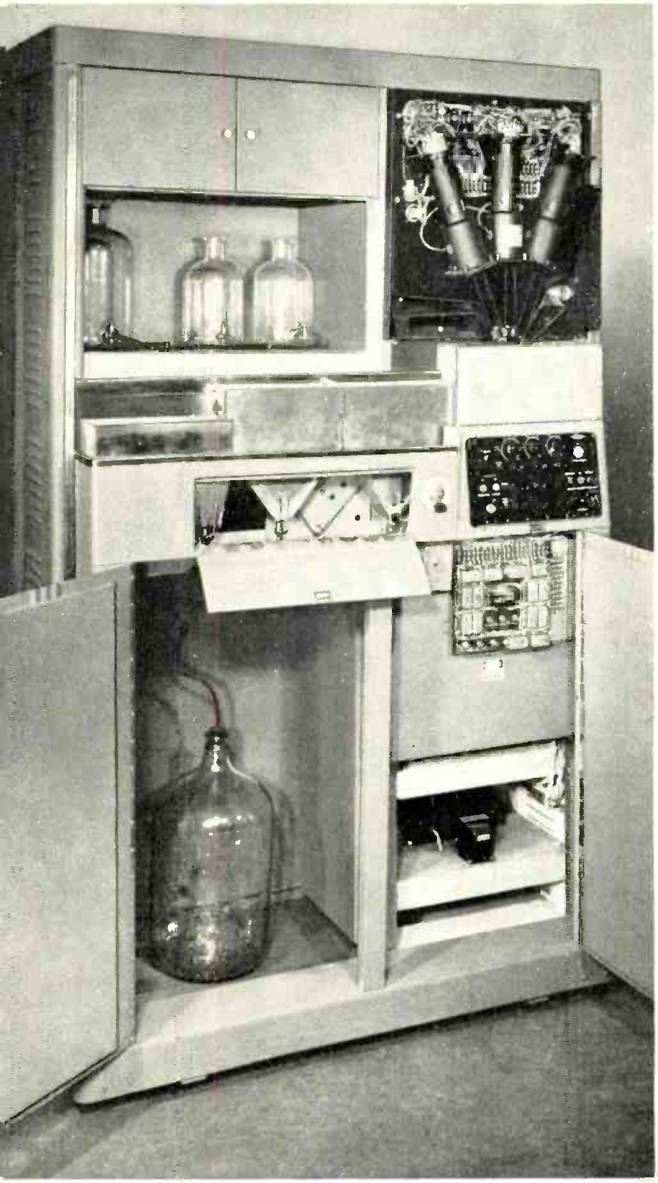

Fig. 2—Opening the doors to the various compartments reveal the three cathode-ray tubes at the upper right; part to the drive for the film, left center; and the drain bottle for solution, below.

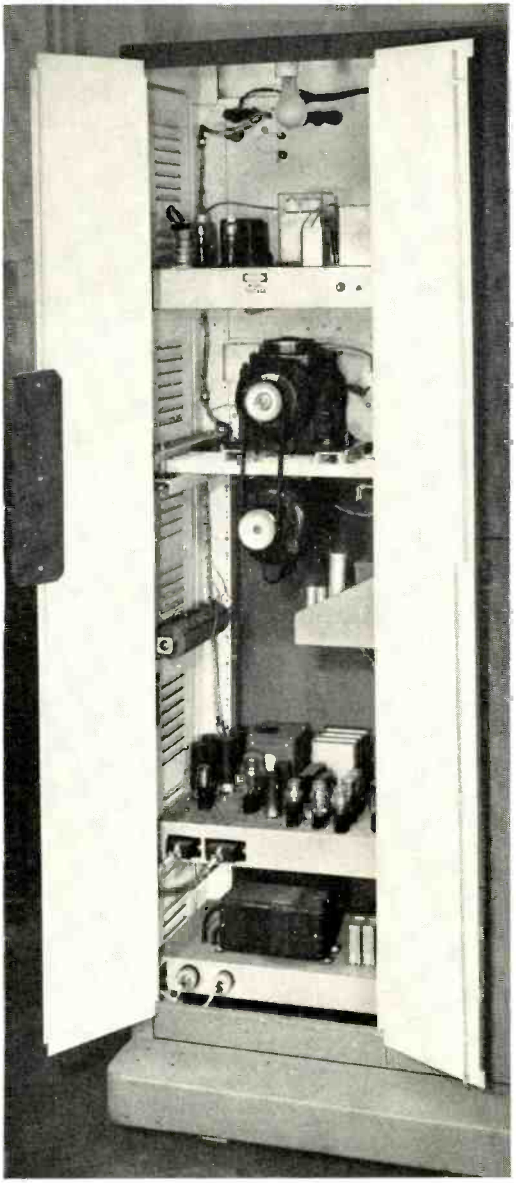

Fig. 3—Access to the camera driving motors is from the rear of the cabinet. The magnetic controls for the camera mechanism are also located here.

clutch roller, the cut-off knife, and the brake band that snubs the supply roll of paper against overrun in stopping, are all operated by a single solenoid supplied from the 60-cycle line through a rectifier. With a current drain of approximately two amperes, this solenoid supplies an average force of about twenty pounds at a two-inch lever arm. With a separate one-twentieth horsepower 60-cycle motor driving the automatic developer, the oscillograph requires service only from a 110-volt 60-cycle line.

"Plumbing" arrangements for passing the developer and fixer solutions to the developer trays are provided to minimize the spillage and inconvenience of solution change which must be frequently made. Storage bottles of one gallon capacity for the hypo and for the developer solution are set in the machine with detachable hose connections to the trays for filling. Drain cocks and waste lines to a five gallon waste bottle stored in the cabinet provide for drainage of the trays.

Initial tests and experience indicate that the new oscillograph is entirely comparable in facility of use with the original string-galvanometer oscillograph and in addition has several worthwhile improvements. Most important of these perhaps is the complete immunity of the cathode-ray recording element from accidental overloads. With a maximum paper speed of 150 inches per record, the instrument cannot produce legible records of continuous frequencies higher than the old, but the 10,000 cycle response characteristic of the cathode-ray tube circuits permits accurate following of single or time-spaced transients which could be detected by the string-galvanometer with difficulty, if at all, and could not be recorded with fidelity. The cathode-ray tube trace can readily be driven to traverse the full width of the paper with amplitude distortion negligible in ordinary time studies; whereas the string-galvanometer amplitude is strictly limited by the small deflection capability of the string. Since our studies show that improvement in the shadowgraph use of the oscillograph would require wider paper with resultant cost increase and reduction in maximum recording speed capabilities, the new unit has the same capability for shadowgraph work as the old.

By the use of commercial components for cathode-ray tube recording, and by replacing machined castings with blanked and formed details in conformity with modern apparatus design practice, the cost of preparation has been reduced greatly with valuable improvements in performance characteristics and utility.

THE AUTHOR: F. H. Hibbard received the M.E. degree from Cornell University in 1914, and at once joined the Engineering Department of the Western Electric Company. After a year in the student training course in Hawthorne and New York, he joined the Transmission Department, where he engaged in transmission calculations, patent examination, and loud speaker testing. In 1918 he transferred to the machine-switching laboratory, of which he was placed in charge in 1921. He remained in this position during the next six years while the panel system was passing through its final development before adoption by the Bell System. In 1927 he was assigned to special instrument studies and to budget and laboratory cost studies. Later he was placed in charge of a group developing relays for the panel system. In 1929 he was transferred to E.R.P.I. where for five years he supervised a group engaged in studies of sound recording on disc and film. In 1935 he returned to the Laboratories to take charge of a group engaged in special products development. Between 1937 and the beginning of World War II, Mr. Hibbard was in the Switching Apparatus Development Department where he was responsible for improvements in the design and development of selector switches, including a relay size selector. During the war, Mr. Hibbard was concerned in the development of a variety of sonar devices and at the conclusion of the war was in charge of the Crystal Lake, New Jersey, Sonar Test Station. Following World War II and up to the present time, Mr. Hibbard has again been active in Switching Apparatus Development activities, particularly special testing equipment.

Fig. 1—Route of the radio relay system between New York and Chicago.

The TD-2 radio relay system

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Transmission Engineering

Within a relatively short span of years there has been a tremendous change in the character of the toll plant. The cross-section of the outside plant facilities has changed from one in which each telephone circuit was represented by a single pair of wires to one in which hundreds of telephone circuits have no physical cross-section at all. Beginning in the very early days when phantoming arrangements permitted two pairs of wires to carry three telephone circuits, and proceeding up through the various carrier systems* that successively permitted one pair to carry two circuits (Type D), one pair to carry four circuits (Type C + voice circuit), two pairs to carry 12 circuits (Type K), two pairs to carry 16 circuits (Type J and Type C + voice), and two coaxials to carry 600 circuits (Type L), we have arrived at a point where even the one pair disappears, and a radio path provides transmission for six two-way broadband channels, each of which is roughly equivalent to a pair of coaxial pipes.

The first radio relay system designed by the Bell System was installed between New York and Boston in 1947 and is known as the TD-X system†. As a result of experience with this field trial, and as an outgrowth of advances in the art, a new microwave radio relay system, known as the TD-2, has been developed and standardized. Installation of a transcontinental route is now under way and has been completed between New York and Chicago with thirty-three intermediate repeater stations located as indicated in the drawing at the top of this page.

The TD-2 radio relay system provides six broad band channels in each direction of transmission. Each baseband extends from about 30 cycles to better than four megacycles and is suitable for one television channel or several hundred telephone channels. A complete TD-2 system is thus roughly equivalent to a 12-pipe L-1 coaxial system.

Frequency modulation is employed to raise signals at the baseband frequency to an intermediate frequency of about 70 MC. These bands are then shifted to the microwave range where each channel occupies a specific 20-MC band in the 3700 to 4200-MC common carrier band. The full frequency allocation for 12 channels is illustrated in Figure 2.

The six channels in one direction of transmission use a common antenna, and are multiplexed to it by means of channel branching filters whose mid-band frequencies are 80 MC apart. The six channels in the other direction are interlaced with the first six, and thus there is 40 MC between mid-band frequencies of adjacent channels in opposite directions. This is done to permit a reduction in filter requirements.

The antennas are of the lens type, but differ in construction from those used on the system between Boston and New York. They are designed to produce a plane wave front by delaying the waves near the center of the antenna relative to those near the edges. The major lobe of the antenna pattern is just under two degrees wide at the half-power points, and this directivity is sufficient to permit point-to-point radio relay

*RECORD, *February*, 1938, *page* 208.
†RECORD, *December*, 1947, *page* 437.

operation without the use of high transmitted power. The shape of the major lobe is shown in Figure 3.

Radio waves at microwave frequencies have many characteristics similar to those of light. Among these is the property of traveling in essentially straight lines, and it is this characteristic that makes it necessary to have a line-of-sight path between adjacent radio stations. It is natural, therefore, to seek elevated sites, such as hilltops, for locating repeater stations, thereby extending the distance between them. By taking advantage of high natural elevations in hilly and mountainous country it is ordinarily necessary only to elevate the antennas above the local trees, but in flat country it is desirable to raise them to a height of 100 to 200 feet to obtain a line-of-sight path and avoid close spacing of repeater stations. Fading margins will be improved if the line-of-sight path is well above intermediate obstructions rather than just skimming the tops. The average spacing for the system between New York and Chicago is about 25 miles.

Two frequencies, 40 MC apart, are assigned to each channel, and they are used in alternate repeater sections. Thus a channel band transmitted from a station is always 40 MC away from the frequency band received at that station. This is done to avoid feedback around the antenna. Since a frequency used at one station is reused at the second following station, however, there is the possibility of over-reach interference, and for this reason precautions must be taken in selecting station sites. This is illustrated in Figure 4. Station B normally receives frequency f1 from station A and station D normally receives the same frequency from station C. Obviously, if the transmitting antenna at A and the receiving antenna at D were pointed at or near each other there would be overreach interference unless a physical barrier (high ground) exists between B and D. If there is no such barrier, the sites should be selected in such a manner that the total antenna discrimination is at least 50 db. This can be computed from Figure 3 by determining the losses corresponding to angles DAB and ADC and adding them.

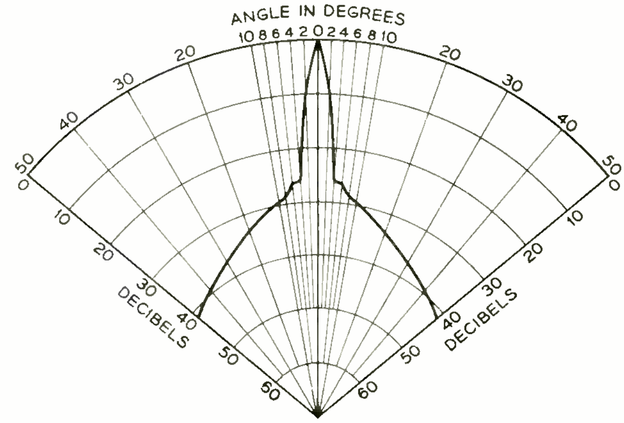


Fig. 3—Radiation pattern of the lens type antenna.

The TD-2 radio relay system has been designed for the satisfactory operation of 4000-mile telephone and television circuits. It is expected that inter-city television networks will be based on the use of main backbone routes bridged at intermediate frequency (70 MC) to supply local broadcasters or branch routes. Thus, the through channels need not be demodulated to video frequency for dropping purposes, although this can be done if desired.

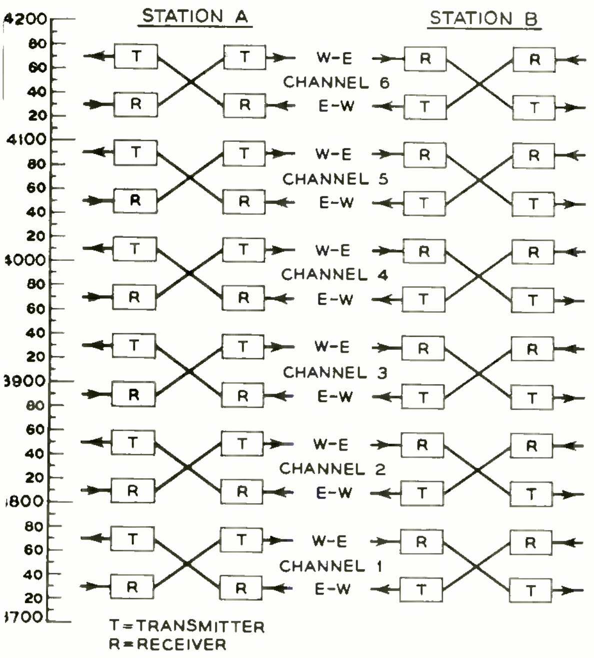


Fig. 2—Frequency allocations of the 12 channels through two repeater stations.

Video programs will normally be supplied to the radio relay system by wire lines employing video amplifiers, by type L coaxial facilities, or by type TE or other microwave radio facilities. Interconnection between the various facilities will usually be made at a common video switching point known as the television operating center. As with the video amplifiers and the TE systems, the TD-2 system is not arranged to transmit the sound portion of a television program. Regular broadcast sound facilities are required unless picture and sound are first combined in L1 carrier equipment and then transmitted over the TD-2 system. Such an arrangement has the disadvantage of reduced band-width of the picture channel, and, in addition, requires that L1 television terminals be used at each point on the TD system where it is desired to supply television service.

Type L carrier terminal equipment will be used for multiplexing telephone circuits and will connect to FM terminal equipment in the radio location. Both types of terminals are required wherever channels are dropped. As many as 16 pairs of FM terminals may be used in tandem.

A schematic block diagram of a terminal station and a repeater station is shown in Figure 5. At terminals, the baseband signal modulates the frequency of a 70 MC carrier in the FM transmitter to produce an intermediate frequency of 70 ± 10 MC. The output at this point is + 3 dbm, and all channels are cabled through a centralized patching and monitoring bay to their respective radio transmitters wherein they are raised to microwave frequencies. Each channel has an output of + 27 dbm, and is connected to a branching filter which serves to multiplex the six channels on one waveguide and antenna.

The IF patching bay provides the switching, bridging, and monitoring circuits required for maintenance and program switching purposes. By means of these circuits spare radio channels can be substituted for regular channels with little or no effect on service, and television networks can be rearranged at intermediate frequency instead of at baseband frequency when it is desired to do this.

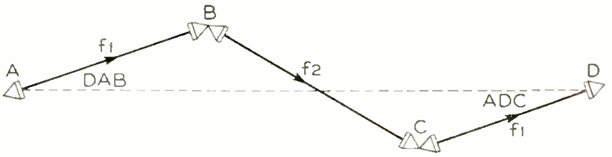


Fig. 4—Overreach interference conditions that must be considered in locating repeater stations.

At repeater stations, the microwave energy is picked up by the receiving antenna and fed through waveguides to channel branching filters mounted in the repeater bays. Because it is necessary to install antennas at heights that will clear obstructions between stations, and because it is desirable to install the microwave repeater equipment at a lower elevation in order to improve accessibility for maintenance, it is frequently necessary to employ long waveguide runs between the two locations. The best transmission is obtained when these runs are short and for this reason sites permitting short towers are advantageous. The impedance match between waveguide and antenna at one end, and between waveguide and repeater equipment at the other end is not perfect, thus resulting in reflections at these points. The longer the waveguide runs, the more the reflections, or echoes, are delayed, and the more serious the transmission impairment becomes.

After being selected by its appropriate filter, each channel is converted to intermediate frequency (70 MC) and then amplified in the radio receiver. Also included in the receiver is an automatic gain control circuit which is used to keep the output power constant by compensating for fading losses and vacuum tube aging. The output of the radio receiver is connected to the input of the radio transmitter either directly (for auxiliary repeaters), or through the IF patch bay (for main repeater stations) and then raised to microwave frequency in the same manner as at transmitting terminal stations.

In addition to the difference between main and auxiliary repeater stations just mentioned, there are two other major differences. At main repeater stations, the radio receivers and radio transmitters have separate microwave generators (local oscillators), and they are supplied with power over separate leads from the power room. In this manner they are made independent of each other, thus permitting flexibility in patching or splitting without service hazard or interference with maintenance.

At auxiliary repeater stations, a single microwave generator serves both transmitter and receiver, and the 40 MC difference required between incoming and outgoing frequencies is obtained by using a 40 MC shifter between the generator and the receiver. This plan has the advantage that a change in the frequency of the microwave generator will not cause any error in the transmitted frequency because the change is applied to both the receiving converter and transmitting modulator and thus cancels out. Power supply leads are used in common by transmitters and receivers in the same through channel without sacrifice in reliability since at these auxiliary stations no patching facilities are provided for interconnecting transmitters and receivers on different channels.

The receiving terminal arrangements are also shown in Figure 5. Incoming microwave energy is received through antenna and branching filters, and then demodulated to the 70 MC intermediate frequency in a radio receiver in the same manner as at repeater stations. The IF is reduced to the baseband frequency in an FM receiver whose output may be connected to carrier telephone terminal equipment or to television switching and distributing equipment.

The TD-2 system makes use of a recently developed alarm and control system to protect unattended radio stations. These may be either auxiliary stations, or unattended or partially attended main stations. In normal operation, each protected station transmits a continuous and distinctive voice-frequency tone to its alarm center. Wire line facilities are usually used for this purpose, although VHF radio facilities have been used in a few instances. Whenever an alarm condition arises at an unattended station, this tone is temporarily interrupted and an alarm is caused to register at a fully attended alarm center and identify the station in

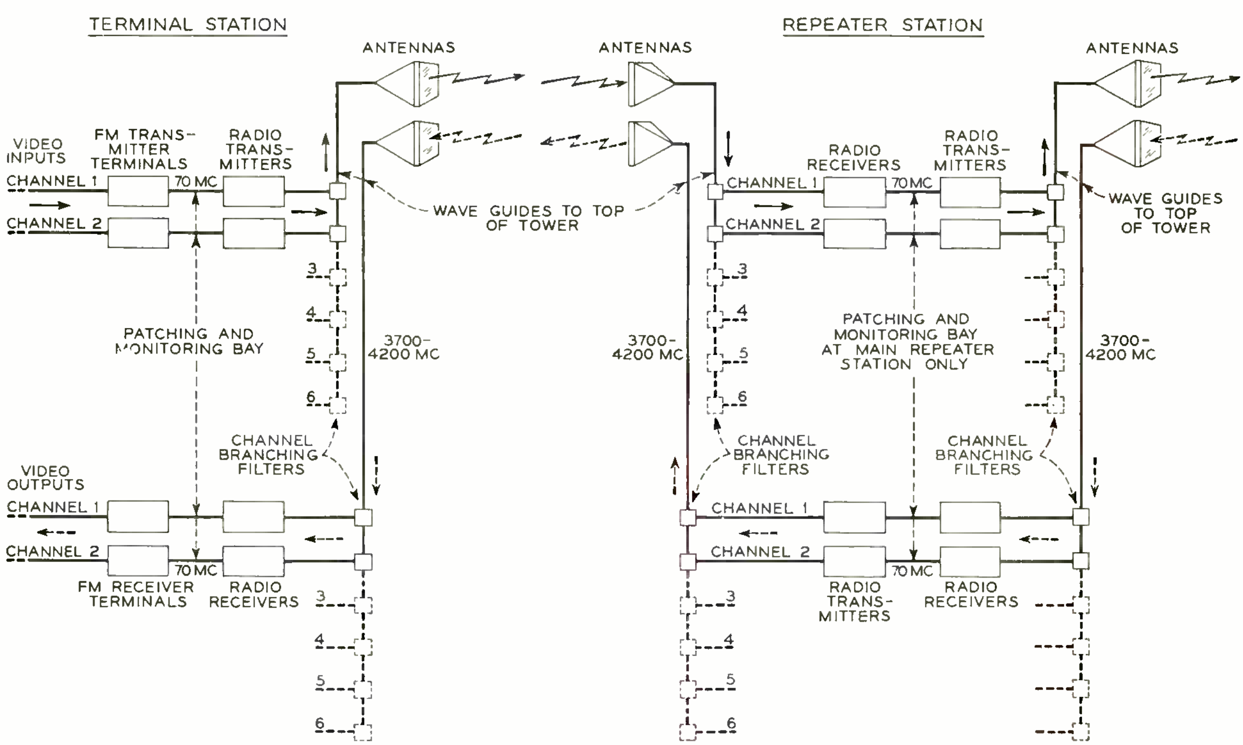


Fig. 5—Block diagram of a terminal and a repeater station.

trouble. The same alarm would register if the sending oscillator failed or if line trouble developed, thus protecting the alarm system itself.

To determine what specific trouble caused an alarm to be sent in from an unattended station, the maintenance man at an alarm center sends a voice-frequency order over the control system directing that station to report all individual alarms that have operated. A maximum of 42 different indications can be sent back to the alarm center from each unattended station, and this is accomplished by means of gated, voice-frequency pulses. The control system permits the alarm center to send a maximum of 10 remote control orders to each of twelve unattended stations.

Two types of talking circuits are provided for plant maintenance purposes. One is a local order circuit that terminates at adjacent main stations and is accessible to all intermediate auxiliary repeater stations and alarm and maintenance centers. Its use is limited to local maintenance within one main repeater section. The other is an express order circuit that is used for over-all system maintenance. It is available to terminals, main repeater stations, alarm centers, and maintenance centers. Both are four-wire circuits, and are connected to intermediate points by means of four-way bridging or three-hybrid coil bridging arrangements.

The TD-2 radio equipment requires three power supplies: 12 volts, 130 volts, and 250 volts. An additional power supply of 24 volts is required for alarm circuits, VF amplifiers of the order circuit, talking battery, rectifier control circuits and other purposes. These voltages are obtained from batteries that are

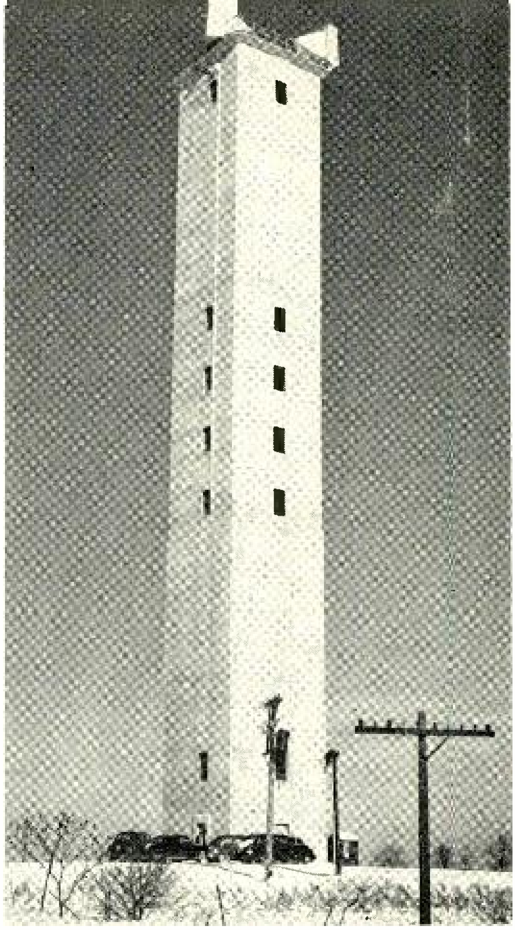


Fig. 6—The Valparaiso station on the radio relay system between New York and Chicago.

THE AUTHOR: C. E. Clutts, after graduating from the U. S. Naval Academy and completing two years sea duty in the Navy, joined the headquarters staff of the American Telephone and Telegraph Company in 1929. There he engaged in the study of toll circuit maintenance problems with particular reference to the development of toll test boards and methods for locating faults in the outside plant. He continued this work as a member of the Systems Development Department of the Laboratories and later as a member of the Transmission Development Department. During the war, Mr. Clutts served first as an instructor in the Laboratories war training school, but subsequently rejoined the Navy and was assigned to the Electronic Division of the Bureau of Ships. Since 1946 he has been a member of the Transmission Engineering Department and has been associated with the operating and maintenance aspects of the TD-2 radio relay system.

floated on the line through rectifiers operating from commercial 60-cycle power. Except for the 24-volt battery, multiple rectifiers are provided, and when a working rectifier fails another automatically takes over.

Emergency power for radio repeater stations is obtained from 20 KW or 30 KW engine-generators, the latter being used only at main stations having a large number of branching channels. If a commercial power failure persists for more than about two and one-half minutes, the engine starts automatically, and, after a five minute warm-up period, takes over the load. The station batteries serve the dual purposes of supplying power to the load during the above interim period of seven or eight minutes, and of carrying the load if the engine fails to start.

Further details of the TD-2 system will be described in future issues of the RECORD.

Borocarbon Resistors

A markedly improved type of deposited carbon reistor, expected to find widespread use in the communications and electronic fields, has been developed by the Laboratories. The initial announcement was made in a technical paper presented by R. O. Grisdale, A. C. Pfister and G. K. Teal befor the National Electronics Conference in Chicago on September 27.

In the new resistor, the element boron, as well as carbon, is pyrolitically deposited in a thin film on a suitable ceramic core. The addition of this element, it has been found, gives considerably lower temperature coefficients of resistance than those possessed by plain carbon resistors, as well as good stability. In addition, the new borocarbon resistors provide access to resistance ranges heretofore impossible to attain in stable, accurate film-type resistors. These advantages are expected to permit widespread substitution of borocarbon resistors for the larger and more costly wire bound types.

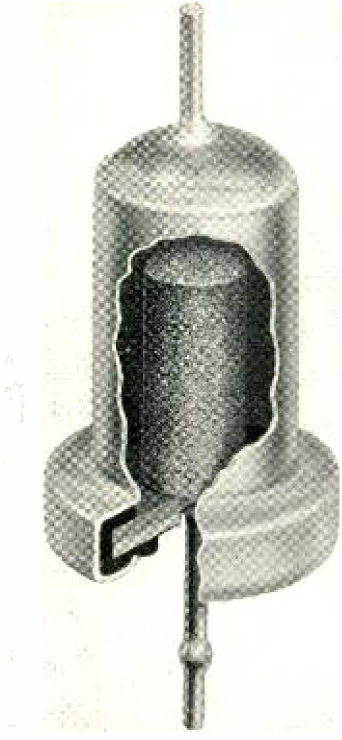
Recent years have seen an increasing growth in the use of pyrolytic carbon resistors.* Known variously as "cracked carbon resistors" or as "high stability carbon film resistors," they are composed of very thin films of microcrystalline carbon formed over the surfaces of ceramic cores. The conducting films of carbon are deposited by the thermal decomposition or pyrolysis of hydrocarbon gases or vapors.

While primarily developed for high frequency applications, the pyrolytic carbon resistor possesses other characteristics which have led and are leading to greatly expanded fields of application. Principal among these are the tolerances of one per cent or better attainable in production, the stability in use, the relatively small and predictable temparature coefficient of resistance, and the low noise level.

Borocarbon films are produced by the pyrolytic co-deposition of boron and carbon from suitable gaseous compounds of these elements. Their temperature coefficients of resistance depend both on film thickness and on boron content. By suitable variation in these, temperature coefficients as small as 20 PPM per degree C can be achieved. Borocarbon resistors of 10 megohm values in half watt sizes with temperature coefficients less than 100 PPM per degree C can be produced, while resistors of 250,000 ohms or lower have temperature coefficients less than 50 PPM per degree C. These values of temperature coefficient are comparable with and, indeed, smaller in many cases than for wire wound units of the same resistance value.

The specific resistance of borocarbon films depends on their boron contents, and by suitable variation in composition, films of very high resistances per square can be produced. Values of 500,000 ohms per square are readily obtained and values in excess of 1,000 megohms per square have been studied. The temperature coefficients of resistance for these high resistance films are larger than for films of lower resistance, but in the extremely high resistance ranges made accessible through use of these films temperature variations are generally of lesser importance.

*RECORD, *October,* 1948, *pages* 401 *and* 407.



Tantalum electrolytic capacitors

M. WHITEHEAD
Transmission Apparatus Development

Sintered tantalum electrolytic capacitor shown about five times normal size.

To meet the needs of miniaturized equipment, it is frequently necessary to provide capacitance of the order of several microfarads in very small space. Offering by far the most capacitance for their size and the lowest cost per microfarad, are capacitors of the electrolytic type. Electrolytic capacitors of the aluminum type which have been commercially available are not considered sufficiently reliable for many Bell System uses. Now, through the use of tantalum instead of aluminum as the electrode metal, these limitations are in a large measure removed. In addition, tantalum provides a further reduction in size as illustrated by Figure 1 which shows the comparative volumes of various types of capacitors having the same electrical rating.

The dielectric in an electrolytic capacitor consists of an extremely thin oxide film formed electrolytically on the surface of the metal electrode. The electrolyte conductively connects the opposite side of the film to a second electrode which may be a foil or the container. The electrolyte, also supplies oxygen as needed during operation to maintain the insulating properties of the oxide layer.

The thickness of the film is a linear function of the voltage at which it is formed and is of the order of 10^{-7} cm. per volt. It is the extreme thinness of the dielectric film which permits the realization of large capacitances in small physical sizes. Because of its asymmetric resistance property an electrolytic capacitor conducts current more freely in one direction than the other and is therefore essentially a polarized device. However, if the second electrode is also filmed with oxide it constitutes another capacitance in series with the first one. This non-polar construction is sometimes necessary where there are reversals of the applied potential polarity in service.

Tantalum, named after the Greek god Tantalus, because of the tantalizing difficulties met in isolating this metal from its ore, has advantages in electrolytic capacitors for both chemical and mechanical reasons. From a chemical standpoint, tantalum resists attack from most acid reagents and it permits the use of electrolytes with operating characteristics superior to those which can be used with aluminum. From a mechanical standpoint, the properties of tantalum permit the fabrication of capacitors to smaller sizes than aluminum.

Tantalum capacitors are made in two forms: one is of the conventional foil construction and the other one is the sintered type. As illustrated in Figure 2, the foil type is made by winding two paper-separated foil electrodes into a cylindrical unit. The absorbent paper serves essentially to contain the electrolyte and to prevent mechanical abrasion of the film during winding and use. For non-polar designs in this construction, both foils are filmed with oxide. In aluminum capacitors, the oxide-forming area of the foil is increased by chemical etching. So far, the tantalum capacitors employ foil only in its smooth rolled condition. But tantalum foil is inherently rougher, providing 10 to 20 per cent more effective area than smooth aluminum. Also its oxide film is 50 per cent higher in dielectric constant and the metal can be used in thinner form. As a result the present tantalum foil capacitors are about 30 per cent smaller than their etched aluminum counterparts. They are, however, larger than the sintered types for low-voltage ratings.

Tantalum is very amenable to powder metallurgy techniques. Hence for the sintered type shown in the head piece, the anode is made by pressing powdered tantalum into a compact shape and then sintering it in a vacuum furnace to weld the powdered particles. This results in a porous mass in which a relatively large surface area is available for oxide film formation. The oxide forming area in this structure is as much as 40 to 50 times that of a solid non-porous body of similar dimensions which provides an outstanding reduction in size per unit of capacitance. The second electrode of this capacitor is usually the container.

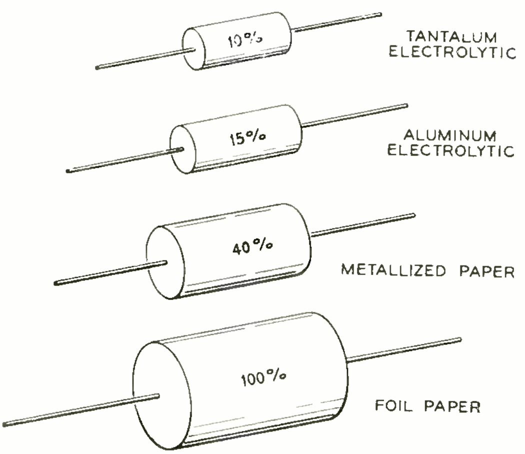


Fig. 1—Comparative volumes of foil-type 1-μf, 150-volt paper and electrolytic capacitors.

One of the controlling considerations in the choice of electrolytes for these capacitors is the power factor. The power factor increases with the resistance of the mean conducting path from the anode surface through the electrolyte to the cathode. In the sintered type, the path from the anode to the container is relatively long because of the porous nature of the anode and the required clearance between the anode and the container. To minimize the power factor for the sintered type, therefore, a higher conductivity electrolyte is required than for the foil type where the close spacing of the electrode and the non-porous nature of the foil results in very much shorter conducting paths. Also a highly fluid electrolyte is necessary to penetrate the pores of the sintered structure

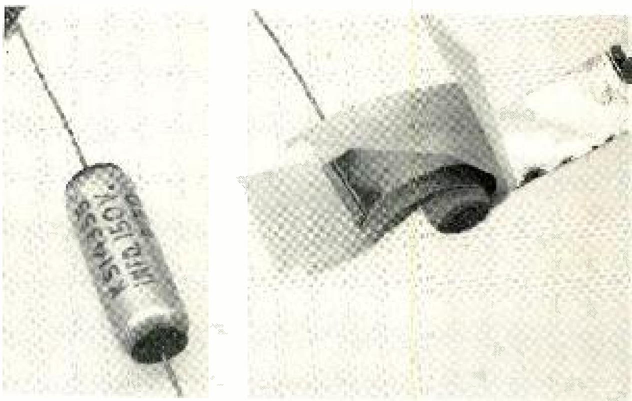


Fig. 2—Foil type electrolytic capacitor.

and realize the full capacitance available, whereas a glycol base electrolyte of higher viscosity can be used in the foil type.

The use of a high conductivity electrolyte in the sintered capacitors imposes a voltage limitation which is dictated by the threshold potential at which sparking occurs at the oxide film. This potential depends on the type of ion present, its concentration and mobility. Electrolytes of lower ionic concentration and mobility, and therefore of lower conductivity like the glycol type, permit operation at higher voltages. For this reason, the foil type which can be used with low-conductivity glycol is employed for the higher operating voltages. The maximum

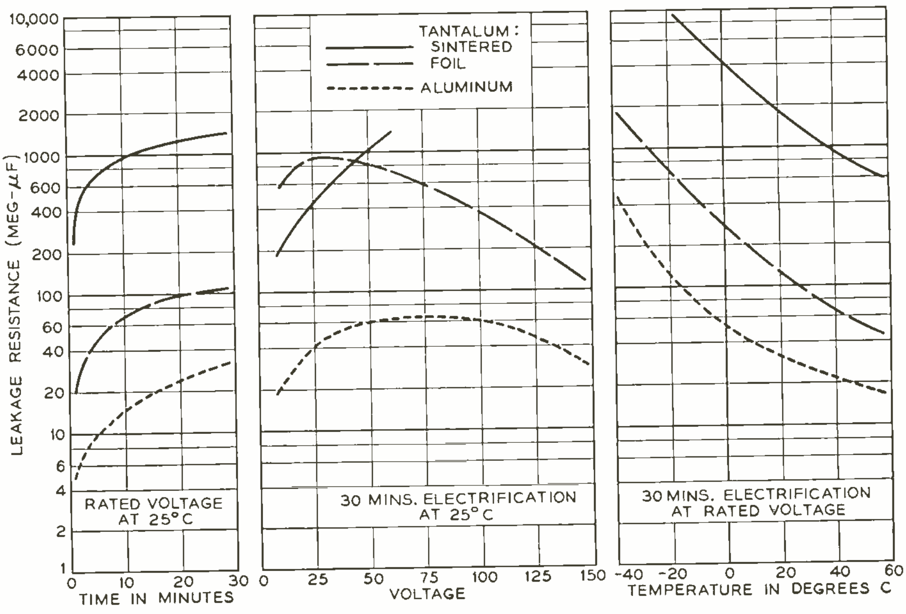


Fig. 3 – Leakage resistance characteristics.

safe operating potential of the sintered capacitors is about 70 volts with the aqueous solution of lithium chloride in current use.

The containers for the two types of capacitors are distinctly different in function. In the foil type, the container is merely a housing for the capacitor, whereas in the sintered type the container is part of the electrical circuit. The inert nature of the glycol base electrolyte used in the foil capacitors permits a simple container of a silver-plated copper tubing crimped at each end onto a rubber stopper. For the sintered capacitors, the container is of drawn fine silver which is used because of its resistance to chemical action from the more corrosive electrolyte. Silver wets well and provides a low contact resistance with the electrolyte. Furthermore, it catalyzes the recombination of any pressure-creating hydrogen gas evolved through electrolysis at the cathode. To provide a nonpolar version of the sintered capacitor, tantalum is essential for the container instead of silver.

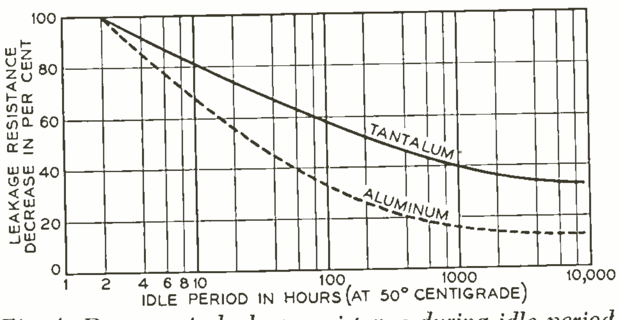


Fig. 4–Decrease in leakage resistance during idle period.

The tantalum capacitors, described herein, are of recent design on which development and life studies are still in progress. While some life test data have been collected on representative samples, these data, at present, are inadequate to permit evaluating the full life expectancy. However, from the known properties of tantalum together with the indicated stability of the tantalum oxide film, it is expected that tantalum will endow electrolytic capacitors with a greater service life than experienced with the aluminum types.

One of the characteristics of electrolytic capacitors which can be used as a figure of merit to indicate the completeness of the oxide film and its ability to withstand operating conditions for long periods is the leakage resistance. The leakage resistance performance of tantalum capacitors compared with aluminum, with respect to the time period of the applied voltage, the magnitude of the voltage, and with respect to temperature are shown in Figure 3. The higher initial leakage resistances for tantalum are an indication of longer life expectancy and, moreover, the oxide film stability maintains this high order of leakage resistance both in operation and under idle conditions to a higher degree than aluminum.

In idle equipment or in storage, electrolytic capacitors of all types undergo a decrease in dc leakage resistance. This is caused by diffusion of a polarizing gas layer and deterioration of the film at minute spots where metallic impurities are present on the surface of the base metal. The affected areas are too small to cause important changes in the ac capacitance and effective series resistance. Upon reapplication of voltage, this reduced leakage resistance permits relatively large leakage currents which in the case of aluminum capacitors, may be so high as to cause destructive overheating before the film reforms. For this reason, the safe storage period for aluminum types is normally limited to about two years. The leakage resistance with tantalum is not only higher but as illustrated in Figure 4, it decreases less during idleness. Hence, the storage limitations necessary with aluminum capacitors are being disregarded.

In paper capacitors impending failure of the dielectric under voltage is frequently foreshadowed by large decreases in the dc leakage resistance. This is not true of electrolytic capacitors, the failure of which is associated with the development of a high impedance rather than a short circuit. The behavior of the impedance is the best indication of aging effects leading to failure. Loss of capacitance and increase of effective series resistance are the trends to be expected and these are primarily a function of the stability of the electrolyte. Open circuit failures from uncontrollable corrosion of the base metal, as frequently experienced in aluminum capacitors, are non-existent in tantalum capacitors because of the immunity of this metal to common contaminants.

The relatively high power factor of electrolytic capacitors limits their use to low voltage ac applications since at higher values, internal dissipation overheats the capacitors and sometimes vaporizes the electrolyte creating dangerous internal pressures. The high power factor also makes them unsuitable for most tuning circuits. The power factor of the tantalum capacitor is not improved importantly compared to aluminum. A typical curve of the power factor as a function of frequency for tantalum capacitors of the ratings covered by this article is illustrated in Figure 5.

Due to the wide swing in the conductivity of the electrolyte with temperature, electrolytic capacitors exhibit a large increase in power factor at low temperatures, the predominant effect of temperature being observed in the effective series resistance component. Characteristic curves of the power factor and the change of capacitance with temperature are shown in Figure 6. The tantalum capacitor has a better temperature coefficient than aluminum and can be used as low as –60 degrees C whereas the usable range of the aluminum type is limited to about –40 degrees C. As with aluminum, the temperature coefficient of capacitance increases with increasing frequency.

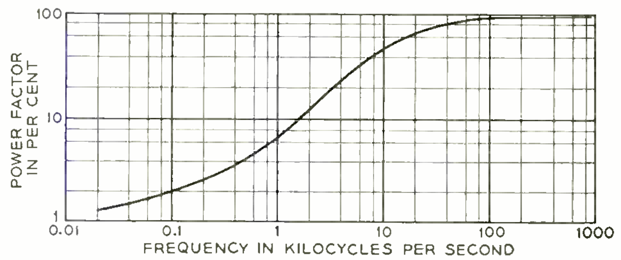


Fig. 5—Typical curve of the power factor as a function of frequency for tantalum capacitors.

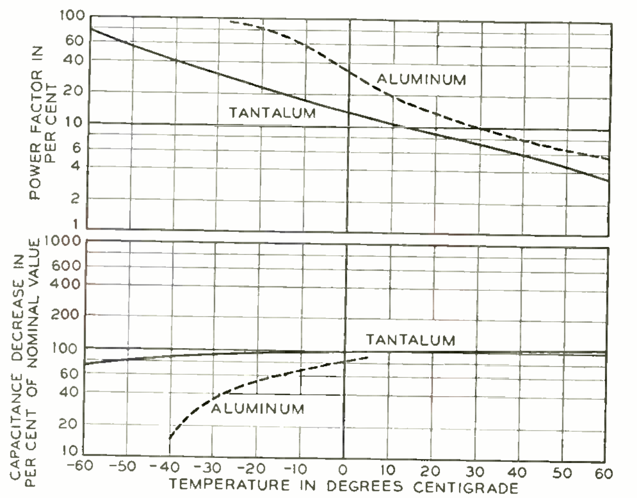


Fig. 6—Top: Power factor versus temperature at 1 kc. Bottom: Capacitance versus temperature at 1 kc.

So far, the tantalum capacitors of relatively low capacitance values have been used principally as substitutes for paper capacitors where the small size of tantalum is an advantage from the standpoint of equipment layout. It is expected that a large field of use for tantalum capacitors will be at capacitance ratings similar to those of conventional paper capacitors. Three ratings are in commercial production for use in the Type-N system, one of the sintered construction—4 μf/60 volts polar and two of the foil construction—1 μf/150 volts polar and 1 μf/150 volts non-polar.

The sintered capacitor is manufactured by the Fansteel Metallurgical Corporation and the foil type by the General Electric Company. Considerable laboratory and manufacturing development effort has been undertaken by both the Laboratories and these suppliers in making the capacitors useful and practicable components, and further work is in progress to develop them for other uses in the telephone system.

THE AUTHOR: M. WHITEHEAD received an E.E. degree from Rensselaer Polytechnic Institute in 1926 and a year later joined the Technical Staff of the Laboratories. As a member of what is now the Transmission Apparatus Development Department, he has engaged in a variety of work concerning chiefly our relations with the Underwriters' Laboratories, repair requirements for sound picture equipment, station maintenance practices and development of thermistors and electrolytic capacitors. He now directs a group engaged in the development of electrolytic and adjustable air capacitors.

Who Owns the A T & T?

The American Telephone and Telegraph Company is owned by 970,000 stockholders. They reside in cities, towns and rural areas throughout the country and hold an average of 28 shares. These investors are a cross section of America, more than 200,000 of them are Bell System employees who have acquired stock through payroll allotments.

At least one in every 50 families has a direct investment in A T & T. Many more have a beneficial interest through the holdings of insurance companies, schools, churches, hospitals and various charitable institutions.

No one stockholder holds as much as one-half of 1 per cent of the stock. The largest holding of an individual is less than one-twenty-fifth of 1 per cent. At the last annual meeting it would have taken the combined holdings of the 73,000 largest holders to have voted a majority of the outstanding stock.

Each year A T & T reports its 30 largest stockholders to the Federal Communications Commission. The last list included 23 bank nominees, two brokers, two insurance companies, a charitable foundation, a banking firm, and an investment trust. The aggregate holdings of these 30 accounts represented but 4 per cent of the total stock. Each of these holds stock in a fiduciary capacity.

An article in the Commercial and Financial Chronicle stated that information furnished by one of the bank nominees at the top of the A T & T stock list showed that shares carried in its name belonged to some 1,000 different accounts. Similarly, shares held in the largest broker's account belong to 2,700 customers with average holdings of 33 shares. The two insurance companies, owning 50,000 shares each, hold the stock for the benefit of several million policyholders. The remaining three accounts on the large holder list also represent many indirect owners or beneficiaries.

H. T. WILHELM
Transmission Apparatus Development

Maxwell bridge for measuring loading coils

An increasing use of loading coils for long subscriber loops and local area cables since the war had so stepped up their production that it became evident additional bridges for measuring their inductances would be necessary. The bridges* that have been used for nearly twenty-five years are of the comparison type. Although they have been giving very satisfactory performance, improved techniques of bridge design have been developed in the meantime. It seemed desirable therefore to design a Maxwell bridge† for factory measurements rather than duplicate the present comparison type bridge. As a result, the bridge shown in Figure 1 was developed by the Laboratories and is now in use at the Hawthorne plant of the Western Electric Company.

Since the telephone circuits in which these loading coils are used are all balanced to ground, the value of the inductance the coils insert is the effective balanced-to-ground inductance. Although most inductances are measured with one terminal of the inductor grounded, loading coils are measured with the two terminals balanced to ground. In existing bridges, as shown schematically in Figure 2, this is accomplished by shielding the bridge so that all capacitance to ground is concentrated at the two test terminals C and D. Additional capacitance is added, when necessary, to make these two capacitances CCG and CDG, equal. The test terminals are then balanced to ground, but an effective capacitance equal to CCG and CDG in series has been added to the CD arm of the bridge. This is readily balanced out by an adjustable capacitor CAD in the standard arm of the bridge. Consequently, when a loading coil, having an inductance L1 and associated capacitances to ground C1 and C2, is connected to the bridge, the bridge measures the effective inductance LX due to L1 shunted by C1 and C2 in series, which is the desired balanced-to-ground inductance. A resistance standard is also provided in series with LS to measure the effective resistance of the loading coil.

Previous Maxwell bridges, on the other hand, are designed for grounded measurements only. Their arrangement is as indicated in Figure 3. Here C and D are the test terminals as in Figure 2, but the bridge standards are now in the AB arm. Inductance in the test arm CD is measured by capacitance in AB, while resistance in CD is meas-

Fig. 1—The balanced Maxwell bridge mounted in a loading coil test set in service at the Hawthorne plant of the Western Electric Company.

*RECORD, *July*, 1927, *page* 399.

†RECORD, *June*, 1938, *page* 341; *and March*, 1945, *page* 89.

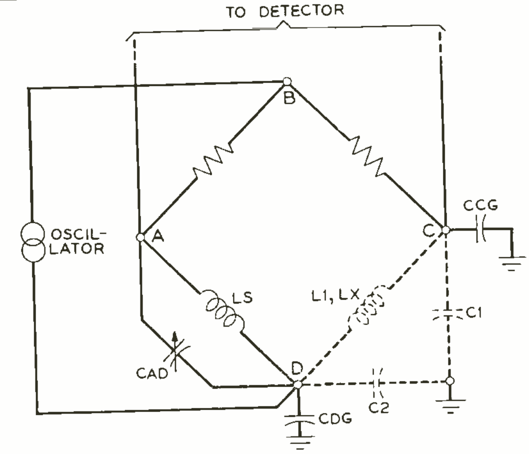


Fig. 2—Comparison-type bridge for measuring balanced-to-ground inductance.

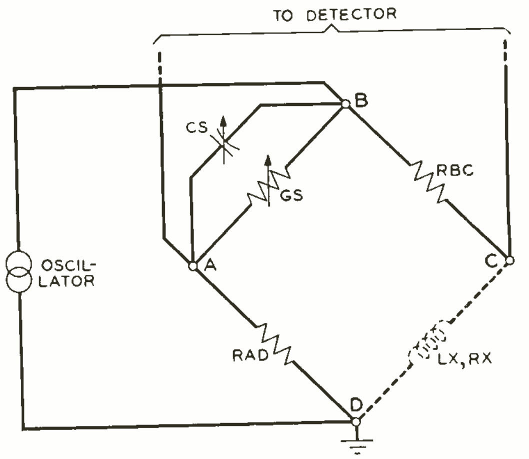


Fig. 3 – Maxwell bridge for measuring grounded inductance.

ured by conductance in AB. Unlike the bridge in Figure 2, however, there is no provision for balancing out capacitances in the CD arm, and the bridge is therefore designed so that all capacitance to ground is concentrated at the B point, resulting in capacitance from B to D which does not affect the bridge balance. To adapt the Maxwell bridge to balanced-to-ground measurements, it was necessary to find some means for compensating for capacitance in the CD arm.

From the general bridge equation, $Z_{AB}Z_{CD} = R_{AD}R_{BC}$, it is evident that for any fixed values for R_{AD} and R_{BC}, the product $Z_{AB}Z_{CD}$ must be constant. If Z_{CD} is changed, therefore, Z_{AB} must be changed inversely. Since parallel capacitance in one arm corresponds to series inductance in the opposite arm, all that was needed, therefore, was to add an inductor in series with the bridge standards, and to concentrate the ground capacitances at C and D as in Figure 2 and make them equal. The resulting bridge is shown in Figure 4, where LA is the compensating inductor, and SS is a shorting switch used for zero balances.

When SS is closed, the AB arm consists of LA which balances the capacitance of CCG and CDG in series, just as in Figure 2 the capacitor CAD balances CCG and CDG in series. Therefore, when switch SS is opened and a balanced-to-ground loading coil is connected to the test terminals, the inductance LX which the bridge measures is the effective balanced-to-ground inductance.

Actually, of course, the solution was not quite that simple. For one thing, any inductor such as LA necessarily has considerable resistance. To compensate for this it is necessary to add a corresponding amount of conductance in the CD arm. Since all of these parameters vary slightly with frequency, it may be necessary to provide adjustable zero balancing elements if the bridge is to be used over an appreciable frequency range.

To cover an inductance range greater than 10:1, it is desirable to provide more than one set of fixed arms (RAD, RBC) rather

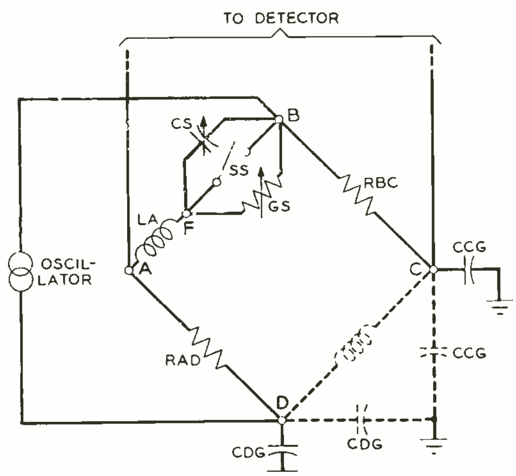


Fig. 4—Maxwell bridge for measuring balanced-to-ground inductance. The compensating inductor is shown as LA and SS is the shorting switch for zero balances.

than increase the range of the bridge standards. In the balanced-to-ground bridge, however, this makes it necessary to provide a compensating inductor, LA, for each value of multiplier product RADRBC. It was found that three product values would give ample range for loading coil testing, and accordingly three LA inductors were provided. The complete inductance range of the bridge is from 10 microhenrys to 1.11 henry, the resistance range is from 0.01 to 1111 ohms, and the frequency range is from 20 to 10,000 cycles/second. Figure 5 shows a schematic diagram of the complete bridge including shielding.

The four switch arms designated SK are operated by the multiplier dial. The shorting switch SS is used to short-circuit the bridge standards and at the same time to insert a protective 100-ohm resistor RP in series with the secondary of the oscillator transformer. Switch SZ is used to insert a zero-balancing inductor in series with the X1 test terminal. This permits making a zero balance with the test terminals short-circuited when it is desired to measure low inductances very precisely. To make the bridge more versatile, a grounding switch, SG, is provided to change the bridge from a balanced-to-ground to a grounded bridge. This is accomplished by grounding the D corner, and at the same time, decreasing the CCG capacitance to half its value so that the capacitance shunting the CD arm remains

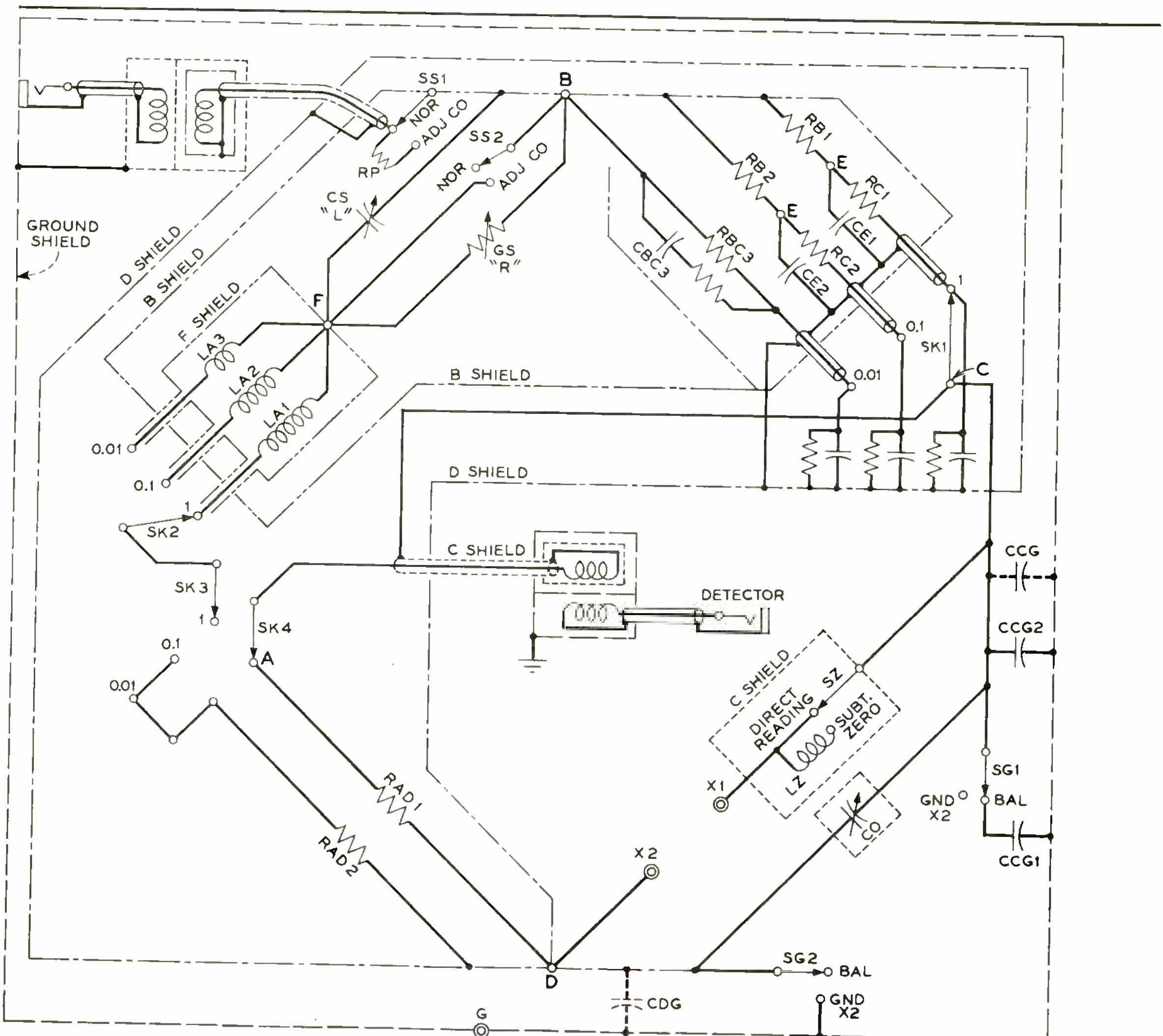


Fig. 5—Complete schematic of Maxwell bridge for measuring grounded and balanced-to-ground inductance

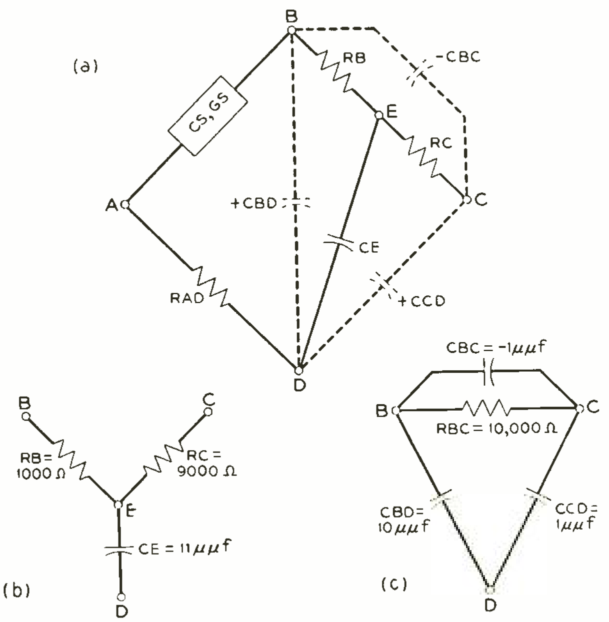


Fig. 6 – Adding capacitance from E to D in bridge schematic (a) is equivalent to adding negative capacitance from B to C, as demonstrated by the Y-Delta transformation in (b) and (c).

the same for both grounded and balanced-to-ground conditions.

In adjusting a Maxwell bridge to read correctly, it is necessary to make the sum of the phase angles of the two resistors RAD and RBC equal to zero. Because of residual capacitances in the bridge, the resultant phase angle is usually capacitive. Although this capacitance could be neutralized by adding inductance in series with one of the resistors, it has been found preferable to provide a neutralizing capacitor* CE from a tap on resistor RBC, as shown in Figure 6(a). By redrawing the network BCD as in Figure 6(b), it can be recognized as a Y, and may thus be transformed into an equivalent delta. This delta is actually composed of complex admittances, but at audio frequencies these admittances reduce to the circuit shown in 6(c). By way of illustration, if CE is 11 μμf, the effect is to add a negative capacitance of 1 μμf across RBC. A capacitance of 10 μμf is also added across BD, but this does not affect the bridge balance. A capacitance of 1 μμf is also added across CD, but this is combined with other capacitance in the CD arm and is balanced out as already discussed. Consequently by properly adjusting the CE capacitor, it is possible to obtain any reasonable negative capacitance across RBC, and thus make the sum of the phase angles of RAD and RBC equal to zero. A similar compensation scheme has been used in previous grounded Maxwell bridges.

Figure 7 shows a picture of the front of the bridge. Unlike most bridges in which the decade dials are located in two rows, one above the other, the standard decade dials are here all in a single row. This arrangement was suggested by the Western Electric test set engineers to enable the operator to grasp one of the R dials with the left hand and one of the L dials with the right hand and thus balance the bridge more rapidly. The lower left dial is the multiplier switch SK. The remaining dials are used infrequently and are therefore protected by hinged covers. At the center is the shorting switch SS; the right-hand compartment includes the zero-balancing capacitor CO, the substract-zero switch SZ, the grounding switch SG, and, below this, the test terminals.

Figure 1 shows the bridge mounted in a

*U. S. Patent 2,494,499.

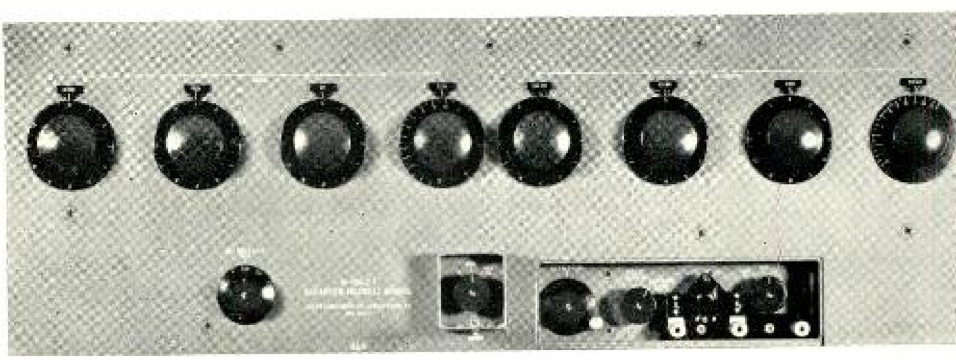


Fig. 7—Front view of bridge while under test at the Laboratories. Controls in the lower compartments are normally covered when bridge is in service.

THE AUTHOR: H. T. WILHELM joined the electrical measurements group of the Laboratories in 1922, but in 1924 left to complete his studies at Cooper Union. He graduated in 1927 with a B.S. degree in Electrical Engineering, and received the E. E. degree in 1936. After graduating in 1927, he resumed work with his former group. Since then he has been engaged in the design of measuring apparatus including impedance bridges, and in the development of test methods used by the Western Electric Company. He is a member of the A.I.E.E.

loading coil test set. Above the bridge is a cathode ray null detector.* The horizontal panel in front of the bridge provides for measuring inductance unbalance, d-c resistance and resistance difference. At the left is a fixture for holding the loading coil case under test.

Two of these bridges are being used at Hawthorne for testing loading coils, and another is contemplated.

*RECORD, *March*, 1945, *page* 89.

Patents Issued to Members of the Laboratories by the United States Patent Office During June, July and August

Albersheim, W. J.	Davis, R. C.	Kalin, W.	Morton, E. R.	Ronci, V. L. (2)
Almquist, M. L.	DeCoste, J. B.	Keister, W.	Mott, E. E.	Ruggles, D. M.
Barlow, D. S.	Dermond, F.	King, A. P.	Mueller, G. E.	Schelkunoff, S. A.
Barney, H. L.	Doherty, W. H.	Koenig, W.	Murphy, P. B.	Schramm, C. W.
Barry, J. F.	Edson, J. O.	Krecek, J. A.	Nebel, C. N.	Shann, O. A.
Barstow, J. M. (4)	Edson, R. C.	Kreisel, R. R.	Nesbitt, E. A. (3)	Shepherd, W. G.
Best, F. H.	Ekstrand, S. O.	Lander, J. J.	Newby, N. D.	Shiel, J. B.
Black, R.	Ferrell, E. B.	Lang, A. G. (3)	Newhouse, R. C.	Skellett, A. M.
Bohman, V. F.	Germanton, C. E.	Langabeer, H. T.	Oliver, B. M. (2)	Smith, P. H.
Bond, W. L.	Graham, R. S.	Lavery, G. G.	Pearsall, F. M.	Southworth, G. C. (2)
Bouton, G. M.	Grant, D. W.	Lewis, W. D.	Peek, R. L.	Spencer, H. H.
Branson, D. E.	Grounos, W.	Locke, G. A.	Peterson, E.	Stoller, H. M.
Budenbom, H. T.	Harrison, H. C.	Lovell, C. A.	Phipps, G. S.	Thayer, W. J.
Buhrendorf, F. G.	Hartley, R. V. L. (2)	Ludwig, A.	Pierce, J. R. (2)	Thomas, D. E.
Carbrey, R. L.	Hawks, V. J.	Mahoney, J. J.	Potter, J. A.	Tillotson, L. C.
Chapin, D. M.	Hickman, C. N.	Marshall, T. A.	Potter, J. F.	Townes, C. H.
Clark, J. E.	Hochgraf, L. (3)	Masek, F. E.	Rack, A. J.	Vance, R. L.
Cowley, G. W.	Holdaway, V. L.	Mason, W. P. (2)	Reynolds, F. W.	Veazie, E. A.
Curran, S. T.	Holden, W. H. T. (2)	Mathes, R. C.	Rhoads, C. S.	Walsh, E. J.
Cutler, C. C.	Jahn, A. P.	Mitchell, D.	Rigterink, M. D.	West, J. W. (2)
Darlington, S.	Johnson, K. S.	Mohr, M. E.	Rippere, R. O.	Williams, H. J. (2)
			Robb, T. D.	Wooldridge, D. E.

Three-bay cabinet for laboratory and shop

S. J. HARAZIM
Switching Systems Development

As communication systems become more complex, the need for measurements of higher accuracy and for new types of measurements on the components of the systems calls for correspondingly complex measuring equipment. This usually takes the form of an array of oscillators, attenuators, modulators, detectors, oscilloscopes and meters, which, with power supplies, amounts to two bays or more of equipment. Mounting this equipment to obtain operating convenience, stability and easy maintenance is a problem that is not satisfactorily solved by bolting together cabinets of the conventional type.

As several large phase and transmission sets were to be constructed by the Transmission Apparatus Department, for laboratory and shop use, it was decided that the design of a specialized cabinet for these and similar sets was warranted. This cabinet was to provide mounting space equivalent to that of three six-foot racks; was to take no more space than a standard 28-in. x 60-in. laboratory bench; was to be sufficiently mobile so that it could be rolled through a laboratory door; and was to be designed for easy use, including interconnections, grounding and maintenance. It was agreed that it should be attractive in appearance to encourage good housekeeping in the laboratory.

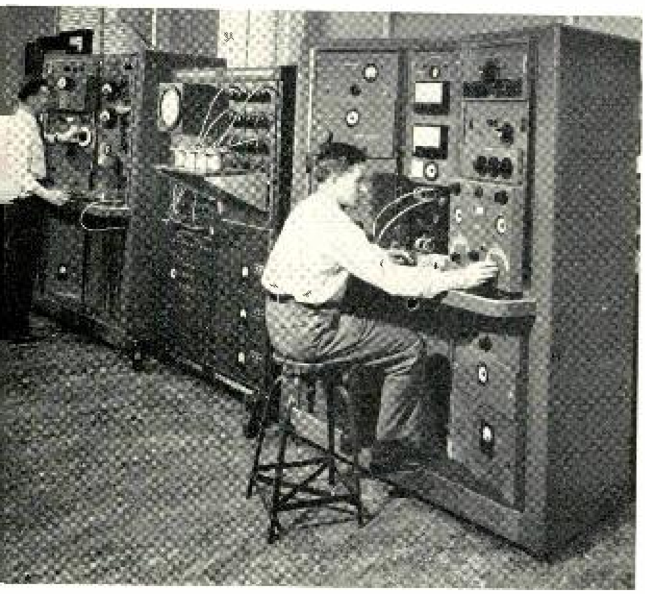


Fig. 1—Phase, delay and transmission sets in the new cabinets in the filter laboratory at Murray Hill. Left to right, F. W. Webb, R. J. Kirkpatrick and D. A. Alsberg.

The cabinet designed to meet these requirements is shown in Figure 2 as it was used for a $3\frac{1}{2}$-mc phase and transmission set already discussed in the RECORD.* Structurally, the cabinet consists essentially of three vertical angle-iron racks welded onto an angle-iron platform and having at the top and middle, cross ties between the center rack (rear) and the inner upright of each of the front racks. The two racks which face toward the front are toed in toward each other and are separated sufficiently to provide a central mounting space for vital individual items such as meters, jack fields and general controls. Formed sheet steel members, gray enameled, make up the rest of the framework. Openings are provided at the front for the instrument panels, at the rear center for additional power supplies and at the sides and rear for easy access to the interior. The narrow vertical members of the racks and the outward slant of the two front racks make all sides of mounted units freely accessible—even more so than in the standard open relay racks where the bulkier vertical members limit access to the

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*RECORD, *July* 1950, *page* 307.

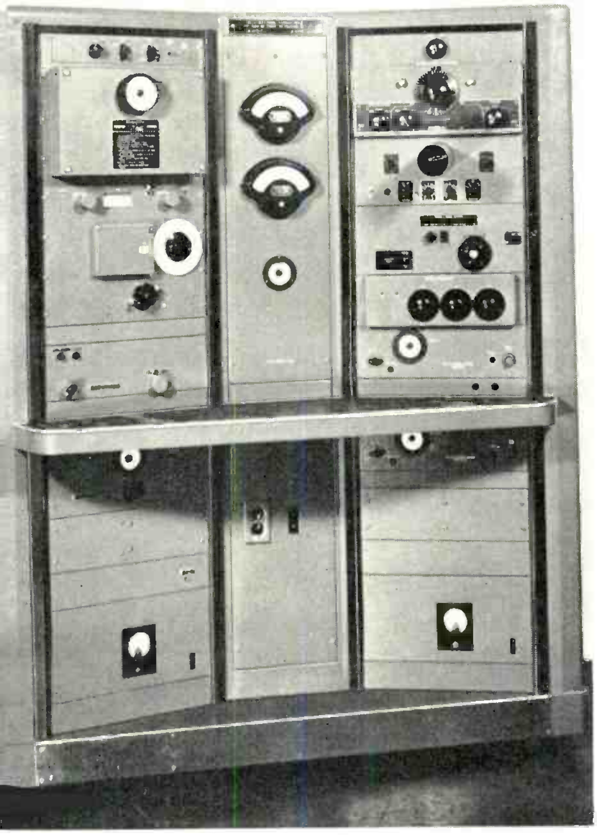


Fig. 2—Front view of the cabinet housing a 3.5-mc phase and transmission set.

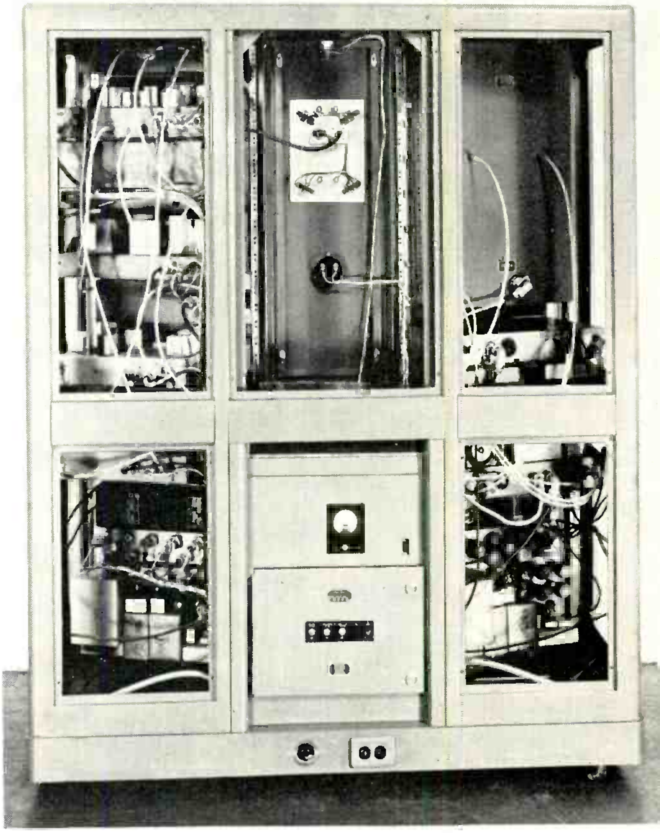


Fig. 3—Rear view of the cabinet as it appears with the covers removed.

sides of the chassis. Aluminum covers for the side and rear openings are held in place by quarter-turn fasteners. Figure 3 shows a rear view of the cabinet as it appears with the covers removed for installation or maintenance of the panel units.

Slanting the racks to the left and right of the center panel has several other advantages besides improving access to the rear of the units. It decreases the total horizontal space required for the equipment to bring this dimension within the desired 60 inches. It also provides a partially recessed space for a shelf practically as wide as the cabinet and of sufficient depth to support the components being tested, and makes it easier for the operator to reach the controls and observe the panel instruments. The shelf is at the same height as the top of a unit bench and is provided with a linoleum surface edged with aluminum beading to improve the appearance. For the same reason, mounting screws on the front panels are covered by snap-on strips of stainless steel. At the bottom platform a kick plate of stainless steel serves as a convenient foot rest. Four heavy duty rubber-faced casters make it easy to move the cabinet as required.

As many of the units operate from a common power source, generally 110 volts 60 cycle ac, two vertical moldings, each containing seven power outlets are mounted in the two rear inside corners. A power input receptacle and a duplex service outlet are located in the rear of the cabinet at the base. Another service outlet for such purposes as a soldering iron and auxiliary lighting is placed on the lower center panel at the front. A master circuit breaker switch is placed beside this front outlet.

As the grounding of high-frequency panels tends to become a critical matter, thin copper channels are slipped around the front flanges of the mounting angles and these are all bonded together by wide copper strips.

It is felt that the various features will make it relatively easy to adapt the cabinet to a variety of shop and laboratory measurement arrangements, with a minimum of application engineering. While it is not a production item, it has been found that this cabinet can be made on a custom basis at a cost which is generally less than 10 per cent of the cost of the equipment housed. At this ratio it seems to be a good investment in terms of utility, space economy, convenience and appearance.

THE AUTHOR: STANLEY HARAZIM joined the Engineering Department of the Western Electric Company in 1919 and immediately engaged in the drafting of electrical apparatus and in routine engineering, and later prepared manufacturing, testing, and conversion specifications on miscellaneous apparatus. In 1923, he graduated from the Technical Assistant Course, and in 1926 received the M.E. degree from Brooklyn Polytechnic Institute. He next joined the apparatus analysis group where he was concerned with tests simulating service conditions of new designs of telephone apparatus. From 1930 through 1948 he was engaged in electrical apparatus development; including a three years' period in the mechanical design of various units of transmitting equipment for broadcast and shipboard use; several years in the design of testing apparatus, such as oscillators, amplifiers, analyzers, potentiometers, and specialized test sets; and wartime development and pre-production of detection systems for underwater mines and spent torpedoes. Since 1948 he has been in the Switching Systems Development Department, engaged in the development of a new line of operators' metal desks for auxiliary services and in switchboard design.

Bell System Rates for TV Network Service

Despite the complex job of providing network service for television, a recently completed Long Lines study shows that Bell System charges for TV network facilities average only about 10 cents a mile for a half-hour program time. The 10-cent a mile figure, incidentally, includes charges for video and audio channels as well as all station connection, switching and local channels.

The study also shows that the average network charge to a station in each of the 28 cities now served by existing Bell System facilities would be approximately \$10 per station for a half-hour of program time. At the end of this year when 41 cities will have been linked, the estimate is \$11 per station. Indications are that Bell System charges average about 5 per cent of the total cost to the sponsor of many common types of television programs.

Bell System television rates are roughly seven times those for radio program service. However, providing network service for TV is a complex and costly job. With present carrier equipment a pair of coaxial tubes can carry as many as 600 simultaneous telephone conversations, yet an entire tube is required to carry a single video program. Video transmission by radio relay also requires a broad frequency band which could be used for hundreds of telephone circuits. The wide frequency bands required and the precision with which TV channels must be equalized are unique among Bell System services.

Some press articles have used the figure \$35 in discussing Bell System charges. It should be kept in mind that this figure is the rate per airline mile for video channels for eight consecutive hours a day for one month—in other words, for 240 hours of service.

Permanent signals in No. 5 crossbar

JOSEPH MICHAL
Switching Systems Development

Ever since the first central office went into service, "permanent signal" has been one of the most prevalent conditions requiring the attention of the maintenance force. When a subscriber wishes to place a call, he must first send a signal to the central office to attract the attention of the operator or, more commonly at the present time, the automatic circuits, so that the connection he desires may be set up. This signal is now sent merely by lifting the handset from its cradle. When the handset is replaced at the termination of a call, this signal disappears, and thus normally the signal is present only while a call is in progress. Sometimes, however, the signal becomes permanent. Perhaps the subscriber started to place a call and then just after the handset was lifted, the baby cried, and the solicitous parent inattentively laid the handset on the table instead of putting it back on its cradle, and ran to her child. When the operator answers, no one is on the line and yet the signal remains there—a permanent signal now exists.

Although a receiver off the hook or a handset off the cradle is the most common source of a permanent signal, it is not the only one. Any line or equipment trouble results in a permanent signal if it grounds or shorts the line in a way that gives essentially the same condition as a receiver off the hook. Permanent signals on a large number of lines is often the first indication of a cable failure.

A permanent signal prevents any calls from being connected to the line since the line is in effect made busy by the permanent signal. As a result, not only is the party responsible for the permanent signal prevented from receiving calls, but on multiparty lines all subscribers are similarly restricted. Its effect on a central office and the apparatus there depends on the type of office. In a manual office, little harm is done. The answering lamp of the line in front of the operator remains lighted, and the line itself is made busy, but other lines and equipment are not affected. In a step-by-step office, each permanent signal ties up certain of the selectors, and with a large number of permanent signals existing at the same time, the reduction in the number of available selectors may become serious. In a panel or crossbar office, any appreciable number of permanent signals would be very serious if preventive steps were not taken, since each permanent signal would tie up a common control circuit, of which there are comparatively few in the office. This situation is avoided by the use of "time out" circuits that release the common control after a comparatively short interval. In panel and No. 1 crossbar offices the methods adopted for dealing with a permanent signal have been guided to a large extent by the fact that a maintenance force is generally available in the office. In the No. 5 crossbar office, however, there may often be no maintenance force in the office for comparatively long periods, and a different philosophy had to be adopted in designing methods of dealing with it.

In panel and No. 1 crossbar offices, the method of dealing with a permanent signal consists of two stages. The first comprises a number of tests made by the operator, such as testing for a grounded line, and ringing on the line or applying a howler tone to attract the subscriber's attention so that the receiver will be replaced if it is off the hook. If all these efforts fail, an interval of between 15 and 45 minutes is allowed before further steps are taken. If the permanent signal has not disappeared at the end of this interval, the circuit is turned over to a test man who can determine the nature of the trouble by measurements on the line and can take steps to have it cleared. These two stages are retained by the No. 5 crossbar equipment, but the over-all supervision is made automatic, and since the operator to whom the line is first turned over may be in an office distant from the No. 5 crossbar office, a signaling system must be provided to transmit information back and forth between the No. 5 crossbar and the distant office.

When an originating register is connected to a subscriber line in a No. 5 crossbar office, it connects dial tone to the line and starts a timing circuit. If dial pulses are not received within approximately 25 seconds, the register calls in a marker and informs it that a permanent signal condition exists on the subscriber's line. The marker then connects the line to a permanent signal holding trunk, and disconnects it from the register. This takes the line out of service and prevents it from making further use of the common control circuits until the trouble has been cleared.

These permanent signal holding trunks are connected to the trunk link frames as are outgoing, incoming, and intraoffice trunks, and usually two are provided for each frame, although more or fewer may be provided if conditions make it desirable. One of these permanent signal holding trunks is indicated in Figure 1, which shows in block form the general method of dealing with a permanent signal in a No. 5 crossbar office.

As soon as a line is connected to it, a permanent signal holding trunk at once takes a number of steps that will lead to the ultimate removal of the permanent signal conditions. It extends the line terminals to the master test frame at the maintenance center of the No. 5 office and lights a lamp there to indicate the number of the permanent signal holding trunk involved, and whether the trouble is on a PBX line, a coin line, or a noncoin line. This information is given to the permanent signal holding trunk by the marker and will be used in clearing the trouble, since different types of lines require different treatments. The holding trunk also extends the line to a test and selector circuit where it will be available for test from the local test desk.

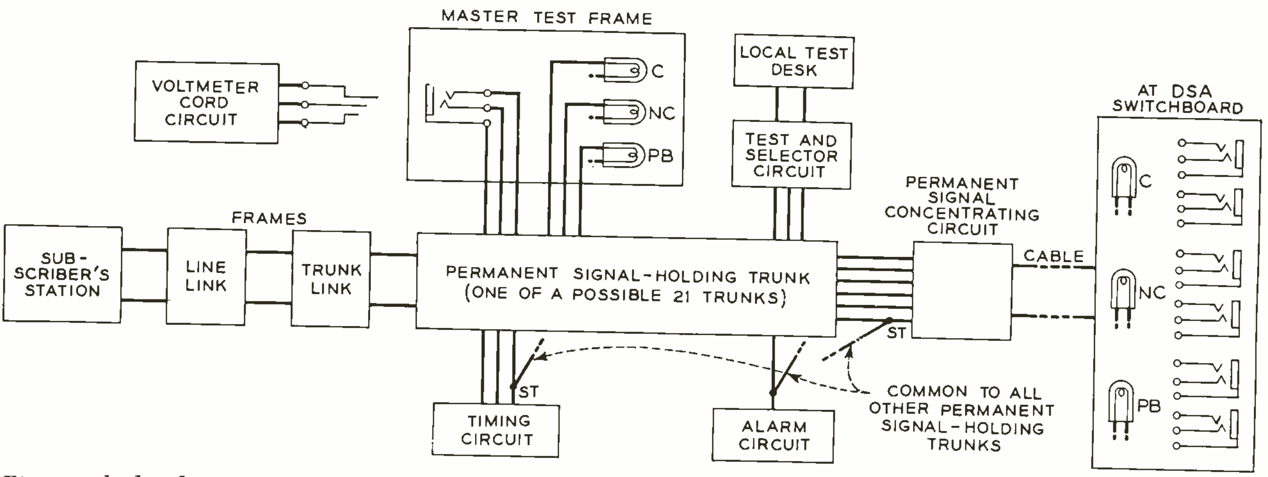


Fig. 1—Block schematic indicating method of handling permanent signal in a No. 5 crossbar office.

Since the first attempt to clear the permanent signal condition will be made by an operator, the holding circuit also extends the line to a concentrating circuit through which it will be extended to a DSA operator. This concentrating circuit can serve as many as twenty-one lines and connect them one after another over a single trunk to a DSA operator for test. It also serves another purpose. The DSA board may be in an office a considerable distance from the No. 5 office, and if howler tone and the other tests the operator makes were applied at the DSA board, the line attenuation to the subscriber station would be too great to allow them to be effective. They are actually applied in the concentrating circuit therefore, but under control of the DSA operator. The concentrating circuit also permits simplification in the holding trunks, since certain of the control features are included in a single concentrating circuit instead of in a large number of holding trunks. At least two concentrating circuits are always supplied, and more may be used where conditions warrant it.

Besides extending the line to these various points, the holding trunk also places a high tone on the ring conductor of the line to make the line readily identifiable. At the same time it starts a timing circuit to provide an interval adjustable between 15 and 45 minutes before demanding active attention from the maintenance force. During part of this period an operator will attempt to attract the attention of the subscriber by ringing on the line or applying howler tone. She may also make certain simple tests to determine the cause of the trouble and to remove it if possible, as already mentioned.

As soon as a line is connected to the concentrating circuit from a holding trunk, the concentrating circuit passes a signal to the DSA board which lights a lamp associated with a pair of jacks at one of the positions. There are three lamps and three pairs of jacks—one lamp and one pair of jacks for each of the three types of lines already mentioned. All the jacks have access to the line from the No. 5 office, but only the lamp associated with one pair of jacks is lighted by the concentrating circuit. The operator plugs into one of the jacks under the lighted lamp and then, if she hears no distinguishable sounds and is unable to get a reply, proceeds to apply her tests. If the permanent signal disappears during one of these tests—indicating that the subscriber has hung up—the operator's type-of-line lamp goes out and the operator takes down her plug. This, together with the disappearance of the permanent signal on the line at the No. 5 crossbar office, disconnects that line from the concentrating circuit and holding trunk and restores all conditions to normal. Should the operator not succeed in clearing the trouble, she still will take down her plug, but under this condition the holding trunk remains connected to the affected line, but the concentrating circuit and switchboard is released.

To permit the concentrating circuit to indicate to the DSA operator the type of line involved, and also to receive the results obtained from the tests that the operator applies, it must be possible to pass six different signals from the concentrating circuit to the DSA board. To permit the operator there to control the application of the various tests at the concentrating circuit, it must be possible to pass seven different signals from the DSA board to the concentrating circuit. Since only one pair is used between these two points for each concentrating circuit, a special sig-

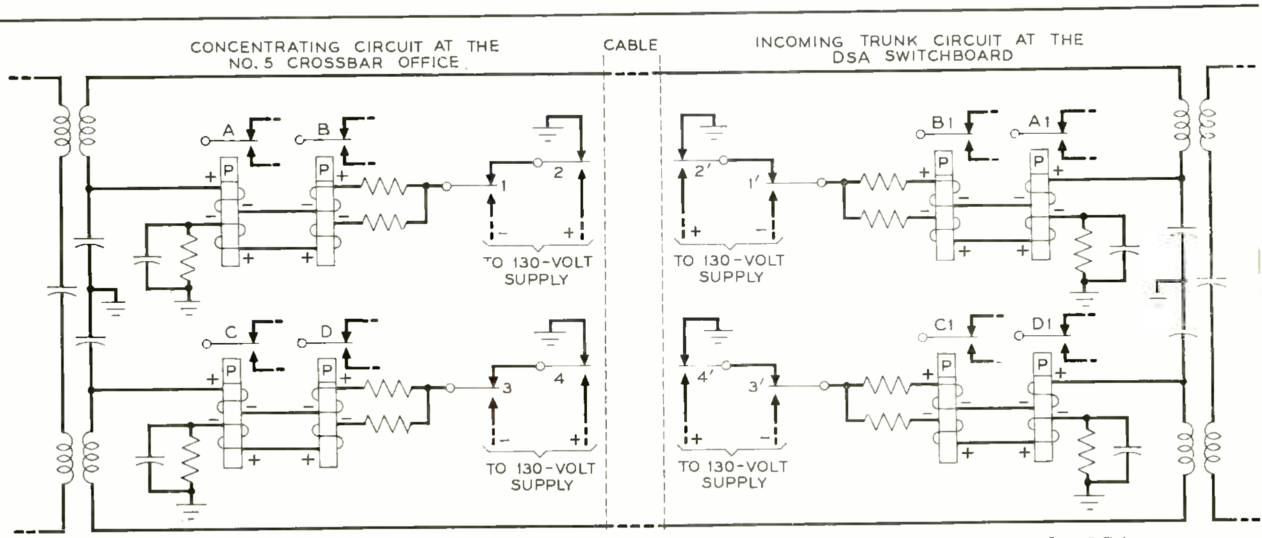


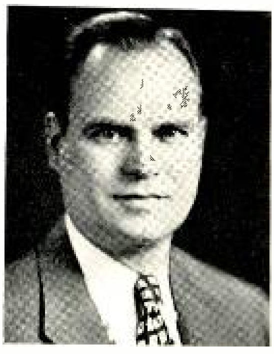
Fig. 2—Method by which six different signals may be passed from the concentrating circuit to the DSA operator and seven different signals may be passed from the DSA operator to the concentrating circuit.

naling circuit had to be developed. This is shown in simplified form in Figure 2.

This circuit permits as many as eight d-c signals to be sent in each direction over a single pair without interfering with voice transmission over the pair, and signals may be sent in both directions at the same time. Four polarized relays are used at each end of the circuit—two in series being connected to each side of the line at each terminal. To either or both of these pairs of relays—through contacts 1, 2, 3 and 4 or 1′, 2′, 3′ and 4′—either positive or negative battery is applied to transmit the signals. With positive voltage applied at contact No. 2 at the concentrating circuit, for example, only relay A1 at the DSA board will operate. Because the current is of the wrong polarity, B1 will not operate, and A and B will not operate because opposing currents pass through both the windings of each. If at the same time a positive potential is applied at contact 2′ at the switchboard, relays A and A1 will operate because of current flowing through their lower windings while no current is flowing through their upper windings. By using combinations of these relays, eight different signals can be received at the switchboard: A1, B1, C1, D1, A1 and C1, A1 and D1, B1 and C1, and B1 and D1. Similarly, eight different signals can be received at the concentrating circuit from the switchboard by using the same combinations of A, B, C, and D.

The operator will have concluded her tests before the end of the timing period that was started when the holding trunk was seized. At the end of the timing period, the holding trunk starts flashing the lamp at the master test frame that it had lighted when it was first seized. The lamp is changed from steady to flashing as soon as the trunk has timed out, but it may flash at either of two rates. It flashes at a lower rate when a connection has been made to the trunk either by the clerk at the repair service desk or by the maintenance man at the master test frame, but it flashes at a higher rate when such connections have not been made. When the trunk times out, it also gives an alarm in the No. 5 office. If there is a maintenance force in attendance at this time, the number of the line and of the permanent signal holding trunk will be reported to the repair service desk.

For economy reasons, permanent signal holding trunks, which are twelve-relay circuits, are provided only in sufficient quantity to handle the normal traffic. When an abnormal number of permanent signal conditions occur at the same time, all permanent signal holding trunks will become busy. Under these conditions, the marker will connect the subscriber line to a common overflow trunk circuit. This common overflow circuit consists of only five relays and is very liberally provided. It not only handles overflow from the permanent signal holding trunks but also the overflow from certain other trunk circuits. When the marker connects a subscriber line having a permanent signal condition to a common overflow circuit, however, it operates a class relay in the

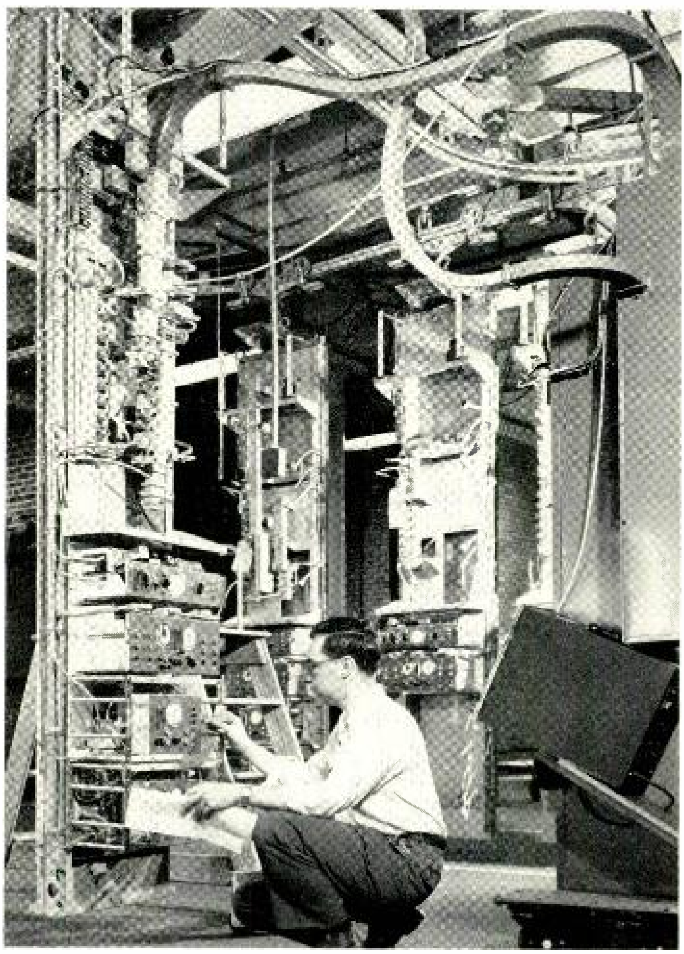


THE AUTHOR: Joseph Michal received B.S. degrees in electrical engineering from Cooper Union in 1932 and from New York University in 1935. As a member of the Toll Systems Department he first worked on various signaling circuits such as ship-to-shore signaling systems for harborcraft. During the war he was an instructor in the Bell Telephone Laboratories School for War Training, teaching the operation of several war devices, such as the M9 director, the M8 gun data computer and various flight trainers. Since the war, he has been concerned with the design of various trunk circuits for the No. 5 crossbar system and is now in a group which is designing improved signaling features for local crossbar systems.

trunk which supplies high tone on the ring conductor, and also extends the line conductors to a jack located at the master test frame, and lights a lamp associated with the jack.

When an abnormal number of permanent signal conditions occur at the same time, it is necessary to attract the attention of the maintenance personnel since they may be due to a cable failure. Each permanent signal holding trunk when connected to a subscriber line and each common overflow trunk circuit when connected to a subscriber line on which there is a permanent signal, connects a resistance ground to a permanent signal alarm circuit. This alarm circuit is an integrating type of circuit and only functions when a definite preset number of low resistance grounds are connected to it at the same time. Thus, when an abnormal number of permanent signal conditions occur at the same time, the permanent signal alarm circuit causes an audible and visual alarm circuit to function, thus bringing this condition to the attention of the maintenance personnel. Should the maintenance force not be in attendance, the alarm will be extended to the distant maintenance center, and the nature of the trouble will be indicated as has already been described.*

*RECORD, *August*, 1949, *page* 294 *and September*, 1949, *page* 322.



Over-all transmission tests on a TD-2 repeater amplifier bay in the Marion plant of the Western Electric Company.

Tells of Use of Laboratories Gun Director

A World War II book of especial interest to Laboratories people is "Ack Ack" by General Sir Frederick Pile*, who headed the anti-aircraft command in Great Britain during the entire war. General Pile gives due credit to the role played by American equipment, much of which originated in the Laboratories. Here are some excerpts from the book:

". . . we had received a considerable number of the new B.T.L.† electrical predictors. These instruments were technically far in advance of our former predictors, for they were capable of dealing with sudden changes of height. And it was by sudden changes of height that the Germans carried out practically all their evasive tactics. But, unfortunately, the electrical predictors were designed to work with a very smooth input of information such as could only be obtained from G.L. III with automatic following. . . .

"The best radar equipment was the American S.C.R. 584 which was specially designed to work with the B.T.L. predictor. So ingenious a device was it that neither at the set nor at the predictor was there any manual operation once the target had been picked up. The guns had been fitted with remote-control apparatus—they, too, were directed without manual operation. Fire instruments and guns, in fact, worked automatically as one entity. It seemed to us that the obvious answer to the robot target of the flying-bomb (against which we were now being warned) was a robot defense, so I asked for an immediate supply of 134 of these amazing instruments. I wanted to get eventually at least 430 of them, so that every B.T.L. predictor in the Command should have one. . . .

"The new American equipments, in particular, raised enormous problems (of training) which we could never have solved without the help of such supreme experts as Colonel A. H. Warner and Dr. E. O. Salant, Dr. C. A. Lovell, and Captain Jean P. Teas, of the U. S. A. forces.

"Furthermore, General Eisenhower took a personal interest in the state of the battle. London, he said, was as much a base for American troops as for British ones. Therefore he would lend 20 American batteries to the defenses. They operated there with their 90-mm. equipment‡ most effectively. And during the battle on the South Coast they contributed 138 flying-bombs to our total score, while they also shared in the destruction of a further 309. . . ."

Commenting on the book, C. A. Lovell says: "I had the privilege of attending several conferences on anti-aircraft problems in 1944 at which General Pile presided. He came to these conferences in his shirt sleeves, without any

*Published by George G. Harrap and Company, Limited, London. Price: 18 shillings net.

† The author footnotes this "An American design".

‡ Members of the Laboratories will recall the exhibition staged at Murray Hill in November 1943 by a 90-mm. battery. Each battery was equipped with a Laboratories M-9 gun director which converted data from target following (either optical or radar) into automatic movement of the four guns.

LIKE A STURDY OAK

The Bell System is a sturdy oak which has grown from the little acorns which are the savings of many hundreds of thousands of people in all walks of life and in every part of the country. It is the money these people invest in the telephone system that provides the capital for new facilities to improve and expand the service.

And the roots of this great tree are rates and earnings that are adequate to meet today's increased costs and attract new capital. For only if rates and earnings are adequate can we give you telephone service that gets better year after year, and that grows and expands to meet your constantly increasing use.

Never before has it been more important to keep this great tree healthy. Good telephone service is always vital to the nation's welfare. But in times like these, a strong financially sound telephone system is an absolute necessity.

The Telephone Hour, August 28, 1950

Experts Inspect Poles at Gulfport

Like a stage setting for a play, this scene catches the spirit of open air debate about ground contact exposure methods for evaluating wood preservatives. From left to right at the Gulfport, Miss., test plot: R. M. Lindgren, L. M. Hutchins, John Leutritz, Jr., Carl Hartley, R. H. Colley and A. F. Verrall. Drs. Colley and Leutritz represented the Laboratories. The others are all from the Division of Forest Pathology, Bureau of Plant Industry, U. S. Department of Agriculture. Photography by Dr. C. Audrey Richards.

insignia of his rank on his uniform and in spite of his somewhat mild manner, he always managed to get directly to the heart of the problem. His writing has a great deal of these same qualities of directness, effectiveness and lack of formality. His book traces the development of anti-aircraft defenses from 1884 when Germany created her first experimental airship establishment, continues through the preparations for aerial warfare in 1913 and the anti-aircraft defenses of Great Britain during the First World War. Beginning with the situation in 1938 when serious rumblings of a coming war were felt, he describes in considerable detail the sad state of the defenses. It is apparent that a democracy enters any war at best partially prepared to fight the previous one. He gives a vivid description of the difficulties of defending a democracy in the midst of its constituents. People who show great courage and stoicism under dangerous enemy action are inclined to protest vocally and loudly at the slightest inconvenience caused by the defenders."

Waveguide Transmission

*Principles and Applications of Waveguide Transmission,** by G. C. Southworth, is the title of a new book in the Bell Laboratories series published by D. Van Nostrand Company, Inc.

Written by the pioneer in waveguide technique, this book provides a complete treatment of the mathematical theory and the physical interpretation of the use of waveguides as transmission lines, antennas, transmitters and receivers, filters, and repeaters. The early chapters review the history of waveguide development, principles of waveguide networks and transmission lines, and the general theory of waveguide transmission. Quantitative material for applying the theory to waveguide transmission lines follows, considering discontinuities and branches to act as impedors. Composite structures may be built up from the several types of elements described, making possible two-way transmission over the same facility using the same frequency in both directions. The final two chapters consider electronic devices for waveguide use, and modulation and demodulation by waveguide methods. Appendices provide wavelength ratio tables, waveguide standards, and properties of certain dielectrics.

*The book has 704 pages and is priced at $9.50.

F. R. Lack Heads Electronics Mobilization Group

F. R. Lack, vice president of the Western Electric Company, has been named chairman of the National Electronics Mobilization Committee. The group, composed of representatives of communications-electronics firms, will coordinate mobilization activities of the industry and offer its services in an advisory capacity to government officials.

Mr. Lack also heads the Electronics Advisory Committee of the Munitions Board and the National Security Resources Board, and is a member of the Signal Corps advisory group composed of leading officials of communications operating and manufacturing companies.

Give Your Heart a Helping Hand

By Dr. M. H. Manson,
Medical Director, A. T. & T. Company

People with a heart or blood vessels which are permanently damaged can still enjoy a normal life by following a few basic precautions.

The American Heart Association, whose chief aim is to help those suffering from heart trouble to prolong life and decrease invalidism, tells us that people frequently worry needlessly, and think that if they have a heart condition, they are doomed to a life of invalidism.

Heart disease covers many different disorders. Whatever form of impairment you may have, there are practical, everyday things you can do to minimize potential discomfort and danger.

Overexertion, overeating, and intense mental activity and emotional excitement are to be avoided especially. Take all those little annoying situations which you cannot change and which worry only enlarges. Try to avoid worrying about them. Learn "not to scratch mosquito bites" and save that energy for the more important happenings which you can more readily control. This is the time to let go that idea that you are indispensable. Delegate to others some of those responsibilities which may have been "wearing you down." Don't think you have to punctuate every statement with a vigorous gesture or work yourself into a lather over some unavoidable situation.

Then take this business of overweight. It is a good idea to keep a little under the ideal figure for height and age. Keeping one's weight down is essentially a matter of keeping one's appetite under control. A reasonable amount of fat in one's meals is needed for good health. An excess, however, results in deposits of a fatty substance in the arteries which in turn favors the formation of blood clots.

Excessive smoking also is considered by some heart specialists to be a factor in coronary heart disease and definitely harmful in high blood pressure situations. In years gone by, many of the so-called acute indigestion deaths, which followed a hearty Sunday dinner and for which the pork roast alone was often blamed, were actually due to acute coronary heart attacks.

Try to plan your work so that you do not get overtired or push yourself to get the job done. This means allowing enough time to do things without a last minute mad rush. It takes one and one-half times as much energy to run for a bus or train as it does to make it on a moderate walk. The heart muscle ordinarily is not subject to strain from exertion as is true of other muscles in the body, but difficult or prolonged effort can cause strain. Avoid shoveling a driveway to the point of exhaustion after a full day's work, and lifting, pushing or carrying heavy pieces of furniture.

Some of the principles which have been applied in business to simplify your work at the office or in the shop, can be well worth copying at home. Learn to eliminate unnecessary motions. For example, garden tools should be kept in one place and have long enough handles to save stooping. And arrange for comfortable work heights and convenient work areas. How many repair jobs can you do sitting down and how well do you plan to have someone help you on those "top-of-the-ladder" jobs where reaching and straining may be involved?

While we are on this subject of strain and overwork, here's a message to the lady of the house whose heart in a particular ailment calls for some restriction in her daily activity. Working at elbow level heights, keeping stretches within a 16-inch reach, having objects which

Representing the Laboratories' Doll and Toy Committee, Muriel Walter distributes dolls at St. Vincent's Hospital on Christmas morning.

are used every day stored at more convenient heights, sitting down for many ordinary tasks such as preparing food and ironing—all these help to lessen fatigue and strain.

A great many unnecessary trips up and down stairs can be eliminated by better planning of the sequence of tasks, by having—wherever possible—duplicate equipment, such as telephones, on both floors, and by storing on each floor those articles which are used there. When you must make the trip, walk slowly. Don't run.

In these and many other ways you can help yourself to a new way of life which relieves your disabled heart of many unnecessary burdens.

Readers who are interested in further information about the heart will find *You and Your Heart** worth reading.

Recipients of IRE 1951 Fellow Awards

The Institute of Radio Engineers will confer the award of Fellow on forty-one outstanding engineers and scientists during the national convention of the Institute, March 19-22, 1951, in New York. Six Laboratories men will be among the recipients of the 1951 Fellow Award. They are W. M. Goodall of Deal, J. B. Johnson, W. T. Wintringham and G. N. Thayer of Murray Hill, and J. F. Morrison and W. C. Tinus of Whippany.

*Random House, $3.00.

Christmas Comes Early at the Laboratories

In October? Yes in fact, in September. That's the time Marie Kummer, Second Vice President of Bell Laboratories Club activated the Doll and Toy Committee. As in the past, this committee will handle hundreds of requests for dolls and toys for poor children from forty or fifty orphanages, hospitals, settlement houses and charitable organizations.

Miss Kummer, now at Murray Hill, will be chairman at that location. Mary Cross Frank will be the New York chairman; Mollie Radtke at Graybar; Gertrude Rooney at Whippany; Helen Conklin at Holmdel; and Laura Fenimore at Deal. Early this month committee members will be prepared to distribute dolls to be dressed for Christmas and to accept toys or contributions from members of the Laboratories.

Pacific Company Radio Assists in Hospital Ship Rescue Work

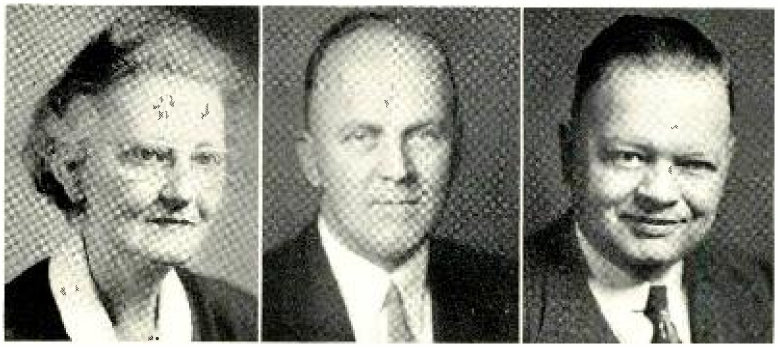
Radio stations of the Pacific Telephone and Telegraph Company handled many emergency calls following the sinking of the U. S. Hospital Ship *Benevolence* by the S. S. *Mary Luckenbach* on August 25. Fifty-one emergency calls were placed through their coastal harbor station KLH, San Francisco, by the Steamship *Mary Luckenbach* and five other vessels engaged in rescue work. In addition, 78 emergency calls with other watercraft engaged in this work were handled by the urban and highway mobile telephone stations in San Francisco and Oakland. The success of the rescue operation was aided materially by these calls.

West Street Girls' Bowling League

Caryl Schrumpf, chairman of the West Street Girls' Bowling League, has announced a change in bowling alleys and the new slate of officers and captains of teams for the 1950-51 season. The National Bowling Alleys at Eighth Avenue and Twenty-third Street, alleys used by the West Street Men's Bowling League, have been selected for the coming year. Starting on September 15 at 5:45 p.m., the girls will bowl each Friday evening until May.

Miss Schrumpf will be assisted by Catherine Dunham as secretary and Clare Halpine as treasurer. Captains for the teams are *Coils,* Agnes Hirsch; *Cables,* Lorraine Moss; *Signals,* Frieda Schultz; *Keys,* Virginia Keyser; *Dials,* Stella Vassilopoulos; and *Relays,* Clo Abascal.

RETIREMENTS



TESSIE CLANCY   C. H. WHEELER   W. H. T. HOLDEN

Among those retiring from the Laboratories are Tessie Clancy with 48 years of service; C. H. Wheeler, 44 years; R. G. Ramsdell, 41 years; R. E. Drake, 39 years; W. J. Leveridge and W. B. Mosher, 34 years; W. A. Phelps, 30 years; and W. H. T. Holden, 29 years.

TESSIE CLANCY

With the retirement of Tessie Clancy, the Laboratories has witnessed the passing of a generation of coil winders whose precision and skill is equalled only by the finest automatic coil-winding machines. Tessie has followed into retirement the three Bell System girls hired with her one spring morning in 1902. Like them, she hopes to enjoy active happy years, to frequent many of the Pioneer affairs and to keep her Laboratories' contacts.

A seventeen-year-old girl with long red braids reaching to the waistband of her flowing skirts, Tessie little thought when she was hired to wind coils by the piece that there would come a day when the precision of great war developments would depend upon her nimble fingers and keen eye. She and her older sister sat side by side at a Shop bench, singing as they wound coils. Noonhour would find Tessie hustling home for lunch, and after her day's work she'd go out dancing. To this day she has loved the same things, music, her day's work and dancing, though now she is merely a spectator.

While acquiring the skill which has made her so well known, she has also acquired a good technical background. There is hardly any major telephone development to which she has not contributed. Back in the days of C carrier development she was winding transformers, as she did later for the J, K and L1 telephone systems. She pioneered the transformers for sound picture development. Her greatest skill was required in World War II projects of unusual precision. Winding all the special coils for a magnetic detection job and making the pre-production coils for a submarine project are but a small part of her wartime record. Tessie grew up with modern relay systems and has had her hand in winding the coils for many of their models.

"Transformers were my favorite," Tessie said in her retirement interview. "The more intricate their winding, the better I liked them." More than her work she liked the people with whom she worked. When the war effort caused personnel to expand to a full Shop around the clock, she found the newer generation as nice as the girls of olden times, and made many friends. In turn, they included her in their activities, respected and loved her more than she had ever hoped to be.

Tessie's family has dwindled to a niece, wife of the principal of Jamaica Vocational High School, and two grandnephews, one an Ensign at Holy Cross, the other at Georgetown.

Tessie will continue to live in her apartment facing a Bronx Park. Music, adventure stories and the movies will help to occupy her time in retirement.

CLYDE H. WHEELER

Entering Western Electric in 1905 before he finished high school, Clyde Wheeler continued his studies at Pratt Institute in mechanical and electrical design. After three years he was put in charge of life tests and handled the analysis and laboratory testing of models and tool-made samples of telephone apparatus. During World War I he worked on telephone and submarine detection apparatus. Returning to testing, his group gradually was enlarged and was also responsible for analysis of coin collectors, telephone booths and other station apparatus, and manual central office apparatus.

In 1939 when station apparatus was transferred to Murray Hill, Mr. Wheeler replaced that work with design and testing of mounting plates, fire-protection apparatus, and toll ticket distributing systems; also he continued the analysis and test of central office apparatus. During the second World War he was liaison man between our Gun Director group and the makers of mobile equipment to transport it. In 1945 he resumed his apparatus design work, until ill health forced an extended leave. Nineteen patents have been issued in his name, on coin collectors, message registers and on a special wire for central office fire detection systems.

Mr. Wheeler is an inveterate saltwater fisherman, and has a summer home at Wading River, Long Island. It is a convenient spot to indulge his other two hobbies—boating and hunting. He and his wife expect to enjoy his two daughters and their husbands and two grandchildren.

William H. T. Holden

After an early interest in the classics, Mr. Holden decided science was his field and graduated from Yale in 1915 with a B.A. in physics. He was awarded the Sloane Fellowship in physics, and was for three years a graduate student at Yale and later for a year at Columbia. He also spent two summers working for Westinghouse in East Pittsburgh. During World War I he attended an officers' school of the Signal Corps. After one year with Westinghouse on rectifiers, he entered A T & T where he continued to work on power supplies as a member of the Department of Development and Research. Soon transferred to the radio group, he worked

W. J. Leveridge W. A. Phelps

on wire networks for broadcasting, and on the long-wave transatlantic project. In 1928 he went over to toll power plant studies and four years later to a study of uses for gas-filled tubes.

When the D & R was transferred to the Laboratories in 1934, Mr. Holden worked on local transmission. In 1936, assigned to a group in switching research, he made fundamental studies of new types of switches. During the early part of World War II he worked on the airplane crew trainer*, and then on an aircraft position indicator. Immediately after the war, he was transferred to crossbar circuit development where he worked on directory-number identification and on voice frequency dialing. His thorough knowledge of electronic tubes was of great value in his latest work on electronic marker and translator systems. One hundred and ten patents have been issued to him, and a number of cases are still pending.

For twenty-two years Mr. Holden has been teaching at Pratt Institute's evening school, in the fields of communication and industrial electronics, and for the last two of those years he has been in charge of the electrical school. When he and Mrs. Holden are settled in their home in Pasadena, he will be a technical representative for a manufacturer of airplane accessories, and he hopes to teach a course in control systems.

W. J. Leveridge

After graduation from Northampton Technical Institute in London, W. J. Leveridge came to this country in 1913 and a few years later joined the Laboratories. His early work was in research design, particularly on telephone transmitters, vacuum tubes and filament coating apparatus. During World War I he was concerned with improvements in binaural sound locating devices for detecting airplanes and submarines.

After the war he was transferred to the apparatus design group where he was responsible for the production design of long range sound projectors and other devices for use with public address and sound picture systems. With this as a background, he was transferred to the Electrical Research Products, Inc., in 1928, where he was placed in charge of the mechanical engineering group and was concerned with film and disc recording equipment used by the industry in making sound picture recordings. In 1937 when E.R.P.I. disbanded, Mr. Leveridge returned to the Laboratories where he joined the research staff and was engaged in the study and development of various vacuum tube and copper oxide rectifiers to be used as substitutes for batteries in the Laboratories and in central office and power systems. While still a member of the Research Staff he aided in the design of experimental relays and switching devices.

During World War II he was placed in the electronics division and was assigned to the development and pilot production of magnetrons used in radar and test apparatus used in connection with them. After the war, with the switching apparatus development group, he designed the paper feed and metal evaporating

*Record, *February*, 1945, *page* 33. Mr. Holden made substantial contributions to this project.

unit for metallizing paper for use in capacitors. He also assisted in the development of the trouble recorder, and the card translator. His latest work was the modification and improvement of quiet vacuum cleaners and portable compressors used in special cleaning devices.

For the time being Mr. and Mrs. Leveridge expect to remain in their present home in Tuckahoe. Their elder son, an engineering graduate of the University of Michigan, is in the air conditioning field, while their younger son, an ex-G.I., will be a senior at Cornell, majoring in agriculture and animal husbandry.

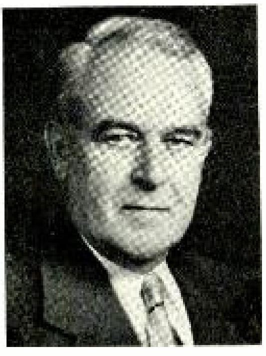
Mr. Leveridge expects to carry on with his design engineering problems and hopes to keep his contacts with his Laboratories colleagues.

Roger G. Ramsdell

With a degree from the University of Vermont, Roger Ramsdell entered the Engineering Department of A T & T in 1909. Ten years later he transferred to the Department of Development and Research where he was concerned with the developmnt of central office apparatus, more particularly of switchboard jacks, plugs and cords, and the tools and gauges required in the field to maintain this apparatus. When the D & R were consolidated with the Laboratories in 1934, he continued in central office facilities work.

During World War I Mr. Ramsdell worked on design of test-desks and positions for the big Army and Navy PBX boards in Washington. In the second World War he was one of a group which compiled lists of spare parts which had to be furnished in appropriate quantities for radar, Spiral-Four, carrier telegraph, radio, and many other systems developed here. For this work he received a Certificate of Appreciation from the War Department. Post-war he has been engaged in the study of maintenance practices and various types of tool for newly developed apparatus.

The Ramsdells live in Rockville Centre. Father and son (an engineer with Consolidated Edison) are active model railroaders; and in addition Mr. Ramsdell has his daughter's two children to indoctrinate in the craft. He is also interested in genealogy and plans to spend some of his leisure in collating a lot of material on his and his wife's families.



R. G. Ramsdell

W. B. Mosher

R. E. Drake

Walter A. Phelps

Entering the Laboratories in 1920, Walter Phelps worked for a while on carrier telephony, and when development was started on a carrier telegraph system for the first Key West-Havana cables he joined in the project. Then followed the Type B carrier telegraph system for open wire lines, and the 12-channel voice-frequency system which is still in use alongside his latest contribution, the 40C system which gives 18 telegraph channels in the voice-frequency band. He and his group have also handled the current engineering required to adapt these systems to special situations.

Along with his telegraphy, Mr. Phelps has been in our telephotograph system work since its inception. His biggest single contribution has been an automatic level compensator which has met the severe requirements of the large nation-wide systems by holding the receiving level constant within a fraction of a decibel.

During World War II Mr. Phelps developed a carrier telegraph system widely used by the Navy in the Pacific; and a system whose reliability against fading was of great usefulness in the North African Campaign.

An inveterate walker, Mr. Phelps has tramped most of the mountain trails in the East, and also in the Canadian Rockies. He and Mrs. Phelps expect to live in New England, convenient to some mountain range. He is a graduate of Dartmouth (B.S. 1910) and Princeton (M.A. 1912). Between the latter and his joining us he taught at Dartmouth and Pratt Institute, did graduate work at Harvard, and was an officer in the Signal Corps in World War I.

William B. Mosher

Soon after "Ben" Mosher entered the C & P at Baltimore in 1916 he worked for the transmission engineer; when the latter went off to World War I, Mr. Mosher took over the job. In the next seven years he designed toll cable systems, made transposition layouts and ran down transmission complaints. Eventually he was chosen to go to New York for training in inductive coordination and, returning, to give a course in that subject to plant men in C & P.

That work led to his transfer in 1924 to A T & T to work on inductive coordination and for two years he was in Minneapolis on one job. He continued his work on noise and crosstalk until World War II.

By 1942 the pressure of government work was heavy, and Mr. Mosher went over to preparing specifications for military equipment. This type of work he continued until retirement, specializing on relays.

A bachelor, Mr. Mosher lives on Brooklyn Heights. He expects to remain there, and to use his leisure to do a few things he could never find time for, such as knocking around Chesapeake Bay under sail.

Ralph E. Drake

After he completed Western Electric's student course in 1912, Mr. Drake came to New York and joined a group working on telephone receivers. Over the next quarter century he had something to do with every receiver developed here after the first hand telephone sets came into use. He studied the instruments returned from the field so that future developments might profit from service experience.

Beginning in 1940, Mr. Drake spent a year on statistical analyses and then went over to the development of varistors. In 1942 he transferred to the development of electrolytic capacitors which were being used in many of our wartime jobs. This work led into the tantalum capacitor, a development described on page 448.

The Drakes live in Morristown, where they plan to continue for the present. Mr. Drake is a graduate of Colorado State, BS in EE 1911.

Helen Monahan, Whippany files supervisor, checks on a drawing with Mary Jane Comly.

Grace Wagner, the new accompanist for the West Street Choral Group, is a member of the General Service Department. Miss Wagner inherits her musical ability from her mother, a concert singer.

News Notes

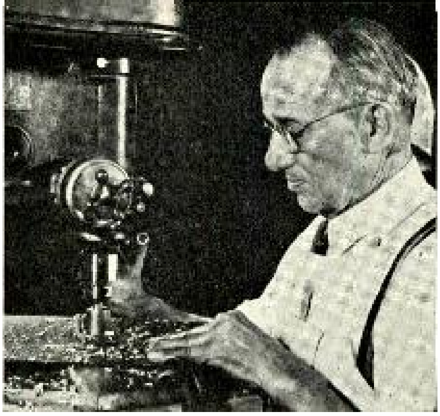
W. J. Kiernan and R. J. Phair were at Hawthorne to discuss application of finishes by steam spray and other finish problems.

C. J. Calbick attended the meeting of the American Crystallographic Association held at New Hampton, New Hampshire.

W. F. Janssen visited the Western Electric Company at Haverhill on problems dealing with the manufacture of transformer coils.

A. W. Treptow discussed the manufacture of porcelain enamel frits at the Thomas C. Thompson Company, Chicago.

NEWS OF THE TELEPHONE PIONEERS



Nick Schoen drilling a panel for a broadcast studio using a WatchMaster timing standard in its clock system.

Nick Schoen Still Going Strong

1865. The Civil War had just ended. In that year Lincoln was assassinated. Those two facts picture the period in which Nicholas Schoen was born on the lower East Side of New York. But the East Side wasn't the same in those days. Indeed, there were vacant lots along the wharves on which Nick could play ball and the river was handy for swimming after Grammar School, No. 13, was out.

But Nick, smart boy, was graduated from school at the age of 14 and took a job with the Sohmer Piano Company as errand boy at $2.00 a week. Continuing his studies at night he later qualified for entry to City College but decided not to go when he was offered a good opportunity in the John Williams Machine Shop. He continued at this type of work with various companies and worked on Government contracts during the Spanish-American War.

After the war in 1899, he went to work for the Western Electric Company in its machine shop and was transferred through several manufacturing departments, in many instances doing special work for F. B. Jewett, E. H. Colpitts and E. B. Craft. In one of these he worked on the development of a range finder and then installed it on the new Battleship *Maine*.

During World War I, he was in the old model shop and worked on coin slot telephone instruments during their development. He continued in this department through 1931 at which time he retired.

But Mr. Schoen, (a youth of 67 years) found time hanging on his hands and at the age of 77 was invited to join the machine shop of American Time Products, Inc., manufacturer of the WatchMaster Watch-rate recorder and precision timing equipment. This was directly after Pearl Harbor when Nick felt the urge to do his bit, temporarily in the World War II effort. He has held this "temporary" job for eight years. Now, at the age of eighty-four, he is still going strong.

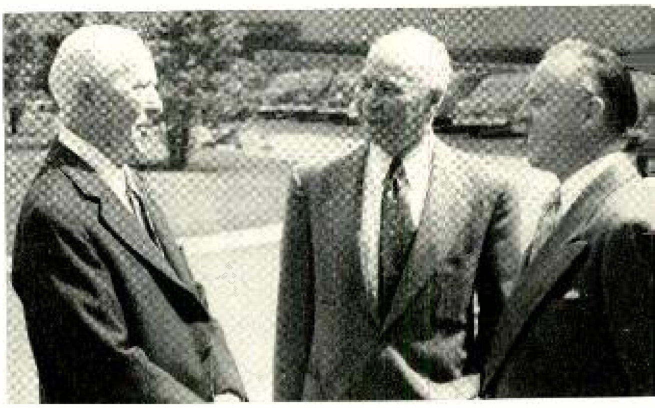
Nick works because he likes to work, because he is an active part of an active world. With faith in the WatchMaster, he feels that he is contributing to an easier and more profitable life for others who find the instrument to be an aid toward better work.

Pioneers of the New York Council, off on a "Package Party" in a coach which left West Street on August 24 at 5:30 p.m., enjoyed dinner in Jersey and the theater at the Paper Mill Playhouse in Millburn where Naughty Marietta *was playing.*

Early-Bird Pioneer

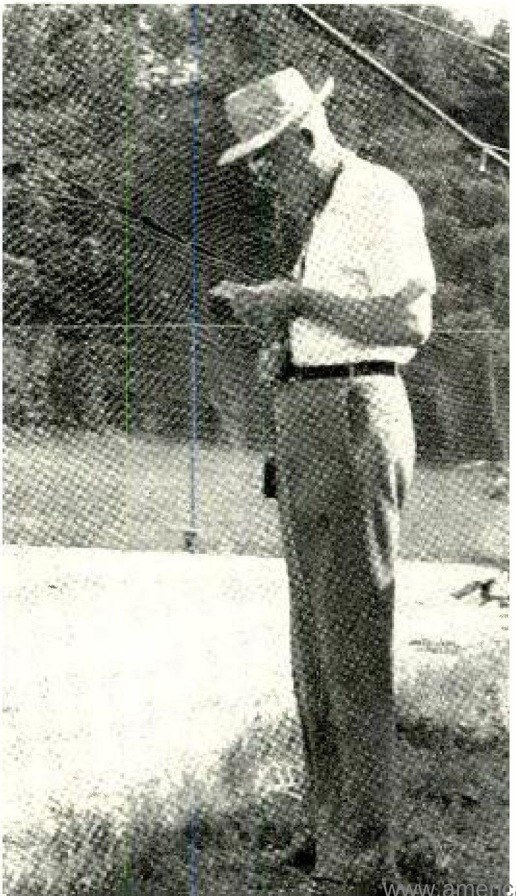
N. J. Council member Herman Alfke recently had as a luncheon visitor at Murray Hill his relative, an early-bird pioneer, John H. Shea now of Syracuse. That in itself is not an unusual statement but several other pioneers including council chairman H. J. Delchamps, A. J. Akehurst, A. R. Brooks and F. E. Dorlon who met Mr. Shea, have something to add, to wit: what a fine figure of a man at 81 years of age and what a pioneer background!

Born in Boston in 1869 and entering the telephone service there as a "boy operator" in 1891, Mr. Shea went on to managerial experiences of various kinds until his 1931 retirement as a life member of Thomas Sherwin Chapter No. 14. He became a pioneer at the organization's very founding and has never ceased to maintain active interest in and appreciation for the fellowship possibilities that are his. You should hear him tell about his meetings and his plans and catch his spirit; then you'd understand how his clear gray eyes reflect his spirit and feeling for life. He divides the seasons between New York State and his beach house southeast of Boston.



John H. Shea, left, of the Thomas Sherwin Chapter No. 14 of the Pioneers, with H. J. Delchamps and F. E. Dorlon.

While vacationing last summer, Pioneer E. K. Eberhart snapped Life Member R. V. L. Hartley methodically preparing to use one of his retirement souvenirs, a 35-mm camera.



The Murray Hill Chorus

The Murray Hill Chorus introduced its 1950-1951 season with a get-together September 26, and will resume regular rehearsals on October 2. The group meets each Tuesday night from 8:00 to 10:00. New with the chorus this year is Mr. H. Thomas Miller, director.

The tentative slate for this season includes a Christmas program, a Spring concert and noon hour concerts at Murray Hill. The chorus plans to continue its practice of presenting programs at Lyons Veterans' Hospital. They have also been invited to sing before the Metropolitan Motion Picture Club at the Hotel Statler.

The group welcomes new members. Those interested in joining the chorus may call Betty Prescott, M.H. Extension 2117.

Elected officers for the ensuing term are: executive chairman, William Vierling; vice chairman, Philip Packard; secretary, Phyllis Klimko; treasurer, Paul Weaver; and librarian, Pauline Schraft. Committee chairmen include: Jack Hinkle, music; Betty Prescott, membership; Betty Scott, publicity; and William Bradley, properties.

News Notes

John Leutritz attended the Gordon Research Conference on *Microbiological Deterioration of Organic Substances.* The Conference was under the sponsorship of the A.A.A.S. and was held the week of July 31st at New Hampton, New Hampshire. Dr. Leutritz was elected to succeed himself as Chairman of next year's Gordon Research Conference.

F. G. Foster received First Honorable Mention for his metallograph *Resolution* which was exhibited in the 1950 A.S.T.M. Photographic Exhibit.

RECENT DEATHS

Erich Von Nostitz, September 5

With the passing of Erich Von Nostitz, the Laboratories has lost an expert in all phases of manual switching circuits. Excepting summer work for the Michigan Central Railroad during his college years, his entire business career was with the Bell System. He graduated from the University of Michigan in 1916, joined the A T & T Engineering Department that year, and became a member of the D & R at its inception in 1919. He came to the Laboratories in 1934.

Mr. Von Nostitz was active in the development of the automatic display call indicator and straightforward trunking circuits in his earlier years and of many different types of manual trunks over a long period. The standard drawing routine, based on the SD– and ED– series of drawings, owes much to his concentrated effort. He also made important contributions to the extension of the tripping, signaling and supervisory ranges of manual trunks.


E. K. Alenius
1892-1950


E. Von Nostitz
1893-1950


J. J. Nutley
1902-1950


LeRoy Armitage
1888-1950

Within the field of manual switching, he specialized on circuits for auxiliary services, which are necessary adjuncts to every type of switching system. He had an important part in the development of facilities for service observing, intercepting and information services. In this particular field his technical counsel was often sought and freely given.

During World War II he was engaged in preparing instruction manuals, particularly on voice-frequency telegraph systems. In 1947 he was transferred to the Quality Assurance Department where his widespread experience made him highly effective as a Quality Specialist in the conduct of Quality Surveys and in the investigation of Engineering Complaints and Employees' Suggestions.

Aside from business activities Mr. Von Nostitz was well known in the Laboratories, and in his home town of Westfield, N. J., for his photographic prowess. His "Child Study" won the gold medal from the Laboratories Club in 1947.

Edward K. Alenius, August 14

Mr. Alenius, an internationally known amateur photographer and exhibitor, and, at one time, world-champion pictorialist, died almost instantly of injuries suffered in an automobile accident near Morristown, New Jersey. A native of Borga, Finland, Mr. Alenius was a Fellow of both the Photographic Society of America and the Royal Photographic Society of Great Britain. He began his career as an amateur photographer in 1928, and rose to the front rank as an exhibitor in photographic salons throughout the world.

A pioneer in color processes, he was honored by the late King George V of England with a request for a print of his color picture *Colorful Roses*. Mr. Alenius' services as a judge, critic and lecturer were widely utilized by camera clubs and organizations. He was past president of both the Metropolitan Camera Club Council and the Jamaica Camera Club, and a member of the Oval Table, an informal organization of photographers.

Mr. Alenius came to the United States in 1923 and joined Western Electric later that year as an instrument maker. Shortly afterwards he became a draftsman in the Systems Department. In 1940 he became drafting supervisor responsible for the art group in Systems Drafting who illustrate all Bell System Practices manuals and educational maintenance manuals. He was also responsible for the art work in many instruction manuals published during the war.

LeRoy Armitage, August 26

Joining the Western Electric Company in 1913 as a laboratory assistant, Mr. Armitage spent five years in various development undertakings, among them iron dust cores. During that period he received his B.S. degree in electrical engineering from Cooper Union. After a year's absence in military service, he returned to West Street and spent two years on the mechanical development of carrier equipment. For the next six years he was in business for himself, manufacturing radio sets. Upon his return to the Laboratories, he engaged in the design of electrical testing apparatus, and in the analysis of crossbar switching apparatus. During World War II he contributed to the development of precision potentiometers for electronic computers. At the time of his death he was a member of the technical staff in Switching Apparatus Development, engaged in meter design.

JOHN J. NUTLEY, September 5

Mr. Nutley of the Development Shops died on August 24. He had been a member of Long Lines Department of the American Telephone and Telegraph Company for a few years beginning in 1929 and then worked for various radio concerns until 1943 when he joined the Development Shops Department as a calibrator and tester on a potentiometer job. He then transferred to Chambers Street as a wireman and assembler. When that building closed, he transferred to West Street where he continued as senior wireman, engaged particularly on the wiring and assembling of crossbar systems.

October Service Anniversaries of Members of the Laboratories

40 years

Lloyd Espenschied
I. H. Henry

30 years

G. T. Anderson
I. W. Brown
P. J. Doorly
N. L. Lamattina
J. Mogilski
J. B. Newsom
R. M. Pease
S. J. Zammataro

25 years

C. P. Carlson
F. E. Dorlon
J. D. Maher
T. Murphy
Nellie Schultz

20 years

R. H. Molloy
J. J. Moravec
W. H. Nelson
J. T. Tweedie
W. H. Walker
F. W. White

15 years

C. W. Nuttman
E. V. Paholek
A. V. Voinier

10 years

J. G. Cisek
W. W. Connick
A. H. Lobisser
D. C. Lodge
Rosemary MacEachen
S. E. Miller
W. P. Stiebitz
F. B. Walters

News Notes

RALPH BOWN attended a meeting of the Naval Ordnance Research and Development Planning Board in Washington.

H. W. BODE, E. N. GILBERT, R. W. HAMMING, L. A. MACCOLL, B. MCMILLAN, R. C. PRIM, S. A. SCHELKUNOFF and C. E. SHANNON attended the International Congress of Mathematicians at Harvard University, August 30-September 6. During the Congress Dr. Shannon spoke on *Some Aspects of Information Theory;* Dr. MacColl, on *Geometrical Properties of Two Dimensional Wave Motion;* and Dr. Schelkunoff, on *Biconal Antennas of Arbitrary Angle.*

DURING a recent trip in Europe, W. SHOCKLEY participated in the Conference on *Ferromagnetism* at Grenoble, France, and in the Conference on *Properties of Semi-Conducting Materials* at the University of Reading, England. At the former he spoke on *Dynamic Experiments with a Simple Domain Boundary;* and at the latter, on *New Phenomena of Electronic Conduction in Semi-Conductors.* He also visited laboratories in France, England and the Netherlands, where he took part in informal discussions. These included the Universities of Bristol, Oxford, Cambridge and Delft, the Postes Telegraphes-Telephones Francais at Paris, and the I. V. Philips Laboratories at Eindhoven.

J. P. MESSANA, R. F. SQUIRES and B. S. WOODMANSEE discussed terminals and related problems with members of the Squier Signal Laboratory at Fort Monmouth.

D. R. MASON gave a talk on *Continuous Stirred Tank Reactor Systems* at meeting of the American Chemical Society in Chicago.

W. WHITNEY visited Norristown, Pennsylvania, in connection with new installation requirements for No. 5 crossbar.

DOROTHY SCHMIDT won two prizes at the Morris County Fair, first prize for woven goods for her afghan and second prize for a knitted tie.

D. T. BELL, A. ALBANESE and W. E. KAHL visited Allentown to discuss the future production of resistance networks.

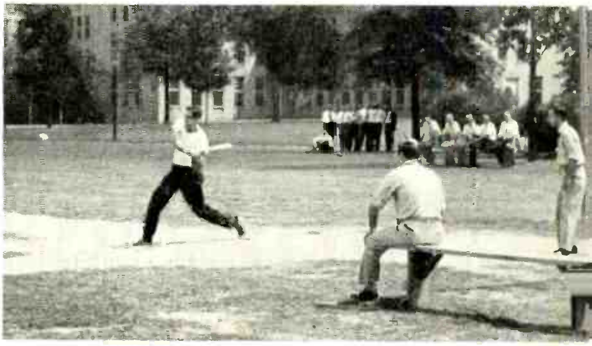
F. H. MARTIN and A. A. BURGESS visited the Newark accounting center in connection with problems relating to message accounting.

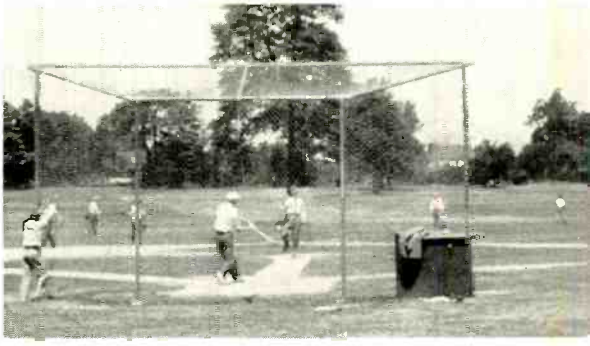
J. R. IRWIN and A. P. GOETZE were at the Vineland and Media No. 5 crossbar offices in connection with contact investigation.

T. F. EGAN, T. A. MCCANN and H. J. KEEFER made dust studies on August 17 at Norristown.

NOONTIME AT MURRAY HILL

Random shots taken with a 35-mm camera by Frank Fosetta and S. O. Jorgensen





J. R. Townsend has been appointed by Governor Alfred E. Driscoll to the Technical Advisory Committee of the Office of Civil Defense of the State of New Jersey.

W. E. Kock has become a member of the Executive Council of the Acoustical Society of America.

V. E. Legg visited Winston-Salem to discuss magnetic materials.

E. M. Boardman and R. M. C. Greenidge conferred at Haverhill on resistances. Mr. Boardman was concerned with preliminary designs of passive identifier networks at Hawthorne.

During a visit to Europe W. H. Brattain participated in informal discussions at the University of Bristol, England, and in France at the Ecole Normale Superieure, Postes Telegraphes-Telephones Francais, and the Observatoire de Paris. He also visited Technische Hochschule in Zurich, Switzerland, and the Universities of Delft and Leiden in the Netherlands. Returning to England he gave a paper on *Semi-Conductor Surface Phenomena* at the Conference on Properties of Semi-Conducting Materials at the University of Reading, and visited the Universities of Oxford and Cambridge, the Telecommunications Research Establishment at Great Malvern, and the Standard Telecommunications Laboratories, Ltd., at Enfield.

D. T. Bell, W. E. Kahl and A. D. Hasley visited Winston-Salem on problems concerning test sets, testing, and network performance.

P. W. Rounds' visit to Haverhill concerned the manufacture of transmission networks.

H. D. MacPherson and A. G. Lang visited the Baltimore toll office to attend the cutover of the A4A toll switching system.

"Telephone Hour"

NBC, Monday Nights, 9.00 p.m.

October 2	Ferruccio Tagliavini, *tenor*
October 9	Igor Gorin, *baritone*
October 16	Polyna Stoska, *soprano*
October 23	Jussi Bjoerling, *tenor*
October 30	Jascha Heifetz, *violinist*
November 6	Ezio Pinza, *basso*
November 13	Mario Lanza, *tenor*
November 20	Marian Anderson, *contralto*
November 27	Barbara Gibson, *coloratura-soprano*

Engagements

*Clotilde Abascal—Salvatore V. Licata
*Marie Adler—Robert Grillo
*Mary Bianco—George J. Graff
*Virginia Curry—Roger Chaffiotte
*Emily Domenguez—Guy Alleruzzo
Gloria Lodovicci—John L. Belfi*
*Margaret McKenna—John H. Fox

Weddings

Joan Berton—Raymond Corcoran*
Anne Dobosz—Francis Raymond Misiewicz*
*Joan Dowling—Joseph Lipsey, Jr.
Julia Klos—Charles H. Dalm
*Rose Kovac—Stanley Rupnick
*Agnes McLean—William E. Murphy
*Mary E. Shortill—George E. Spencer
Shirley Zitzmann—William F. Rauchle

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

G. M. Bouton and A. H. Lince spent several days at Winston-Salem on cost reduction studies for the TD-2 radio relay system.

J. B. Maggio measured and adjusted the frequencies of micro-wave generator units at TD-2 radio relay stations at Pittsburgh, Cleveland, Toledo and Chicago.

G. R. Gohn visited the Bureau of Mines, Ottawa, Ontario, Canada, to discuss fatigue of metals, creep testing and effect of speed of test on tensile test results.

D. L. Moody, M. E. Maloney and O. Myers attended the Baltimore A4A cutover on August 19, 20 and 21.

G. E. Fessler and A. A. Hansen, in cooperation with engineers of the Chesapeake & Potomac Telephone Company, made tests of the performance of multi-link single frequency signaling in a step-by-step intertoll dialing network in the South Boston, Virginia, area. They also studied the performance of originating registers at Westlake, Ohio, as part of the trial of simplified maintenance facilities for No. 5 crossbar offices.

W. W. Brown went to Hawthorne to discuss improvements in central office equipment.

R. M. Bozorth gave a paper on *Magnetic Domain Patterns* at a conference in Grenoble, France. He visited universities and industrial laboratories in France and Germany with the cooperation of the Office of Naval Research. He also talked on *Magnetic Domain Patterns* at the Technische Hochschule in Stuttgart and at Siemens-Halske in Heidenheim.

A. H. White was in Europe this summer, where he visited the I. V. Philips Laboratories at Eindhoven, the Netherlands, and the Post Office Station at Dollis Hill, England.

W. W. Halbrook visited Winston-Salem in connection with production problems on the TD-2 radio relay system.

R. W. Harper went to Los Angeles in connecnection with a service trial installation of line finder circuits for large step-by-step offices.

N. W. Bryant and T. W. Winternitz visited the Bureau of Ordnance at Washington during August for discussion purposes.

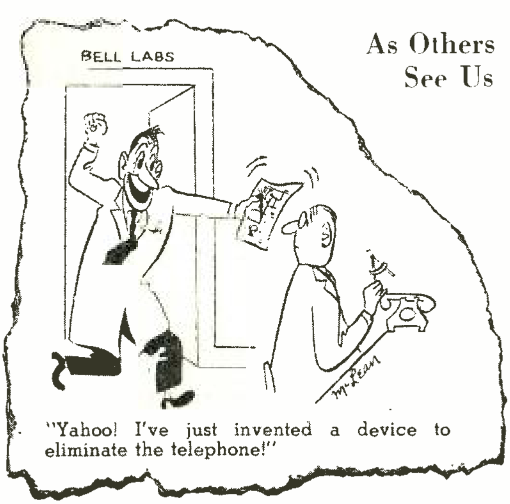
S. D. White has been appointed by Mayor Julius Engel of Raritan Township to serve on the Civil Defense Council of Raritan Township in Middlesex County, New Jersey.

C. A. Lovell, H. O. Siegmund and H. M. Knapp visited Hawthorne on August 30 and 31 in connection with wire spring relays.

D. C. Koehler and K. L. Warthman were at Hawthorne on relay developments.

R. H. Ross, with G. B. Graeff of Western Electric Purchasing, discussed the production of small motors for a special project with the Lamb Electric Company at Kent, Ohio. Mr.

As Others See Us



"Yahoo! I've just invented a device to eliminate the telephone!"

The Blue Bell (Bell of Canada)

"The 3 o'clock pigeon from Murray Hill should be here any minute, now!"

Ross also conferred with engineers of the B. A. Wesche Company at Cincinnati.

A. F. Burns and H. J. Berka conferred with engineers of the Illinois Bell Telephone Company at Chicago and the Western Electric Company at Hawthorne regarding fluorescent lighting designs for central offices.

R. H. Miller attended the cutover of A4A toll switching equipment at Baltimore and discussed engineering problems with the Chesapeake and Potomac Telephone Company.

E. L. Rudd discussed power plant additions with engineers of the Southern Bell Company in Atlanta.

H. N. Wolf was in Harrisburg, Philadelphia, Lewistown and Richmond during the removal of the 1600-cycle single-frequency signaling trial equipment at Philadelphia and Richmond, and the installation of 2600-2800-cycle single-frequency signaling trial equipment at Harrisburg, Philadelphia and Richmond.

J. Blanchard represented the Laboratories Stamp Club as official delegate, M. Esternaux as alternate, to the First National Convention of the National Federation of Stamp Clubs held in Washington on September 9.

A. Tradup made a trip to Montgomery, Alabama, to give a talk before the U.S.A.F. Special Staff School of the Air University at Gunter Air Force Base.

H. R. Wilsey attended a conference on August 30 at Frankford Arsenal in Philadelphia.