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J. N. SHIVE
Electronic Apparatus Development

The Phototransistor

Developments that result in the production of new devices often suggest studies not anticipated at the start of the original development. Such is the case with the Transistor.* Shortly after it was found that amplification could be obtained with the emitter and collector wires touching the same surface of the germanium block, comparable characteristics were obtained by placing these electrodes on opposite sides of a thin wedge of germanium only a few thousandths of an inch thick. The Coaxial Transistor† represents one embodiment utilizing this principle.

It was found that the exciting signal can be charge-produced in the semi-conductor by the absorption of light. Experiments have resulted in the production of a new photoconductivity cell, called the "Phototransistor." A photograph of several of these is shown in Figure 1.

This photocell differs from most such devices in its appearance, in its electrode arrangement, and in some features of its behavior. A longitudinal section drawing is shown in Figure 2. The heart of the device is a pill-shaped wafer of germanium having a spherical "dimple" ground in one side so that the thickness of the wafer at the center is about 0.003 in. The wafer is finally etched in the same way as in the manufacture of germanium diodes, to obtain clean surfaces. The wafer is secured at its periphery in a retaining ring which is force-fitted into one

*RECORD, *March*, 1949, *page* 89.
†RECORD, *April*, 1949, *page* 129.

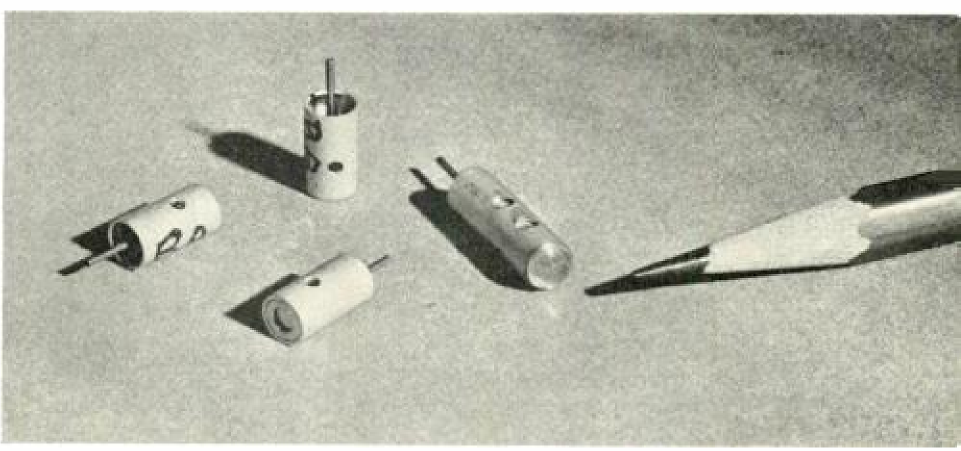


Fig. 1 — The Phototransistor has a high power output for a photoelectric device and gives good response to a rapidly fluctuating light source.

end of a metal cartridge. A pointed wire electrode of 0.005 in. phosphor bronze bears upon the germanium at the center of the dimple; this electrode is called the collector. The wire is fastened to a metal pin embedded in an insulating plug which is force fitted into the other end of the cartridge.

Operation of the cell depends upon the decrease in resistance of the germanium element between the peripheral contact and the collector when light is absorbed by the germanium. In a simple d-c circuit in which the Phototransistor is connected in series with a battery and load resistance, a small current will flow even when the photocell is in the dark. When light falls on the photocell, the current in the circuit increases in proportion to the amount of light falling on the cell. The current increment produced by the light is called the photocurrent.

One of the distinguishing features of the Phototransistor is that a substantial photocurrent response is obtained only when light falls in the immediate neighborhood of the collector on the illuminated surface of the germanium. Figure 3 shows the photocurrent increment as a function of distance when a tiny spot of light is moved across the center of the responsive area of a typical Phototransistor. When this response curve is corrected for the diameter of the spot of light, the breadth of the sensitive area at half maximum is about 0.008 in.

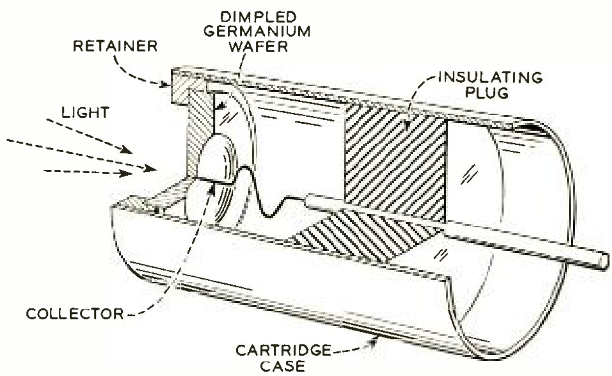


Fig. 2—Longitudinal section of the Phototransistor.

It is apparent that allowing light to fall uniformly all over the germanium surface not only wastes a large fraction of the light, but avoids the realization of the spatial resolving power of which this device is inherently capable. Consequently, it is desirable to provide the cells with lenses to focus the available light into the responsive areas. One way of doing this is to fit a small lens into one end of the cartridge mounting —as shown in the cell adjacent to the pencil point in Figure 1. The cartridge in this instance is made longer than the others so as to accommodate the focal distance of the lens. The small size of the responsive area of the Phototransistor endows this device with a high spatial resolving power that can be obtained in other photoelectric cells only by a special masking arrangement or by some other optical means.

Figure 4 presents a family of collector current versus collector voltage curves for a number of different values of steady light flux. The experiment from which these curves were obtained was performed in such a way that the light fluxes indicated were focused substantially within the responsive area of the cell under test. The photocurrent is best observed and most profitably used when the dark current on which it is superposed is small rather than large. The dark current is made small by biasing the cell as a crystal diode in the reverse direction of its rectification characteristic. This corresponds, for n-type* germanium, to collector voltages negative with respect to the cell cartridge. The currents and voltages are therefore presented, in accordance with convention, in the third quadrant of rectangular coordinates. The particular curve designated "dark" will be recognized simply as the reverse characteristic of a germanium diode, while the other curves show the modification of this characteristic produced by light of different fluxes.

In a typical operating condition for use with time-varying light flux, the cell is connected in series with a load, which for good matching may be from 10,000 to 30,000 ohms. Performance of such a circuit can be deduced by analysis familiar in electronics. Referring to Figure 4, the dashed line shown as 20,000 ohms is called the "load line" for that value of series resistance. The inter-

*An n-type semi-conductor in contact with a metal electrode passes rectified current in the direction of easy flow when the semi-conductor is negative with respect to the metal electrode.

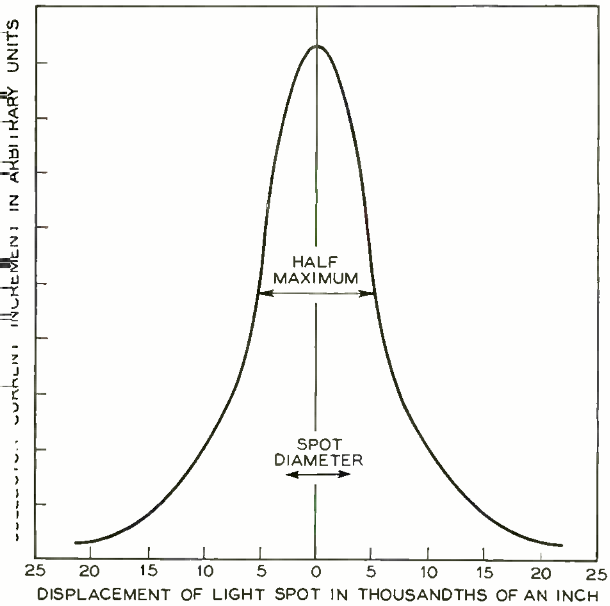


Fig. 3—Profile of the responsive area.

sections of the load line with the curves for the several values of light falling on the cell indicate the collector voltage and collector current for each light value. The collector voltage is the difference between the applied voltage and the voltage drop across the 20,000-ohm load. Calculations for this example yield a current output response of about 0.07 milliampere per millilumen. For a light fluctuation from dark to 20 millilumens, it can be shown that this is equivalent to an alternating current output of about 5 milliwatts.

In operation with light fluctuating at various different frequencies, the output of the cell is substantially flat up to at least 200 kilocycles per second, the highest frequency so far studied. This frequency range is amply wide for applications in the communication field.

Theory of the Photoconductivity Effect

The mechanism of photoconductivity, on which the operation of this cell depends, can be explained by the application of the concepts of modern physics. An atom of any substance consists of a positively charged nucleus and a number of electrons which revolve about the nucleus in orbits of various sizes and shapes. The electrons are prevented from flying away from the nucleus by the electrostatic attraction between the electrons and the nucleus. This attraction leads to a funnel-shaped potential profile, which is centered at the nucleus. This potential is sketched in Figure 5(a). Electronic energy is plotted vertically, while distance, right and left from the nucleus, is plotted horizontally. Another way of describing the situation of the electrons is to say that they are trapped down in the potential funnel, from which they cannot escape unless some external agency endows them with enough additional energy to climb up the sides of the funnel.

Electrons belonging to the various orbits of the atom reside on a number of discrete energy levels in the interior of the funnel, each energy level corresponding to a particular electron orbit. The energy levels are represented by the horizontal lines in Figure 5(a). Positions and spacings of the energy

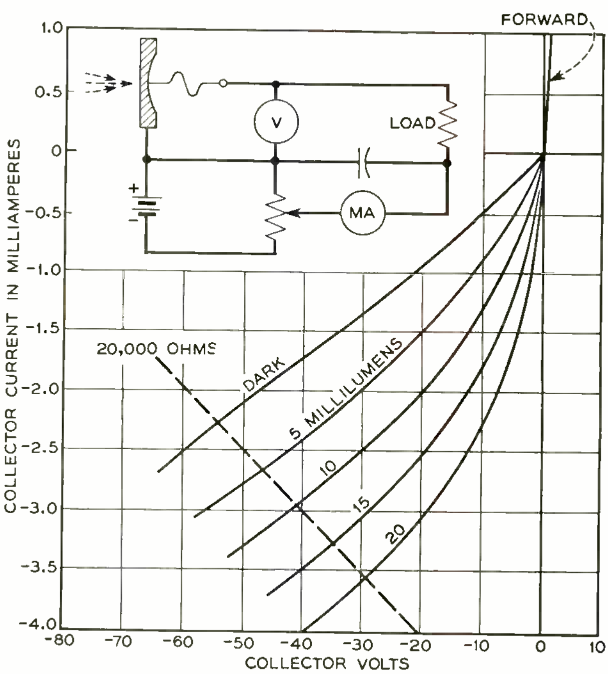


Fig. 4—Static characteristics.

levels are defined by physical laws, which provide also that each level may accommodate a specified small number of electrons, and no more. The orbital electrons belong-

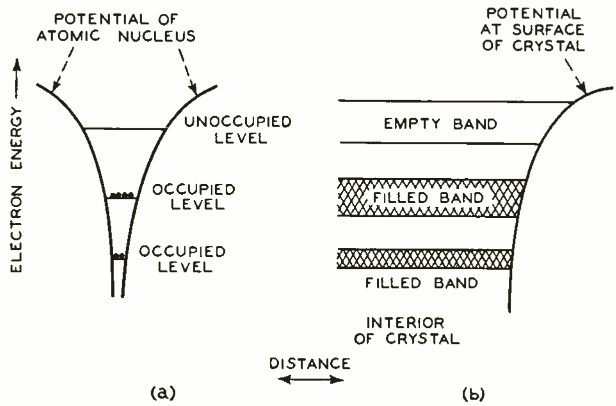


Fig 5—Energy levels for electrons—(a) in an isolated atom and (b) in a crystalline solid.

ing to the atom fill up these levels, starting with the lowest, which corresponds to the innermost orbit. When all the electrons have been apportioned among the lower-lying energy levels, there will be a number of higher-lying levels, of which only one is shown in the figure, which are normally unoccupied. For some elements, moreover, the uppermost occupied level may have fewer electrons than would be required to fill it completely. Although the dispositions and populations of the atomic energy levels differ from element to element, the same general scheme described above is common to all elements.

When the atoms of a particular substance coalesce to form a crystalline solid, the electronic energy levels, which in isolated atoms are discrete and very narrow, broaden into bands, sometimes of several electron volts' height from top to bottom. Figure 5(b) shows how the energy bands of a solid develop from the energy levels of isolated atoms. The lowest filled band in the solid corresponds to the lowest occupied level of the isolated atom, and so on. If there are N atoms in our specimen, each band can accommodate N times the number of electrons which the corresponding energy level can accommodate in the isolated atom.

In some materials the uppermost occupied band is completely filled with electrons; in other materials it is only partly filled. The motions of the electrons in an energy band are governed by the laws of quantum physics. When a band is completely filled, the electrons in that band cannot participate in the conduction of an electric current in response to an applied electric field. It is only when a band is partly filled or partly empty that its electron population may carry a net current. Evidently, then, insulators are substances whose occupied energy bands are completely filled with electrons, while good conductors are substances for which one or more of the bands in the energy level scheme are only partly filled. Semi-conductors are substances in which one or more of the bands are almost, but not quite completely filled, or else almost, but not quite completely empty.

If germanium could be obtained absolutely pure, its energy band scheme would be similar to that sketched in Figure 5(b). All of its occupied bands would be completely filled, all of its non-occupied bands would be completely empty, and the substance would be an insulator according to our definition. However, at ordinary temperatures the specimen contains enough thermal energy to transfer a few electrons from the uppermost filled band to the empty band. This thermal transfer produces a small partial filling of one band and a small partial emptying of the other, thus endowing the specimen with a small conductivity. In addition, all germanium specimens contain small amounts of various impurities which either contribute a few more electrons to the normally empty

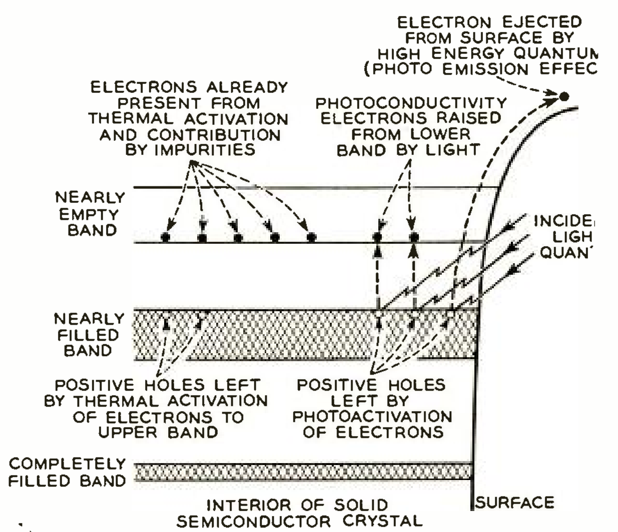


Fig. 6—Mechanism of the photoconductivity effe

band or rob a few electrons from the normally filled band, thus further increasing the conductivity of the specimen. These concepts explain a fact well known in semiconductor technology, that the conductivity of a semiconductor depends markedly both on the temperature and on the impurity content of the material.

A semiconductor which owes its electrical properties predominantly to free electrons in an otherwise empty band is called an n-type semiconductor, while one which owes its electrical properties predominantly to vacant places in an otherwise filled band is called a p-type semiconductor. These vacant places are called "positive holes." They behave to all intents and purposes like particles having charge, mass, and mobility approximately equal to those of an electron, but with charge of positive sign. They move from atom to atom in the direction of an applied electric field, and by their motion they produce a current, just as do the free electrons by their movement in the nominally empty band.

The energy level picture for an n-type semiconductor is shown in Figure 6. The nearly filled band contains a few positive holes left by the thermal activation of electrons to the upper, nearly empty band, while the latter contains additional electrons contributed by the impurities which make the specimen n-type.

A light beam is a stream of radiant energy proceeding through space by the mechanism of wave motion. The energy of the beam resides in discrete energy packets, called quanta, which ride along with the waves. The energy of a single quantum is extremely small. In the visible light from an ordinary 100-watt lamp, and at a distance of three feet from it, there are about 20,000 quanta per cubic centimeter.

When light of the proper quantum energy is absorbed by a semiconductor, the quanta expend their energy in raising electrons from the filled band to the empty band, thus producing additional free electrons and positive holes. This mechanism is illustrated in Figure 6. The photocurrent increment in a semiconductor photoconductivity cell is due to the liberation of these extra charges and their subsequent movement in the applied electric field. When the light is turned off, recombination of the electrons with the holes quickly restores the conductivity of the sample to its original dark value.

With the recombination process continually taking place, even while the light is on, it is evident why the germanium Phototransistor should have a responsive area limited to the immediate neighborhood of the collector contact in the center of the germanium wafer. The distribution of bias current flow lines in the semiconductor is such as to concentrate the electric field near the collector. When electrons and positive holes are liberated here, the charges are separated and collected before recombination can occur. If, however, such pairs are produced near the periphery of the wafer where the field is weak, the charges effectively disappear by recombination before they can be separated and collected.

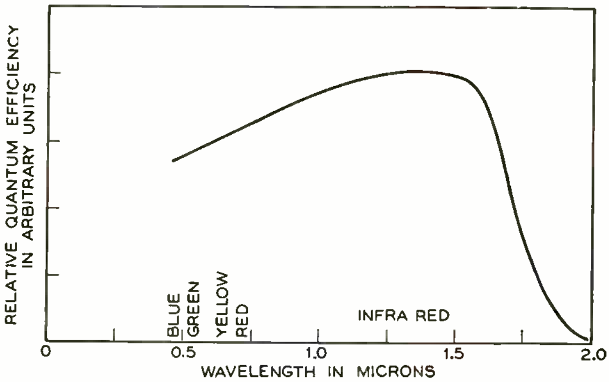


Fig. 7—Relative quantum efficiency versus spectral wave length for the Phototransistor.

In order to induce photoconductivity, the absorbed light quanta must deliver at least enough activation energy to raise the electrons across the energy gap between the top of the nominally filled band and the bottom of the nominally empty band. Since the energy of a light quantum varies inversely with the wave length of the light, it follows that the photoconductivity response depends upon the wavelength of the incident light. Figure 7 shows this dependence for the germanium Phototransistor.* The response in this case is presented in terms of

*These spectral response determinations were made in collaboration with Howard B. Briggs.

relative quantum efficiency, which is the photocurrent increment in the external circuit when a given number of quanta per second are incident upon the responsive area of the cell.

The response curve of Figure 7 has a long wave length limit in the vicinity of 2.0 microns. This wave length corresponds to a quantum energy of 0.61 electron volt, which represents the least energy that can create a free electron-hole pair in germanium. It may therefore be considered as the activation energy for the photoprocess, being equal to the energy gap between the top of the nearly filled band and the bottom of the nearly empty band. This value is in good agreement with the figure of 0.75 electron volt† obtained independently from measurements of the temperature variation of the specific resistance of germanium at high temperatures.

Referring again to Figure 6 one may deduce that if the quantum energy of the incident light is sufficiently great, electrons may be given enough energy to enable them to escape completely from the sample against the work function field at its surface. The photoemission effect comes about in just this way. For most substances, however, the quantum energies required correspond to wavelengths in the blue, violet, and ultra violet regions of the spectrum, and emission type photocells made from even the best of these materials are not suited to take the most effective advantage of light from incandescent filament sources, for example, from which the emission at these wavelengths is comparatively meager. Since the induction of photoconductivity requires less quantum energy than the induction of photoemission, it follows that, in general, photoconductivity cells are responsive to light of longer wavelengths than are photoemission devices. For the Phototransistor cell in particular, as can be seen from Figure 7, the sensitivity is greatest in the spectral region from 1.0 to 1.5 microns. This is the same region in which the quantum emission from ordinary incandescent light sources is greatest. The germanium cell is therefore a particularly suitable device for use with such sources of light.

†W. H. Brattain and J. Bardeen: *Physical Review*, Vol. 74, 1949, page 231.

THE AUTHOR: After receiving his B. S. degree at Rutgers in 1934, J. N. Shive entered the Johns Hopkins University Graduate School. Here he combined teaching and graduate study in physics, receiving the Ph.D. degree in Physics in 1939. He then came to the Laboratories, where his work was on studies of thermistors and selenium rectifiers until World War II; during the war, he was engaged in applying these devices to military purposes. Since the war, he has been concerned with selenium rectifiers, and more recently, the various aspects of Transistor developments.

The Automatic Monitor

J. W. BRUBAKER
Switching Systems Development

In the panel and crossbar systems that preceded No. 5 crossbar, the senders, which perform the functions of both the register and sender in the No. 5 system, are maintained by circuits that originate test calls to each sender to check its various features—advancing automatically from sender to sender unless a trouble condition is disclosed. In the No. 5 system the objective has been to indicate troubles in senders and registers while they are handling service calls.

To meet this objective, the automatic monitor was designed to connect on a random basis to the registers and senders as they are selected for service calls. If connected to a register, the monitor independently records the called number pulsed into the register from the line, and checks it against the number that the register passes to the marker. If connected to a sender, the monitor records the number pulsed out over the trunk by the sender, and checks it against the number passed to the sender. If the numbers do not check, a trouble record is made.

This monitor forms part of a larger circuit known as the automatic monitor, register, and sender test circuit.* These latter facilities, which will be described in a subsequent article, are used to locate both the troubles reported by the monitor and those indicated by other methods. The monitoring and testing facilities are combined into a single circuit because a number of the circuit units are used for both. Actually the test facilities comprise the greater part of the circuit.

The monitor is arranged to check three general types of circuits: originating registers, incoming registers, and outgoing senders. It progresses from one type of circuit to the next in the order named under control of a ten-step allotting circuit, which steps once for each monitored call. Cross-connections in the alloting circuit provide flexibility in apportioning the monitoring between the three types of circuits. This is usually done in proportion to the number of circuits of each type in the marker group. A typical division of the ten calls would be six on originating registers, two on incoming registers and two on outgoing senders. Since during light load periods there may be no interoffice traffic for long intervals, the allotting circuit is arranged to advance one step if no calls are received for one minute to prevent the monitor from waiting for sender or incoming-register calls during such periods. By key selection, monitoring can be confined exclusively to originating registers, incoming registers, or outging senders. Should a register or sender be suspected of trouble, the monitor can be caused to monitor every call that the suspected register or sender handles.

Each time a marker starts to establish a dial-tone or outgoing-sender connection, it requests the use of the monitor, and if the monitor is idle and if its allotter at that time is in the position to monitor on an originating register or outgoing sender, the marker will gain access to the monitor. If an originating register is called for, the marker—having gained control of the monitor—operates a relay in the register that establishes a direct connection between the register and the monitor. In addition to certain signaling leads, this connection includes the tip and ring leads incoming to the register from the subscriber's line. A dial pulse amplifier is bridged across these tip and ring leads in the monitor. The amplifier is a vacuum-tube circuit with a high-impedance input so that it will not disturb the pulsing capabilities of the register. As

* RECORD, *July*, 1950, *page* 313.

the subscriber dials, the pulses are amplified, counted, and registered by the monitor independently of the originating register.

When dialing is completed, the originating register selects a marker to set up the connection called for. The operation from this point on is illustrated by the block diagram of Figure 1. When the register is connected to a marker, a direct connection for a limited number of signaling leads is established between that marker and the monitor, which has remained connected to the register. At this time the monitor selects the master test frame connector and causes the marker also to connect to this connector. This connection between the marker and monitor through the master test frame connector is used principally to permit the monitor to record the called number that the register is passing to the marker. The line location of the calling subscriber's line is also recorded in the monitor at this time so that pulsing failures caused by unfavorable subscriber line or dial conditions can be associated with the line causing the trouble. The relays and leads which connect the marker to the master test frame connector are part of those used when the marker connects to the trouble recorder to make a trouble record. *

When the monitor has recorded the information it receives from the marker, the connections to the monitor both direct and through the master test frame connector are released, and the monitor starts checking the called number. It has two sets of register relays; on one set is recorded the number the monitor received from its dial pulse amplifier, and on the other set is recorded the number that the originating register passed to the marker. If the two numbers are identical, comparable relays in each set will both be operated or unoperated, and a check circuit through all relays will be completed. If this check is satisfactory, the monitor waits for the marker and originating register to restore to normal, and then releases and awaits a new call.

Should the number check fail, the monitor selects the master test frame connector for connection to the trouble recorder. The trouble record card will indicate the called number that the monitor registered, and the called number that the register passed to the marker. In addition the card shows the location of the calling line, the originating register location, and the marker number. When the trouble record is complete,

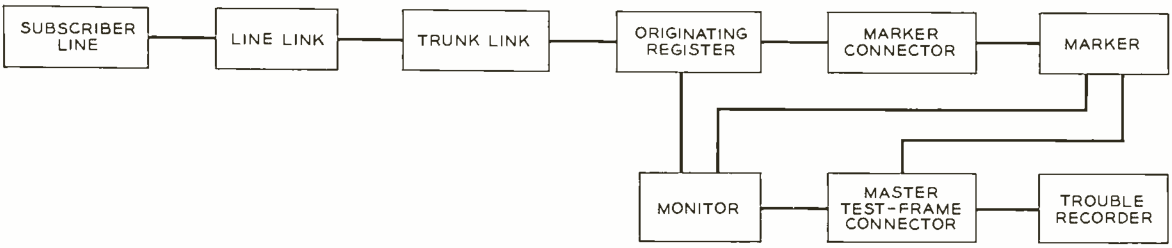


Fig. 1—Paths established for monitoring the action of an originating register.

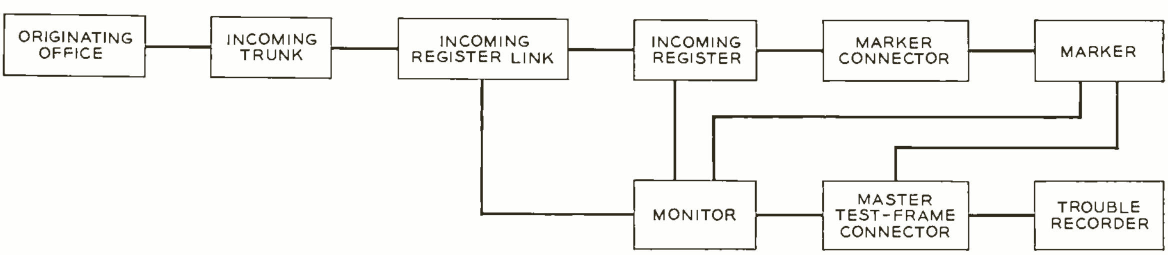


Fig. 2—Paths established for monitoring the action of an incoming register.

* Record, *May*, 1950, *page* 214.

the monitor restores to normal and awaits a new call. Trouble records may be due either to register trouble or to improper line and pulsing conditions. Since both the register and the line are identified on the trouble record card, repeated trouble records should indicate which is at fault.

The connections which are established for incoming register monitoring are shown in the block diagram of Figure 2. When an incoming trunk is seized, it is connected to an incoming register by the incoming register link circuit. As the connection is being established, the use of the monitor is requested by the link, and if the monitor is available, it is associated with the register by operation of a relay in the register. If the incoming register is of the dial-pulse type, the operation from this point on is as described for an originating register except that the location of the incoming trunk instead of the subscriber's line will be shown on the trouble card.

In addition to dial-pulse incoming registers, a No. 5 office may also have revertive and multifrequency incoming registers. For receiving multifrequency pulses, a high impedance amplifier is bridged across the tip and ring to the incoming register. The output of this amplifier is connected to a standard multifrequency receiver associated with the monitor, which detects the incoming frequencies, and operates corresponding register relays.

With revertive-pulse incoming registers, the monitor inserts a low resistance relay in series with the pulsing circuit. The output of this relay is counted and registered in the monitor. In revertive pulsing, the thousands and hundreds digits are translated at the originating office and transmitted to the No. 5 office as three numbers, or "selections," while the tens and units digits are transmitted without translation. In both the incoming register and the monitor the initial three selections are retranslated into the thousands and hundreds digits, since communication between circuits within a marker group of the No. 5 system is on the basis of the digits as dialed.

For outgoing sender monitoring, the marker requests the use of the monitor as soon as it recognizes that the call will require an outgoing sender. The block diagram of Figure 3 illustrates the connections involved. At the time the marker selects the monitor, a direct connection for a limited number of signaling leads is immediately established between the marker and the monitor. The monitor also connects to the marker through the master test frame connector. Through this latter connection the monitor receives the called number, which is being passed to the marker from the originating register, and also the signals passed from the marker to the sender, which may require the sender to modify the number sent it. On

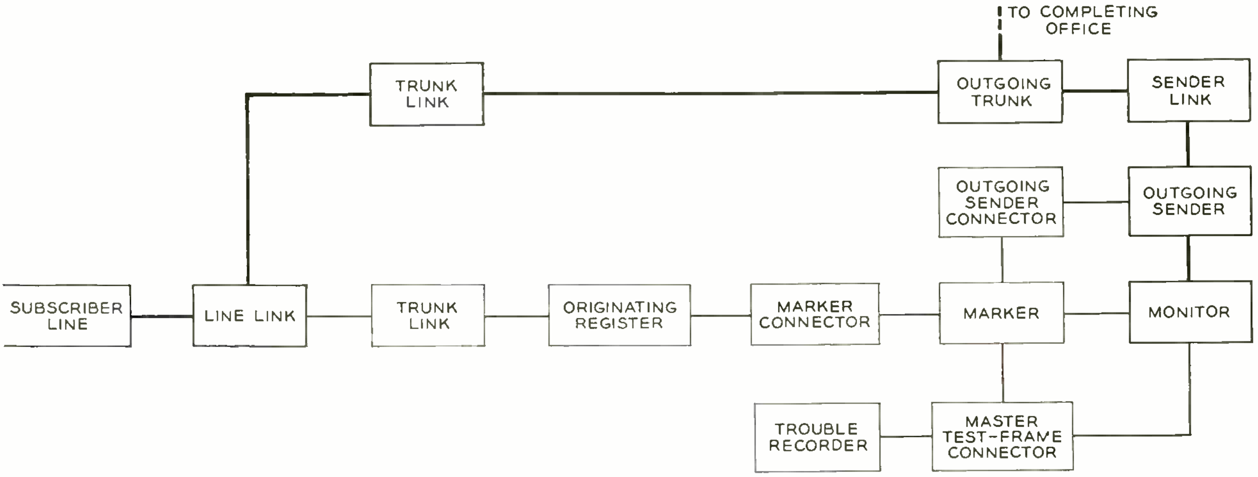


Fig. 3—Paths established for outgoing sender monitoring.

a direct call to another office, for instance, the office code will not be pulsed out, and the marker will indicate this to the sender. The marker may also direct the sender to prefix a one-one, an additional digit, or both ahead of the number passed to the sender. Such signals from marker to sender are recorded by the monitor, since it must readjust its checking circuit to take into account any difference between the number which is passed to the sender and the number which is pulsed out. In addition to the called number, the monitor records the location of the outgoing trunk used on the connection. When all necessary information has been recorded, the paths between the marker and monitor both direct and through the master test frame connector are released.

When the marker connects to the outgoing sender, a relay is operated in the sender that establishes a direct connection between the sender and the monitor. After the marker has completed its functions, it releases, and for the remainder of the time, while the sender is pulsing out, the connections are as shown by the heavy lines in the diagram.

Through the direct path to the sender, the monitor connects to the tip and ring over which the sender outpulses. The pulses sent out by the sender are picked up, counted, and recorded in essentially the same manner as described for registers. There are four types of outgoing senders, multifrequency, dial pulse, revertive, and panel call indicator. Monitoring on the latter sender requires a special amplifier to repeat the PCI (panel call indicator) type of pulsing. After the sender has completed pulsing, the monitor checks the pulsed out number against the number passed from the register to the marker. A trouble record is made if the numbers do not check.

In the initial No. 5 crossbar installation at Media, records indicate that there are approximately 35,000 daily usages of outgoing senders, originating registers, and incoming registers. There are approximately 2,000 monitor usages per day. Thus about one call in every seventeen handled by a register or sender is monitored. Larger offices will, of course, have more senders and registers, but one monitor is still considered adequate to sample sender and register operation and to bring any faulty operation to the attention of the maintenance forces.

THE AUTHOR: J. W. BRUBAKER received a B.S. degree in Electrical Engineering from Union College in 1925, and then joined the Technical Staff of the Laboratories. With the Systems Development Department, he worked on circuit development until 1942, when he transferred to the School for War Training for the World War II period. Since the end of the war, he has been engaged in circuit design work for the No. 5 crossbar system.

Sampling a sound in an ear

The fixture on the handset shown in the accompanying illustration samples the sounds transmitted by a receiver into an ear in one of many tests which guided the development of the 500-type telephone set. And why? Because what matters to the telephone user is the sound pressure actually developed in his or her ear. Engineering tests tell how much sound the receiver is capable of developing in a closed chamber. But there are losses by leakage when the instrument is held loosely to the ear. Then, too, individual ears differ in size and shape, and these differences affect the sound heard. Hence, the test.

A condenser microphone is mounted on the receiver; from it the sampling tube reaches around into the ear canal. As the sound comes from the telephone receiver into the canal, a minute portion of the sound is detoured into this tube and thence to the calibrated condenser microphone which sends it along to amplifiers. These minute signals tell exactly the intensity of the sound in the ear canal at each frequency.

They tell, for example, what is coming through in the region of 180 cycles where telephone set designers face a special problem. Pleasant telephone listening requires low background noise and one source of noise is power hum in the circuit at 60, 120, and 180 cycles. To make this inoffensive, design engineers planned an over-all transmission loss of approximately 16 db at 180 cycles relative to the loss at other talking frequencies.

Now some of this loss, they knew, would be contributed by the loss over the air path between the receiver and the ear. If this were not sufficient, they would have to build additional loss into the circuit. First, therefore, they had to know the loss in the receiver-ear air path. This, the test disclosed, is approximately 8 db. The additional loss which had to be built into the circuit was therefore 8 db. Interestingly, they introduced this extra loss simply by making a hole of the proper size in the diaphragm of the receiver.

With the new technique it has been possible to make sampling tests on numerous Laboratories people, representative of the range of telephone users, and so to determine the loss between the receiver and ear

Jean Kennedy demonstrates the method of measuring sound pressure in her ear.

for typical conditions. This information is then used to interpret the data obtained by the standard technique, using a receiver coupled to a closed chamber, so as to determine how a particular receiver will behave in use.

This technique for sampling sound in ears is one of several which have been perfected in the past ten years. With it the Laboratories can now, better than ever, learn how the telephone affects the subscriber and so how to design it for better talking and listening.

Termites and their control in telephone poles

C. H. AMADON
Outside Plant Development

In recent years, termites have received much publicity, all of it adverse, some of it highly deserved and some of it greatly exaggerated. These insects are related to the common cockroach but in the millions

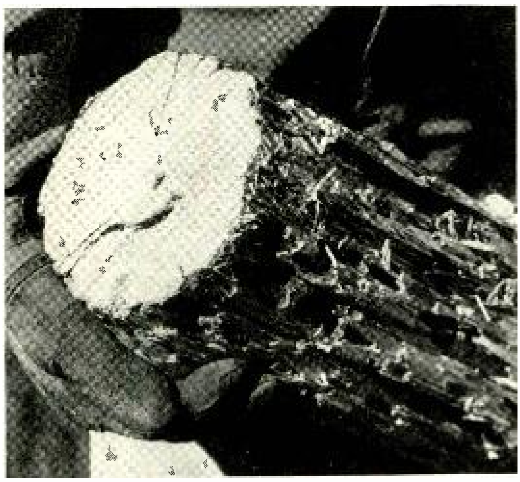
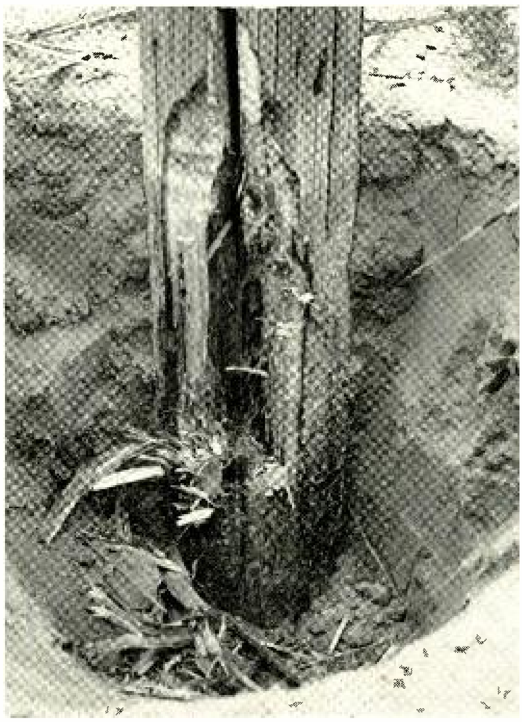


Fig. 1—Channels and galleries of dry-wood termites in the above-ground untreated section of a western red cedar pole.

of years during which termites have existed they have developed a communal type of living in which specific functions of feeding and tending, building and protecting are performed by groups of nurses, workers and soldiers. Each such community established by a single reproductive pair remains in deep seclusion separate and distinct from any neighboring colony. Termites never appear willingly in the open, except at a time when the colony has become so numerous that a considerable number of individuals develop wings and leave the old nest in a dense swarm from which mated pairs disperse widely to start new colonies. Consequently the very existence of a termite infestation may remain undiscovered. If that happens in the case of a structural member such as an untreated telephone pole, the interior may become so riddled with termite channels and galleries as to weaken or otherwise render the pole unfit for service.

There are fifteen hundred or more separate species of termites, broadly classified into two main groups: wood-dwelling (dry wood and damp wood) termites which nest in the wood on which they feed, and earth-dwelling (subterranean) termites which nest in the ground and travel through self-made tunnels to their food supply. Subterranean termites are found in practically every region of the United States; the wood dwellers have a limited range, along the South Atlantic and Gulf Coasts, in Arizona,

Fig. 2—Large cavity of desert dampwood termites. They entered through a large check, penetrating the original butt treatment of this western red cedar pole.



Southern California and thence in a narrow belt along the Pacific Coast to Mendocino County, California. Where the areas of these two general groups overlap, untreated wooden structures in contact with the ground may be attacked by both groups.

Dry wood termites enter untreated wood only at points above the ground level and penetrate deeply enough to insure their own security plus favorable conditions of moisture and temperature. Their channels and chambers eventually become extensive; in butt treated poles, for example, the outer inch or more of the body of the pole may be so "honeycombed" as to present some degree of hazard to a person climbing or working on the pole.

Damp wood termites usually enter untreated wood directly at or close to the ground line, and the damage they do results eventually in a thin-walled cavity at the location of greatest stress in a pole.

Subterranean termites attack below ground line; they preferably feed on softened or decaying wood, usually inward from the surface, slowly reducing the pole at the section just below the ground line.

It has been standard practice in the Bell System for many years to use poles treated with materials which are toxic to wood destroying fungi, and fortunately these same materials are also effective against termites of all species. Poles of those species of timber which have thick non-durable sapwood, like southern pine, are deeply impregnated over-all with the preservative, and they are rarely attacked by termites. Other poles like western red cedar and western larch which have a durable heartwood and a thin sapwood have been impregnated with preservative only in the sapwood of that portion of the pole which will be in contact with the soil when the pole is set in place. These poles are open to attack by dry wood termites in the untreated section above ground; and, if seasoning checks develop after treatment or tool cuts puncture the thin treated sapwood, the openings thus provided permit attack by damp wood and subterranean termites. Figure 1 shows damage by dry wood termites in the outer layers of the above ground or untreated portion, and Figure 2 the internal damage by damp wood termites within the ground or treated section of a butt-treated western red cedar pole. In the latter case the insects had found access to the interior of the pole through the large check which shows at the top of the cavity.

Fig. 3—R. C. C. Baker of Long Lines exhibits the dissected butt of a western cedar pole chosen as an example where an internal application of preservative eliminated a colony of dampwood termites.

Experience with butt-treated western cedar poles during the past 25 years has shown that although attack by dry wood termites is very common within their range, the damage does not materially shorten the normal expected service life. In some instances, however, the security of hardware attachments has been affected, and occasionally poles have been replaced because they were considered hazardous to the safety of men frequently working on them.

The relationship of the damp wood and subterranean species to butt treated poles is different. Standard Bell System inspection practices are adequate to discover their presence and supplementary treating practices devised by the Laboratories are effective in preventing further damage, which in practically all cases is confined to that critical section of a pole within a few inches above to possibly two feet below the ground line. Figure 3 shows a butt treated pole which contained many hundreds of desert dampwood termites. The supplementary internal treatment was applied and after 24 hours the pole was removed and split open to reveal the extent of the termite work, and the distribution and effectiveness of the preservative fluid. Not a single live termite could be found among the hundreds of dead ones. Figure 4 illustrates a western red cedar pole to which the supplementary treatment was applied externally, to combat a discovered attack of subterranean termites, by pouring approximately one gallon of the preservative around the pole.* The solution seeps downward along the pole and floods the tunnels through which these termites make their attack well below ground line of the pole.

The method of applying the supplementary internal treatment to infested poles which are fit to leave in line is simply the introduction of as much as a quart of the standard "B" Wood Preservative, which is a solution containing 5% by weight of pentachlorophenol in petroleum; other effective preservatives are straight creosote or a mixture of equal parts of the standard solution and creosote. An ordinary garden type sprayer or a pressure grease or oil gun, fitted with an extended nozzle, are convenient means of applying the preservative. Where the cavity can be opened without materially increasing damage to a pole, or where there is certainty that a check enters the cavity, the preservative is introduced directly into the cavity or the check; in

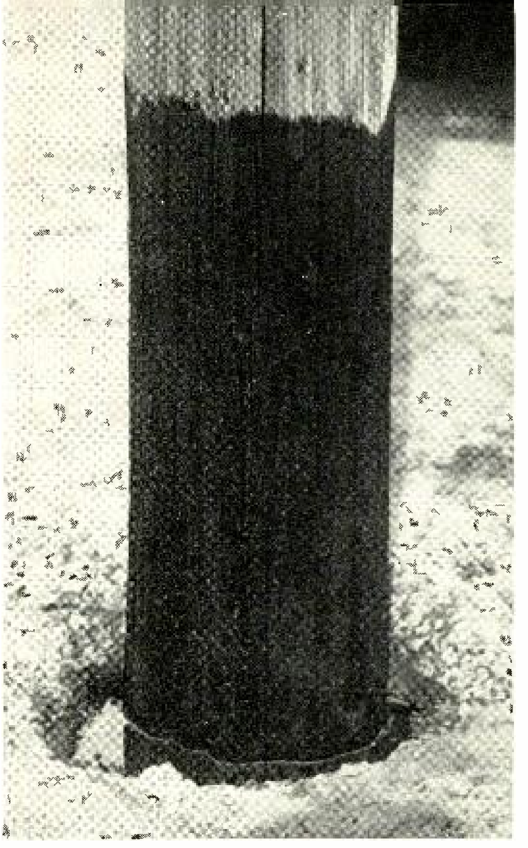


Fig. 4—A western red cedar pole given a supplementary treatment in place to combat attack by subterranean termites.

* Record, *July*, 1944, *page* 468.

THE AUTHOR: C. H. Amadon graduated from the Biltmore Forest School in 1908 and then continued in the practice of forest engineering until he joined the Engineering Department of the Western Electric Company in 1917. Since then he has been engaged in establishing standard inspection procedures and in supervising inspectors of the timber products used in outside telephone plant. This work was carried on in the Inspection Engineering Department until 1927 when it was transferred to the newly organized Outside Plant Development Department. Since that time, as a member of the timber products group until his retirement from active service last month, Mr. Amadon had a responsible part in setting standards for timber products and in the development of improved processes for the preservation of wood.

other cases where there are no obvious openings into the cavity, two or more small holes are bored to intersect the cavity and the preservative is introduced into these small holes. Where only subterranean termites are involved, the preservative is simply poured against the pole in a small low-pressure stream from the sprayer.

Although the wide geographical distribution of termites and their capacity as wood destroyers might appear to constitute a real menace to the telephone pole plant, the forward looking use of full length treated poles (75 percent of the pole plant) together with competent inspection practices and application of supplementary treatments developed by Bell Telephone Laboratories when needed, have reduced this type of damage to infrequent and usually isolated cases.

Patents Issued to Members of the Laboratories by the United States Patent Office, February to May, Inclusive

Albersheim, W. J.
Albert, W. P.
Anderson, L. T.
Atkins, G. E.
Augustadt, H. W.
Bachelet, A. E.
Bacon, W. M. (2)
Baker, G. H.
Baker, W. O.
Bascom, H. M.
Benfer, R. W.
Bouton, G. M. (2)
Bowne, L. J.
Burelbach, F. M. (2)
Burton, E. T.
Calbick, C. J.
Carbrey, R. L.
Caroselli, F.
Clark, J. E. (2)
Craft, C. J.
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Espenschied, L.
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Garvin, J. S.
Gee, R. C.
Germer, L. H.
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Goodall, W. M. (3)
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Samek, C. T.
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Shanck, R. B.
Shann, O. A. (4)
Sharpe, D. T.
Shockley, W. (3)
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Vance, R. L. (2)
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Watson, E. F.
Wehe, H. G.
Wente, E. C.
Wertz, H. S.
Williams, S. B.
Williford, O. H. (2)
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Automatic frequency control for heterodyne measurements

D. LEED
Transmission Apparatus Development

Precise measurement of phase and amplitude characteristics of transmission networks depends not only on the accuracy of such physical items as resistors and capacitors, but on the closeness with which the measuring currents are held to the frequencies specified. In the phase and transmission measuring set described in the July issue,* where the sensitivity of the detecting equipment to small changes of intermediate frequency is very high, special automatic means are incorporated to insure that this frequency remains constant.

As described in that article, there are two sources of current: a master oscillator directly energizing the reference and apparatus channels at the desired frequency, and a slave oscillator, controlled automatically by the master oscillator, so that its output frequency is exactly 31,000 cycles higher than that of the master. Voltages from these two sources combine in the modulation section of the measuring equipment to produce the 31,000 cycle intermediate frequency at which detection is performed.

To maintain this intermediate frequency automatically within 1 cycle of 31,000, the circuit of Figure 1 is used. The output frequency F of the master oscillator can be set at any value between 50 kc and 3.6 mc. It is generated by modulating the output from a FIXED LOCAL OSCILLATOR 1 whose frequency f is of the order of 15 mc, with the output of a variable local oscillator 2 whose frequency is adjusted to a value of f–F. By selecting the lower sideband, whose frequency is the difference of the two, the resultant frequency is f – (f–F) or F. This is put through a low-pass filter before delivery to the measuring circuit.

To stabilize the output frequency of the slave oscillator at F + 31 kc, the circuit shown in (a) of Figure 1 is used. Part of the output of the FIXED LOCAL OSCILLATOR 1 is put through a tripler circuit and the resultant frequency 3f is applied to a modulator. Also applied to this modulator is the frequency f + 31 kc of the CONTROLLED OSCILLATOR 3, after it has been put through a tripler and brought up to 3f + 93 kc. The output of the modulator is (3f + 93 kc)–3f, or 93 kc. This 93 kc output is applied to two control loops acting on CONTROLLED OSCILLATOR 3 so as to maintain it at exactly f + 31 kc. The loop on the left side includes a frequency discriminator and REACTANCE TUBE 1, which introduces a correction based upon the deviation of the controlled oscillator *frequency* from the exact frequency desired. Because this control requires the existence of a small frequency error in order to be operative, it is not capable of controlling the oscillator exactly to the required 1 cycle tolerance.

A second control, that shown in the right-hand loop, reduces the frequency error to the desired degree by applying a correction based upon *phase comparison* of the frequency difference between the tripler circuit outputs with a wave of reference phase from a 93 KC CRYSTAL OSCILLATOR 4. This comparison is made in the phase discriminator which produces the phase sensitive control on the CONTROLLED OSCILLATOR 3 by actuating REACTANCE TUBE 2. Thus the composite effect of the two loops is to obtain control by frequency error through REACTANCE TUBE 1 and by phase error through REACTANCE TUBE 2. The net effect is to deliver to the heterodyne circuit of the slave oscillator, (b) of Figure 1, a current

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

of frequency f + 31 kc. By modulating this with (f—F) and selecting the lower side-band by a low-pass filter, we have as output (f + 31 kc) — (f—F) or F + 31 kc to be delivered to the measuring circuit. A control circuit of this type belongs to the class of negative feedback regulators called "proportional plus integral."

The action of the automatic control circuit shown in (a) of Fig 1 in eliminating an error of frequency may be understood by analyzing the circuit response to, let us say, a sudden 1-kc increment to f. For the sake of explanation, let it be assumed that, prior to the sudden increase of f, the automatic control circuit is "unstressed"; i.e., f = 15 mc, E_1 is zero and operation is at $\pi/2$; E_2 is zero, and Figure 2 is the control characteristic of either REACTANCE TUBE 1 or 2 on the controlled oscillator frequency. The phase discriminator voltage (E_1) curve shown in (a) of Figure 1 indicates the relationship between the d-c voltage output of the discriminator and the difference of phase between its two output voltages e_1 and e_2. E_1 is zero whenever this difference of phase is an odd multiple of 90 degrees*. The curve of frequency discriminator output E_2 vs discriminator input frequency is also shown in (a) of Figure 1 above the frequency discriminator block. Now, when f is suddenly increased from f = 15 mc to f = 15 mc + 1 kc, the output of the modulator drops from 93 to 90 kc, producing in consequence, an error of 3 kc at the input to the frequency discriminator. As yet, no error of phase has developed

* The construction of the phase discriminator is similar to that of the phase detector used in the 3.6-mc phase and transmission set and is described in the *Bell System Technical Journal, April* 1949, *pages* 230-233.

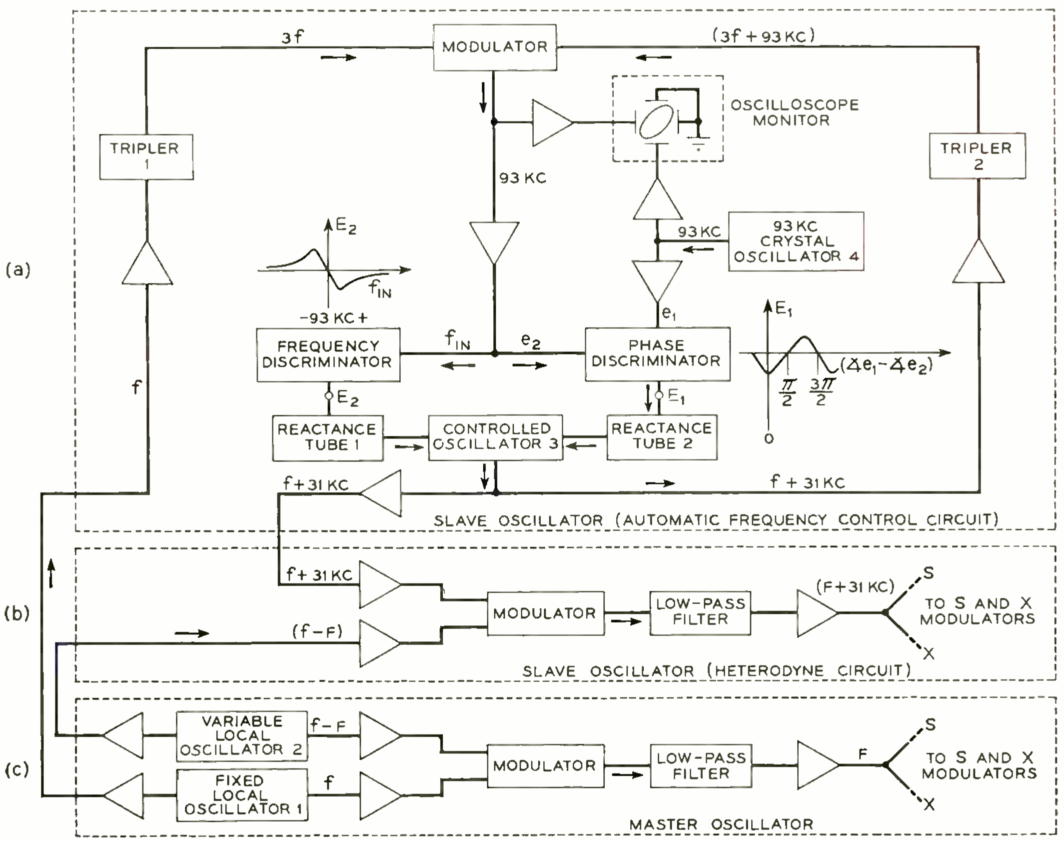


Fig. 1—Block diagram of automatic frequency control circuit.

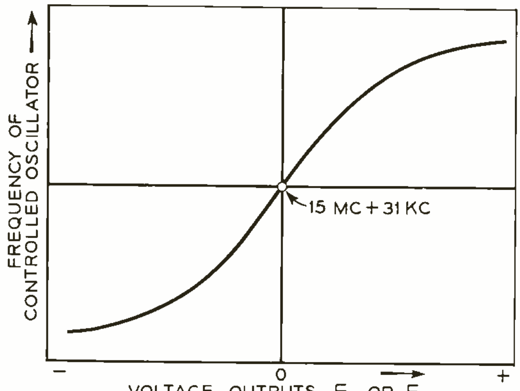


Fig. 2—Reactance tube-controlled oscillator frequency characteristic.

between inputs e_1 and e_2 to the phase discriminator, because the change of frequency is assumed to occur in infinitesimal time. At this instant, the phase discriminator exerts no corrective force and may therefore be considered momentarily inoperative, while the frequency discriminator is wholly operative and capable of exerting its full correction. This it does, raising the frequency of the controlled oscillator and reducing the frequency error by an amount dependent upon the effective loop gain of the frequency sensitive loop. In the control circuit (a) of Figure 1, this gain is about 30 and the frequency error initially present is cut to 1/30 of this value, or 100 cycles.

In theory, all this is accomplished before any corrective voltage appears at the output of the phase discriminator. The combined system then responds jointly to cancel the remaining error. Since the frequency of e_1 is greater than e_2, its phase now begins to advance over that of e_2 and this produces increasing positive voltage at the output of the phase discriminator. This increasing voltage is applied to the REACTANCE TUBE 2 grid which raises the frequency of the oscillator, thus diminishing the error. As the steady state is approached, and the need for correction less strongly felt, the rate at which the error is eliminated decreases, causing the rate of phase advance of e_1 over e_2 to decrease. Finally, when the error is zero and the controlled oscillator has been raised in frequency by the 1 kc increment given to f, the phase difference between e_1 and e_2 is static, but no longer ninety degrees, and E_1 will now have a value somewhere on the positive slope of the phase discriminator curve. The new value of E_1 will depend on the total phase advance of e_1 over e_2 in the time interval required to effect the frequency correction of the controlled oscillator, and will remain at this new value as long as no further stresses are imposed on the automatic frequency control circuit.

Such a system of combined phase and frequency sensitive control possesses several advantages not found in systems having phase control only or frequency sensitive control only. In a control circut that uses only a phase discriminator and associated reactance tube, the CONTROLLED OSCILLATOR 3 may lock in at either of the sideband frequencies, $f - 31$ kc or $f + 31$ kc. This may be demonstrated from that part of Figure 1 designated (a) if it is imagined that only the loop including the phase discriminator is operative. Then let it be further imagined that the CONTROLLED OSCILLATOR 3 is still at $f + 31$ kc and operation on the phase discriminator voltage curve (E_1) in (a) of Figure 1 is along the positive slope centered at $\pi/2$.

With the CONTROLLED OSCILLATOR 3 operating at $f + 31$ kc, if the frequency f is slightly increased, this is reflected as a decrease in the frequency of e_2 in relation to e_1 so that the phase of e_1 advances over that of e_2, and increasing corrective voltage E_1 is developed at the phase discriminator ouput. This voltage raises the frequency of the CONTROLLED OSCILLATOR 3 by means of REACTANCE TUBE 2 according to the curve of Figure 2, hence eliminating the error. However, if the controlled oscillator happens to shift its frequency to $f - 31$ kc, the modulator inputs will be 3f and $3f - 93$ kc and the output will be −93kc. The minus sign means that the phase of e_2 has been reversed, so that the phase discriminator is now operating on the negative slope of the curve centered about $3\pi/2$. In this condition, if f is increased, this is reflected as an increase in the frequency of e_2 over

e_1 so that the phase of e_1 slips behind that of e_2. This causes the point of operation on the negative slope of the phase discriminator characteristic to move upward, thus increasing the frequency of the CONTROLLED OSCILLATOR 3 and eliminating the error. Therefore, there are points of stable operation at both f + 31 kc and f – 31 kc, only one of which is, of course, desired.

In contrast, the frequency-sensitive loop is not subject to this ambiguity. Let us suppose that the CONTROLLED OSCILLATOR 3 is operating at the correct frequency f + 31 kc. Then a frequency increase at the output of FIXED LOCAL OSCILLATOR 1 will appear as a change in the input to the modulator of from 3f to 3f + δf. The lower sideband for this modulation will be (3f + 93 kc) – (3f + δf), or 93 kc – δf. According to the curve as shown above the frequency discriminator in (a) of Figure 1, this will increase voltage E_2, which in turn (from Figure 2) will increase the frequency of the CONTROLLED OSCILLATOR 3 until the frequency of the modulator output returns to 93 kc, when stable operation is reached. Frequencies of the two inputs to the modulator of the slave oscillator (b) of Figure 1, have now been increased by the same amount, but their difference remains at the same value, F + 31 kc. On the other hand, if the CONTROLLED OSCILLATOR 3 should attempt to operate at f–31 kc, then the lower sideband becomes (3f + δf) – (3f – 93 kc) or 93 kc + δf. From the two curves mentioned above, this increase δf will cause a decrease δ′f in the frequency of CONTROLLED OSCILLATOR 3. The lower sideband

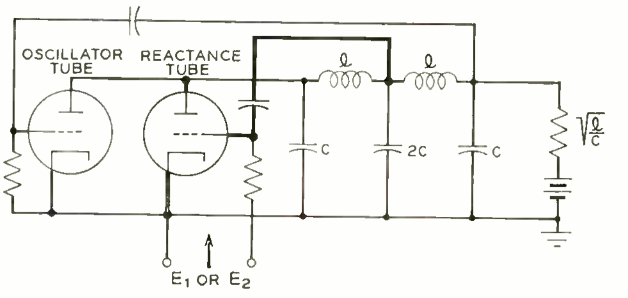


Fig. 3—The basic reactance tube controlled oscillator circuit. In the slave oscillator, two reactance tubes are employed, one actuated by the frequency discriminator voltage and the other by the phase discriminator voltage. Frequency of oscillation = $1/2\pi\sqrt{LC}$ approximately, depending upon the reactance introduced by the reactance tube.

of modulation will increase in frequency still further, becoming 93 kc + δf + 3δ′f, so that an unstable situation is created. Thus there is no danger of the system "locking in" on a controlled oscillator frequency f – 31 kc and a corresponding system output of F – 31 kc.

Another advantage of the joint system of frequency and phase control lies in greatly improved stability of the controlled oscillator. Tendencies for oscillation to occur in the phase sensitive loop due to delay and frequency distortion, are damped out by the parallel frequency sensitive control, allowing increased sensitivity and range of control to be used in the phase sensitive loop. Consequently, variations in the fixed local oscillator frequency f may be much greater than with only a phase sensitive

THE AUTHOR: After graduating from the College of the City of New York in 1941, where he obtained the B.S. degree in Physics, DANIEL LEED spent three years with other engineering concerns before entering the U.S. Army Engineers Corps. He was attached to the Los Alamos Laboratories of the Manhattan District from 1944 to 1946. Since joining the Laboratories' Technical Staff in 1946, he has been engaged in circuit developments for phase and transmission measurement systems, particularly in the field of automatic frequency control.

loop, before the CONTROLLED OSCILLATOR 3 will pull out of synchronism.

The reactance tube controlled oscillator used in this circuit was selected because it possesses high sensitivity, frequency stability which is high for reactance tube-controlled oscillators, and comparative independence of oscillation level with frequency deviation. It was designed by F. R. Dennis and is described elsewhere.* Figure 3 illustrates the circuit. Plate and grid of the oscillator tube are connected together through a phase shift network consisting of two similar π structures in cascade. The frequency of oscillation, which is such that the phase difference between grid and plate terminals is 180 degrees, can be changed over very wide limits by applying reactive loads at either end of the network. This reactance is supplied by an electron tube, the plate of which is connected to that of the oscillator and the control grid a-c coupled to the mid point of the phase shift network. Since the voltage at the mid point is in phase quadrature with the plate, the tube appears as a reactance placed in parallel with the plate of the oscillator. It is this characteristic that gives rise to the name "Reactance Tube," and the magnitude of the reactance developed is dependent upon the reactance tube transconductance. Frequency of oscillation can, therefore, be varied by grid bias changes of the reactance tube. This bias is supplied by the voltage outputs of the frequency and phase discriminators.

To meet the requirement of a high degree of isolation between the master and slave oscillators, the sub-circuits represented by the blocks shown in (a) of Figure 1 are placed in individually shielded compartments. Particular attention is paid to filtering filament and power supply leads to prevent interstage pickup.

The development to produce the master and slave oscillators embodying automatic frequency control touches many phases of the electronic art. In addition to the immediate application in the 3.6 mc phase and transmission set, the experience gained has been valuable in the design of automatic frequency control systems for other types of measuring equipment.

* *Bell System Technical Journal, October,* 1949, *page* 601.

Telephone service for the pentagon building

What will be the world's largest private branch exchange system is coming into being in Washington for the Department of Defense. A step-by-step system, it was manufactured by Western Electric and furnished to the Government by the Chesapeake and Potomac Telephone Company. It will have 18,500 lines and 33,000 telephones and will handle upwards of 250,000 calls a day. By calling Liberty 5-6700, any telephone in the Pentagon can be reached; and by October when Navy telephones are transferred, the same number will reach them.

A number of Laboratories men collaborated with Telephone Company engineers in conferences both in Washington and New York. Mention should be made of H. H. Abbott and P. V. Welch of Manual Switching Engineering; R. W. Harper, F. R. Lamberty and W. Bennett of Step-by-Step Circuits, and F. G. Colbath of the Current Development Group of Systems Engineering.

Large enough to serve a city of 200,000 people, the new system could be nearly doubled in size in an emergency. Incoming calls to the Defense Department will be handled at the Pentagon switchboard on a 24-hour basis, with the Navy switchboard being used eight hours per day and five days each week.

E. L. ERWIN
Switching Development

Trunk selection by No. 5 crossbar markers

In the No. 5 crossbar system* the trunks of all routes are distributed as far as possible over all the trunk link frames.† Because of this distribution of the trunks, and because some of the frames may be busy with other markers, a marker in searching for an idle trunk has to find a frame not busy with another marker—or an idle frame as it is called—that has an idle trunk of the desired group.

If markers were required to seize frames to find whether or not idle trunks were available, many unnecessary frame seizures would occur. These would not only waste the time of the marker but would delay other markers that might wish to use that frame, thereby increasing their holding time. The circuits are arranged, therefore, so that the marker may locate idle frames that have idle trunks of the desired group before seizing a frame.

Originating registers are also distributed among all the trunk link frames, and thus so far as the work of the markers in selecting trunks is concerned, the originating registers may be considered as trunks of one route. In what follows, therefore, the term trunk will be considered to include also the originating registers.

There may be from two to twenty trunk link frames in a No. 5 crossbar office, and from three to twelve markers. Each trunk link frame has capacity for 160 trunks of which 120 can be outgoing and intraoffice trunks, including registers, and after a marker has seized a frame, it must determine which trunks of the desired group are idle and then select one of these. The work of the marker in finding an idle trunk is thus divided into two steps. It first locates an idle frame that has at least one idle trunk of the desired route without establishing a connection to the frame through its connector. The marker then connects to that frame and selects and seizes one of the idle trunks of the desired route.

The arrangement of trunks, frames, connectors, and markers, and some of their interconnecting paths, is illustrated in a diminutive scale in Figure 1, which shows only three trunk link frames and two markers. The red and black lines represent those paths over which the marker tests for idle trunks and frames, respectively, before seizing, while the other paths are those used after a frame has been seized.

An FT lead (red) runs from each trunk to one of a set of FT terminals on the trunk link frame. When the trunk is idle, the FT lead will be grounded. From an adjacent set of terminals, marked FTC, leads run directly to all the markers without passing through the frame connectors. Each FTC terminal represents the trunks of a single route, and on each frame an FTC terminal is cross-connected to the FT leads of all the trunks of that group. By looking at the FTC leads to the desired route from each of the frames, therefore, the marker may determine which frames have idle trunks.

Each frame connector, as indicated in Figure 2, has an MC relay that is operated when the frame with which that connector is associated is in use by a particular marker, and when an MC relay is operated, it grounds an FB lead (black) through one of its front contacts. The FB leads from all the connectors associated with one frame are connected together and carried to all the markers. By looking at these FB leads, therefore, the marker can determine which frames are busy.

How the marker selects an idle frame that has an idle trunk of the desired route may be followed with the help of Figure 2. Each marker has a route relay—not shown

* Record, *March*, 1949, *page* 85.
† Record, *October*, 1949, *page* 360.

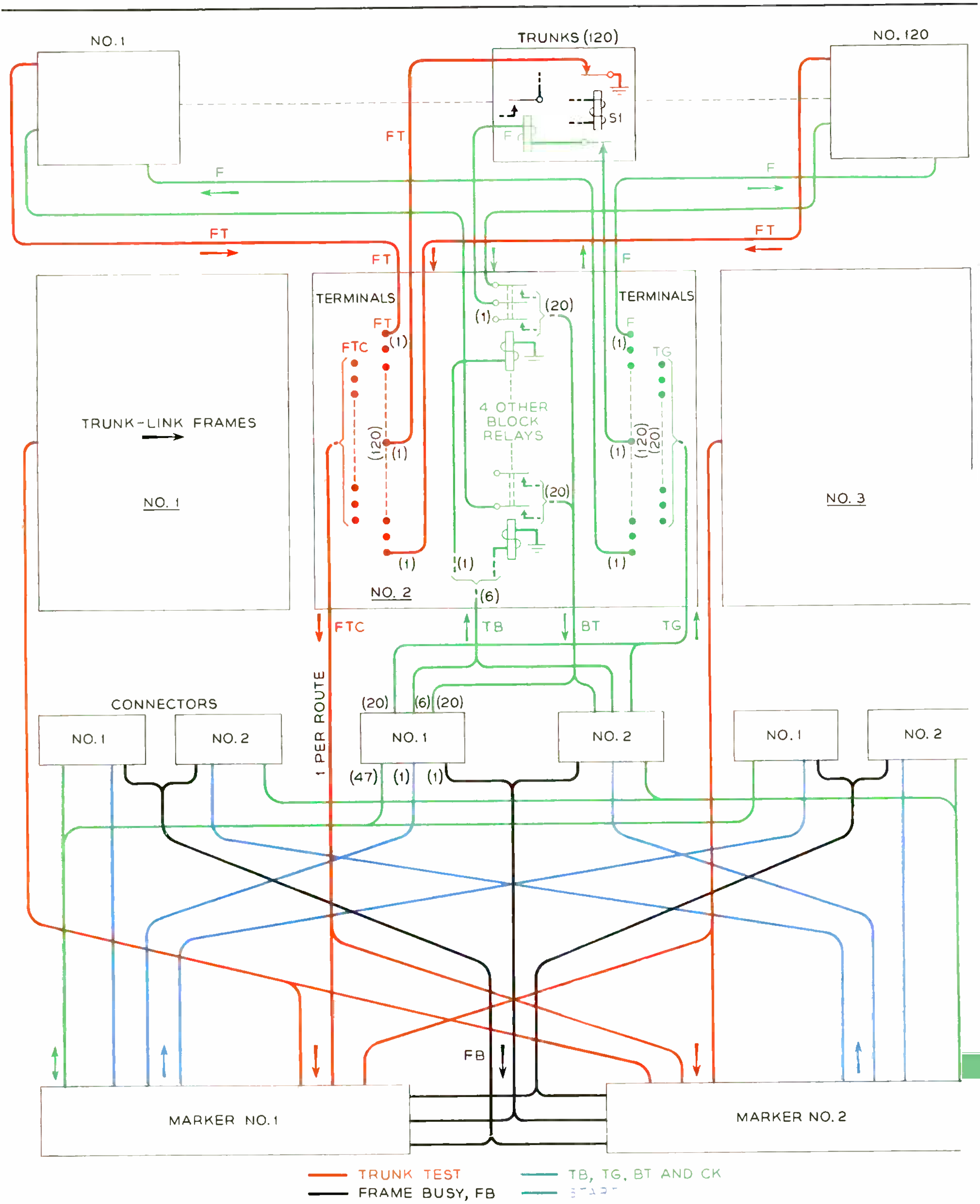


Fig. 1—Simplified diagram indicating some of the interconnections between trunks, trunk line frames, connectors, and markers in the No. 5 crossbar system.

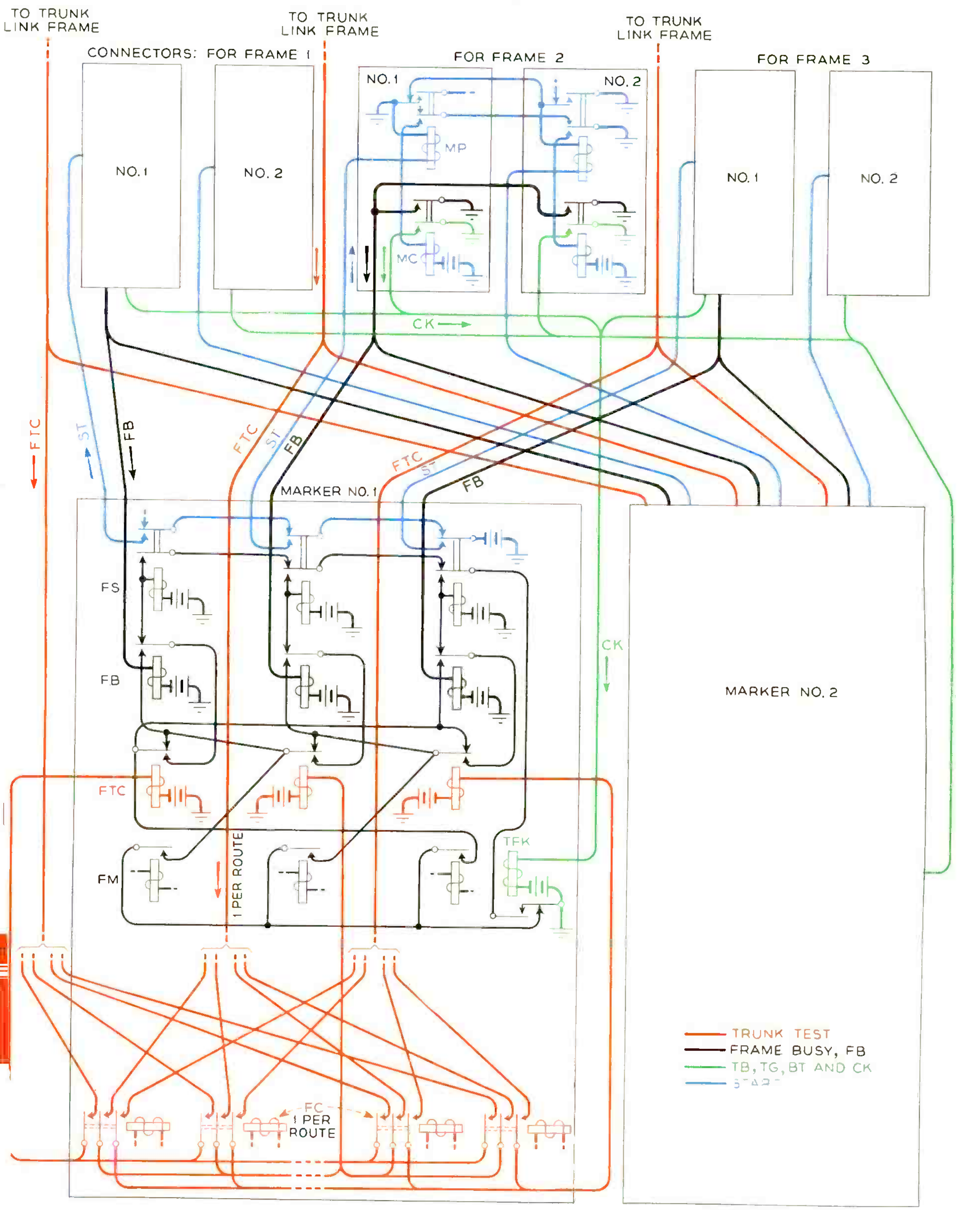


Fig. 2—Simplified diagram indicating some of the relays in the connectors and markers and their interconnections in the No. 5 crossbar system.

in the diagram—for each of the trunk routes in the office, and when a marker is seized, it operates the route relay required for the call. When the marker is seized by a calling line, it operates the route relay for the originating registers, while when it is seized by a register after a number has been recorded, it operates the route relay that corresponds to the office code data passed to it from the register. One contact on the route relay operates an FC relay in the marker, and the operation of this relay connects the FTC leads (red) for that route of trunks on all the frames to the windings of a set of FTC relays—there being one FTC relay for each frame. The FB leads from the connectors for each frame run to the windings of a set of FB relays in the marker. In addition, there is also one of these relays for each frame.

The FB and FTC relays for each frame are associated with an FS and an FM relay to form an interconnected set, and there is one of these sets of four relays for each frame. They are all interconnected as shown in the diagram. For each frame that is busy, the FB relay will be operated, and for each frame that has idle trunks of the desired route, the FTC relay will be operated. The FM are memory relays, and the FM relay associated with the frame last used by the marker will be operated when the new call comes in.

Should all the trunks of a route be busy, the marker—after a short interval—will advance to the next route, which may be an alternative route, to the desired destination or an overflow trunk, which gives an "overflow" tone to the calling subscriber. This action is under control of a timing circuit that starts operating when the frame connector relays operate. If an FTC relay operates—indicating an idle trunk—the timer will be stopped and the marker will not advance.

Ground from a back contact on the TFK relay passes through a front contact of the operated FM relay to the armature, contact of the FTC relay of the next higher numbered frame. If this relay is operated, indicating at least one idle trunk on that frame, the ground will be continued to the armature contact of the FB relay for that frame. If this relay is not operated, indicating that the frame is idle, ground will pass through its back contact and operate the FS relay for that frame, thus selecting the frame. From the interconnections between these sets of relays, it will be noticed that if the FTC relay had not been operated, or if the FB relay had been operated, the ground would have been extended to the FTC relay of the next higher numbered frame. With this circuit, therefore, the FS relay is operated for the first frame encountered—following that of the operated FM relay—that is not busy and that has idle trunks in the desired group.

When an FS relay operates, it connects battery to the start lead (blue) running to that marker's frame connector for that particular frame. This operates the MP relay in the connector which in turn operates its associated MC relay. Operation of MC grounds the FB lead (black) to indicate that that frame is now busy (occupied by a marker), connects to the marker a group of leads that the marker will use in subsequent handling of the call, and grounds a CK lead (green) to the marker. Ground on this latter lead operates relay TFK in the marker. This locks the FS relay that was operated, and removes the ground from the FM relay contacts.

If the only idle trunks of the desired route are on trunk link frames in use at the time by other markers, the marker—under control of its timing circuit—will wait a short interval for one of these frames to become idle. Should none of the required frames become available within the established time intended, the marker will cause a trouble record to be taken and then give the connector a trouble release.

Having thus selected and connected to a suitable frame, the marker now proceeds to select an idle trunk on that frame. For the purpose of finding and seizing a suitable idle trunk after the frame has been seized, the 120 possible trunks of a trunk link frame are divided into six blocks of twenty trunks each, and within each block from one to twenty groups are provided. As indicated on Figure 1, the blocks are physically represented by six block relays each with twenty contacts, and the formation of groups within each block will depend on the number of trunks of the various routes that are included in that block. Each group of a block will include all the trunks of one route on that trunk link frame. If there are many routes of only one trunk each, the block might include twenty groups, while if one route had more than twenty trunks, half of them would form a group in one block, and the remaining trunks of that route would form one group in another block but with the same group number. All the registers connected to a frame, usually five or six, will form one group in one of the blocks.

With this arrangement, the number of trunks per group may differ for each block, but in any block a group always includes only the trunks of one route, and it will include all the trunks of that route except when there are more than twenty trunks per route. In testing and seizing trunks, the marker designates one block and one group, and this combination always identifies the trunks of one route. The same group but a different block, or the same block but a different group, would, of course, identify trunks of a different route. It is

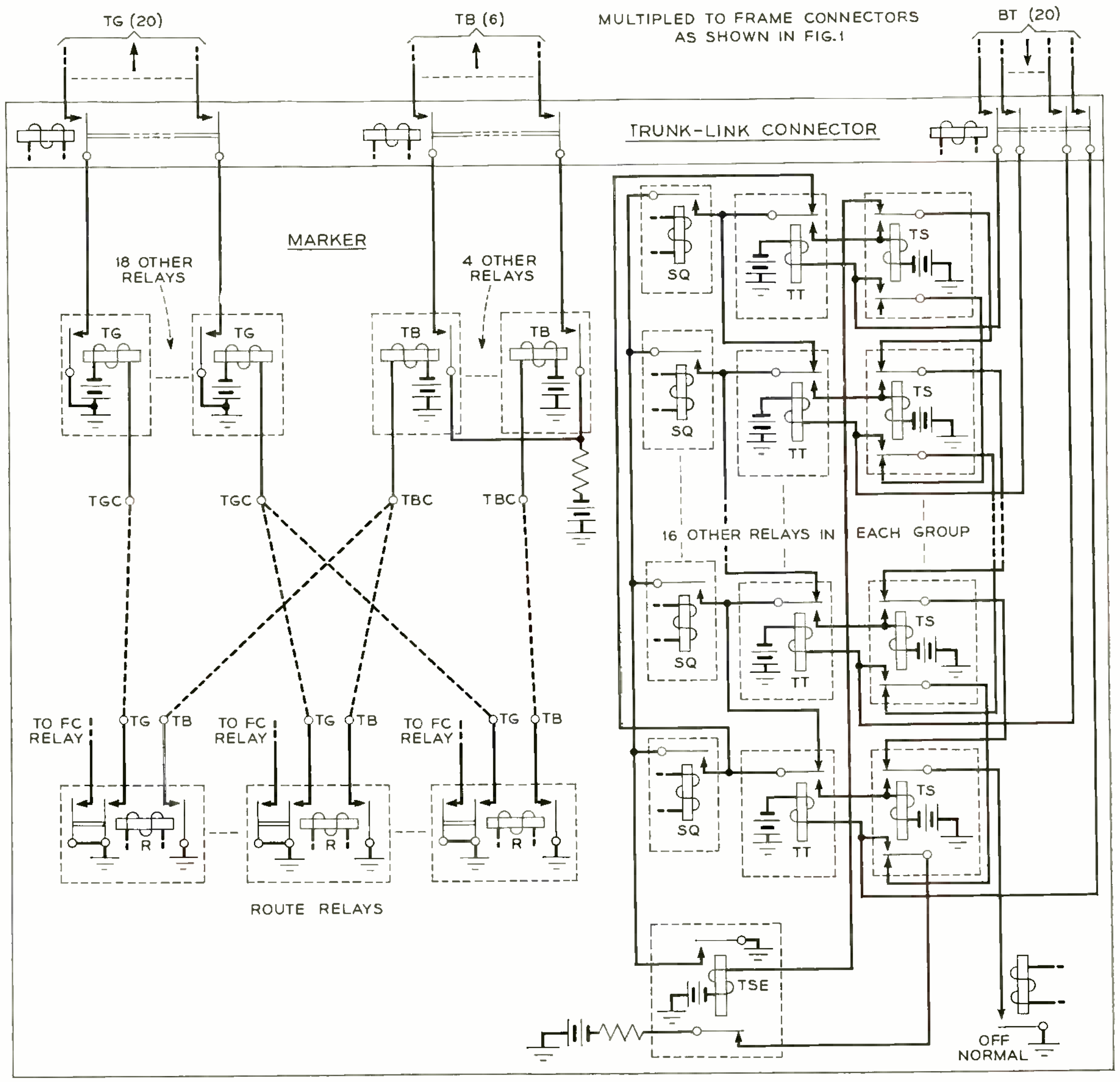


Fig. 3—Simplified diagram indicating some of the relays in the marker and trunk line connector.

because of this identifying method of the marker that the trunks are assigned as described above.

Two relays in each trunk circuit are involved in busy testing and seizing a trunk; an F relay, which is operated to seize the trunk, and an S1 relay, which remains operated as long as the trunk is in use. One end of the winding of the F relay is carried through a back contact of the S1 relay to a set of F terminals, there being one terminal for each trunk of the frame. If the trunk is in use, this circuit will be open at the S1 relay. The other end of the F relay winding is connected to one of the armature contacts of one of the block relays. This arrangement is indicated in the upper part of Figure 1.

The front contacts of the six block relays are multiplied, and brought down through the connector to the marker as a group of twenty leads (green). Each of these leads connects to a winding of a TT relay as indicated in Figure 3. The other end of the winding of the TT relay is connected to battery. Only one block relay is operated at a time, and thus the BT leads will be connected only to the F leads connected to the block relay operated.

When the route relay operated in the marker, it in turn operated a TB and TG relay as well as the FC relay referred to in connection with Figure 2. There are six of the TB relays—one for every block relay on a trunk link frame—and there are twenty TG relays; which particular TB and TG relays are operated by any one route relay is determined by jumpers run between the two sets of terminals shown in the marker in Figure 3. An operated TG relay connects ground—after a frame has been seized—to one of a set of TG terminals on the frame as shown in Figure 1. These TG terminals are adjacent to the F terminals through which the trunk test leads are connected. Each TG terminal represents, a group, and jumpers are run between the TG and F terminals to form the groups of the six block relays. Group 1 in block 1 might be six registers; in block 2, it might be three trunks to office A; in block 3, one trunk to office B; in block 4, eight trunks to office C, and so on. Jumpers would thus run from the No. 1 TG terminal to the F terminals of all the trunks comprising group 1 in all the blocks. When a frame is seized, ground from the operated TG relay would thus be applied to the F leads of all these trunks, but only the trunks associated with the particular block relay operated at that time would have their circuits completed to the TT relay and battery in the marker, and these would be the trunks of only one route. For the busy trunks of that route, moreover, the circuit would be open at the S1 relay. When a frame is seized, therefore, a TT relay for each idle trunk of the desired route will operate.

As shown in Figure 3, each TT relay in the marker is associated with an SQ and a TS relay to form twenty sets of three relays. When a marker is seized, ground from a marker off-normal relay is carried through back contacts of the TS relays in series, and operates relay TSE, which puts ground on the armature contacts of the SQ relays. These SQ relays are part of a sequence circuit, whose function is to rotate the preference, and one is operated in turn for each call that the marker handles. When a frame is seized, therefore, current flowing over the BT and TG leads and through the trunk test leads of 1 group of 1 block, operates certain of the TT relays as a result. Ground from the operated SQ relay passing through the armature contact of its associated TT relay will operate the associated TS relay if that TT relay is operated. If that particular TT relay is not operated, the ground will pass to the next TT relay above, and either operate its associated TS relay, or be passed to the next TT relay. In this way, the first TS relay with an operated TT relay will operate. Actually there are only ten SQ relays instead of the twenty indicated, but their association with multiplier relays is such as to give the effect of an SQ relay for each TT relay, as indicated in Figure 3.

The current flowing over the trunk test circuit, although sufficient to operate a TT relay, is not sufficient to operate the F relays in the trunks. When a TS relay is operated, however, it opens the circuit to the TSE relay and thus releases it, and from a back contact of TSE, battery through a low resistance is applied to the BT lead of the selected trunk. This causes enough current to flow through F to operate it, and the trunk is thus seized. Relay TS also locks itself through the off-normal ground and thus it no longer needs to be held by the circuit through TT and SQ.

These selecting operations, which have taken considerable time to describe, would appear to one watching in the marker as occurring almost simultaneously. The operation of a route relay immediately after the marker is seized is followed by the immediate operation of an FC relay, and this by the operation of a number of FB and FTC relays and one FS relay that seizes the connector and frame. As soon as a trunk link frame is seized, paths are prepared for operating one or more of the TT relays, and through contacts of one of these, a TS relay operates. That in turn operates the F relay in one of the idle trunks, thus connecting a group of leads from that trunk to the marker over which the marker gives the trunk the information needed to complete the call. The operations from the time that the route relay operates until the F relay of the trunk operates take place in about 0.09 second.

THE AUTHOR: E. L. ERWIN, in 1918, received the B.S. degree from the University of Chicago. He joined the Installation Department of the Western Electric Company in 1921, and for the next three years was occupied in installing panel offices. Following this, he joined the Technical Staff of the Laboratories, where he was with the circuit laboratory until 1932. He then transferred to the circuit design group, where he has been engaged in development work on panel, crossbar and P.B.X. systems, and, more recently, on the No. 5 crossbar system.

H. F. Dodge Receives Merit Award

H. F. Dodge received the first Award of Merit of the Society "in recognition and appreciation of his outstanding service to the American Society for Testing Materials." Mr. Dodge was nominated for the award on the basis of his long active service on A.S.T.M. committees, his marked leadership in the Society's activities, his outstanding contributions in the form of test methods and procedures, and the publication of papers that have been of special benefit to the work of the Society.

The award was presented to Mr. Dodge on June 29 at Atlantic City by J. G. Morrow, President of the Society.

Communications Development Training Program Graduation

Following a dinner in the Murray Hill conference dining room on July 6, graduation ceremonies were held for twelve students who had completed the full Communications Development Training Program, (CDT), Class of 1948, and for twenty who had completed part of the Program.

In the presence of Laboratories vice presidents, general department heads, and the committee responsible for the Training Program, M. J. Kelly gave a talk on *Plans for Communications Development Training Graduates,* after which E. E. Sumner responded for the class. Personnel Planning Director Morton Sultzer presented the 12 graduates of the full program to Dr. Kelly who awarded their certificates.

The ceremony touched a lighter vein in a humorous talk by F. F. Romanow entitled *Impressions of an Instructor in the CDT.* Mr. Sultzer then presented the twenty engineers who had completed part of the Program to Personnel Director F. D. Leamer, who presented their certificates. Dr. Kelly's closing remarks brought the ceremonies to an end.

Graduates of the full Program are: C. L. Beckham, B. M. Bowman, R. C. Boyd, N. J. Herbert, R. S. Pitt, D. D. Sagaser, R. E. Staehler, E. E. Sumner, V. W. Wall, R. J. Watters, 3rd, N. C. Wittwer, Jr., and B. J. Yokelson.

Those receiving certificates for completing part of the Program are: F. T. Andrews, Jr., E. G. Baldwin, J. J. Douglas, R. F. Dusenberry, H. G. Follingstad, K. Goldschmidt, H. B. Guerci, T. B. Harker, R. C. Lee, H. L. McDowell, W. C. Meyer, R. E. Rath, E. O. Ruhlig, G. A. Sellers, Jr., F. H. Shorkley, L. M. Spandorfer, J. L. Troe, D. C. Weller, R. W. Westberg and J. J. Yostpille.

One of this group, Mr. Guerci, began his Laboratories' career as a messenger, was trained in the Laboratories' Drafting Apprentice classes, and became a draftsman. During World War II, he rose to the rank of Lieutenant Colonel in Anti-Aircraft Artillery. He was granted a personal leave to complete his college work and was later employed as an engineer in the Communications Development Training Program.

Among the guests at the graduation exercises were: M. J. Kelly, Ralph Bown, M. H. Cook, J. B. Fisk, F. D. Leamer, W. H. Martin, M. B. McDavitt, J. W. McRae, D. A. Quarles, P. W. Blye, A. G. Ganz, T. C. Henneberger, S. B. Ingram, J. Meszar, F. F. Romanow, Morton Sultzer, E. J. Thielen and H. E. Mendenhall.

Graduates of the Communications Development Training Program with Laboratories executives and members of the committee responsible for the Program.

New Head of Staff Departments

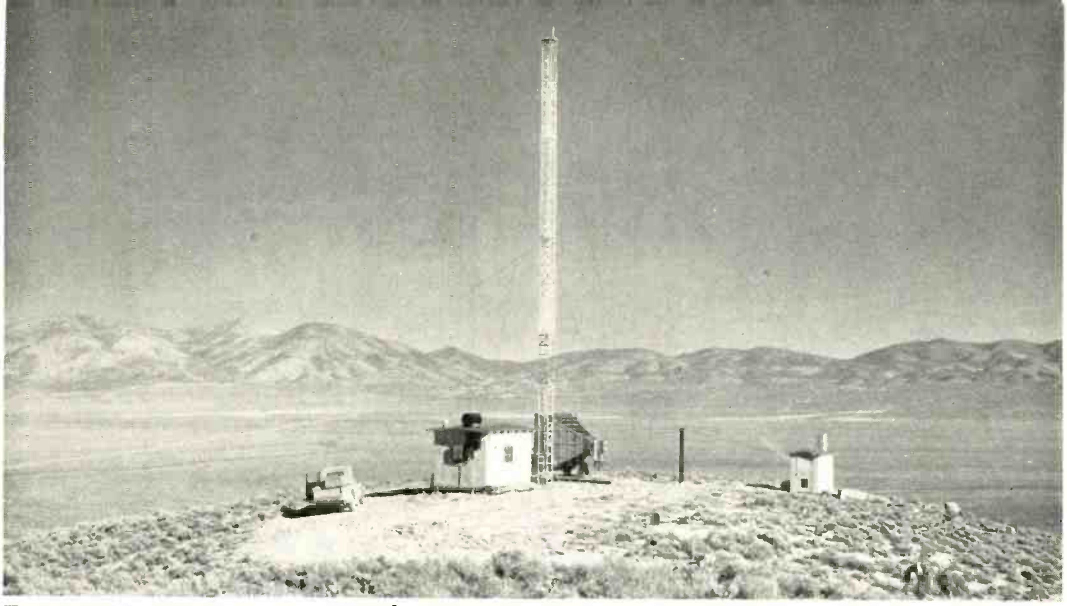
Sanford B. Cousins, Vice President and General Manager of the New England Telephone and Telegraph Company, was elected Vice President and a Director of the Laboratories at a meeting of the Laboratories' Board of Directors on July 17. He assumes his new duties August 1, in charge of staff functions reporting to President Buckley, with the title of Vice President and General Manager.

Mr. Cousins is a native of Gray, Maine, and entered the Bell System shortly after his graduation from Bowdoin College, Brunswick, Maine, in 1920. After serving for a year with the Long Lines Department of the American Telephone and Telegraph Company, he transferred to the New York Telephone Company and filled a number of positions in the Traffic Department of that Company in New York City, Newark, N. J., Buffalo, Albany and Syracuse, N. Y. In 1940 he was appointed General Traffic Manager at New York City. In 1944 he was appointed Assistant Vice President, personnel relations, of the American Telephone and Telegraph Company.

He went to Boston in November 1948, when he was elected Vice President and General Manager of the New England Telephone and Telegraph Company. He was elected a Director of that Company in January 1949.

Mr. Cousins was president of the Bowdoin College Alumni Association in 1947-48 and in June of this year was elected a member of the Board of Overseers of the College.

Staff departments previously reporting to Mr. Quarles, with the exception of Patent, report to Mr. Cousins. Mr. Quarles, reporting to the Executive Vice President, continues in charge of the Patent and Military Electronics Departments and also continues his responsibilities in relation to the Sandia Corporation. The other technical departments, reporting to the Executive Vice President, are unchanged.



Transmitting station on spur of Table Mountain. The tower is used for loss vs height and the horn for loss vs time measurements.

A Summer's Work on the Desert

By Robert L. Kaylor, Transmission Engineering

Because the microwaves used in Bell System radio relay systems are affected by the hills, plains, deserts and other features of the terrain, a number of Laboratories engineers have gone out into the field to find out just what transmission variations can be expected. Sometimes the living conditions on these jobs are ideal, as when my family and I spent a summer in a house-trailer on the bank of a lake near Wauseon, Ohio. At other times the living is more rugged, as D. K. Martin and his associates can testify after two winters at Wendover in the salt flats of Utah.* Somewhere between the two was the eight months the Kaylors spent at Winnemucca, Nevada, last year.

Winnemucca lies in the northern part of its state, about 160 miles northwest of Reno on U. S. 40. The surrounding country, mostly sand and sagebrush, supports cattle-grazing and there is some mining, for which the town is the supply and shipping point. Reno is the nearest city. Mountains tower six thousand feet above the valley floor which is the bed of a prehistoric lake and is gently rolling with

* Record, *September*, 1949, *page* 334.

In the receiving station near Winnemucca, Mr. Kaylor records calibrations of his measuring set.

Driving through six inches of alkali dust makes a respirator important.

a few low hills. It is typical of the western third of the Chicago-San Francisco section of the proposed radio relay system, and so a knowledge of the variations of the transmission path is important in deciding on the spacing and height of the stations.

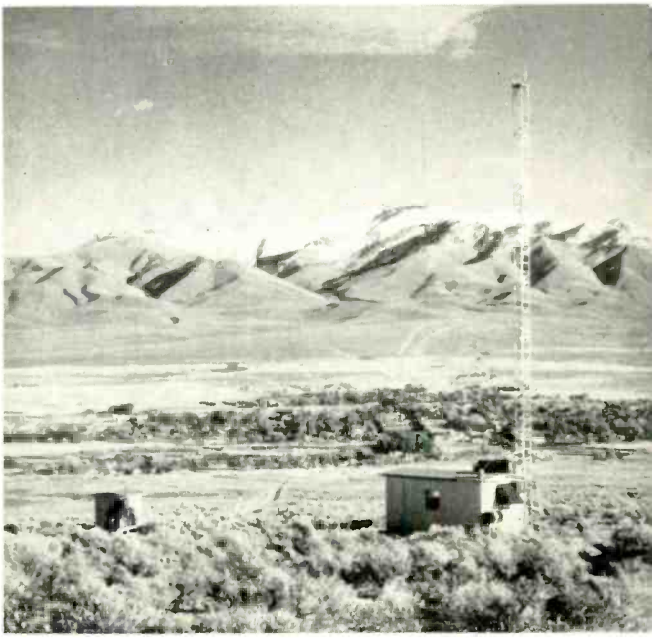
At the end of June 1949, the Kaylor family, consisting of my wife, my ten-year old boy and myself, left New York by car. We paused at the Laboratories' microwave test station near Fremont, Nebraska, where I relieved Herman Franke for two weeks. Arriving at Winnemucca we found the transmitter and two receivers ready for operation. George H. Baker and Walter Strack, with engineers and a line crew from the Pacific Company, had been there for some time constructing the buildings and installing equipment. They now departed, leaving two Pacific Company engineers, John Babcock and Randolph Hollis, to assist in the tests.

From Winnemucca, where the Kaylors found a furnished (?) apartment, the nearest receiver was a mile and a half. The other receiver was about six miles out, and the transmitter about 30 miles. Access to both of the outlying stations involved some improved roads, but a good deal of driving across open country. The station wagon would be useless on these tracks, so it was replaced by a jeep truck, and that was eventually supplemented by an ex-army weapons carrier. With fine dust six inches deep, and steep grades, only a four-wheel drive vehicle could get through; and the dust was so destructive that breakdowns were frequent.

Because of the remoteness of our stations in practically uninhabited territory in the desert, it was necessary to set up a security system for our visits. Normally one member of our crew remained at the base station with a vehicle available when a party went to one of the other stations. If they did not return or contact the man at the base station over our radiotelephone channel within a specified number of hours, he would go forth as a one man rescue party, after notifying local telephone company personnel so that he in turn could be rescued if he too disappeared.

Power for the stations was furnished by gasoline engines driving alternators. At the transmitter, a carrier wave was put on the air, which was received and measured at each of the receivers. It was my nightly chore to go up the hill just before bedtime and check the nearby receiving station. If carrier was coming in from the transmitter, all was assumed well. But if there was no carrier, someone had to make the thirty-mile drive at once to clear the trouble. That seldom happened, because the equipment that was used was reliable and we took good care of it.

R. L. Kaylor (right) shows two Pacific Company men how to measure output power.



A good view of the region around Winnemucca is had from the receiving station.

Although the continuous-recorder tapes showing received signal were processed in New York, considerable editing was necessary in the form of adding weather reports and notes which would explain unusual records. Our TWX station kept us in close touch with West Street, and engineers there frequently requested special tests. Running and reporting on these tests, together with routine maintenance of our three stations and our rolling stock, gave us plenty to do and working hours were long.

Life in Winnemucca was much like that in any small town. Because it is on a main line railroad, stores carried up-to-date merchandise. Food supplies were good, but fresh vegetables were scarce. My son found plenty of playmates, but he was really delighted to return to New York.

That happy event began early in January this year, when it was decided that we had sampled enough fading to call off the work. Five days after a blizzard, we were at work in our shirt sleeves taking down our portable towers.* On January 24, the Kaylors boarded a sleeper at Winnemucca which in due time deposited them in Grand Central.

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

Insurance Counselor's 25th Service Anniversary

This month the Record breaks precedent to chronicle the twenty-fifth service anniversary of a man who is not an official member of the Laboratories, nor even of the Bell System. We do so because so many Laboratories people know him, and he is certainly an esteemed, though unofficial, member of the Laboratories "family."

He is Lloyd H. Bunting, who this month completes twenty-five years service with the Equitable Life Assurance Society of the United States. Some twenty-two years ago the employees' payroll deduction plan for life insurance premiums was first established in the Laboratories and Mr. Bunting became Insurance Counsellor. The purpose of this plan was to make available to Laboratories people information on the advantages of life insurance in relation to their problems and needs and to assist in budgeting insurance costs by making the payment of premiums through payroll deductions. Life insurance needs of individuals vary depending upon the requirements of themselves and their families. In the establishment of an insurance counselor it was felt that competent advice could be made available to those who might not otherwise have access to it. Thus the plan serves to encourage and facilitate the procuring and carrying of adequate life insurance by Laboratories people.

Lloyd Bunting had been a pioneer in developing the payroll deduction plan and worked very closely with the Laboratories in setting up this program. Since December, 1927, when it was inaugurated, approximately 3600 policies have been issued to members of the Laboratories under the plan for a total of more than $12,000,000 in face value.

Under its provisions, regular employees may obtain life insurance from the Equitable Life Assurance Society of the United States through its official representative, Mr. Bunting, and pay the premiums monthly by authorizing the Laboratories to deduct the amounts of such premiums from their pay and remit them to the insurance company. Similar plans are in operation in most other Bell System companies with various other insurance companies.

Very few members of the Laboratories need to be convinced of the value of life insurance as protection for their families and as a source of income in their own later years. Many people, however, may have delayed taking definite action or may have neglected to buy additional insurance which they need. The Laboratories insurance plan offers them an opportunity to have their insurance programs analyzed by an expert and to purchase whatever insurance they need, through payroll deduction or otherwise.

As a matter of fact, every life insurance program should be reviewed at fairly regular intervals to make certain that it is designed to best accomplish the purposes for which it was set up. Many things can happen to affect a life insurance program. The death of any member of one's immediate family nearly always brings the need for changes. Marriage or the birth of children are factors which may call for additional insurance. New laws changing taxes on income or inheritance should be examined to determine their effect upon the estate. As children grow older or as a man approaches retirement, his insurance program should be carefully analyzed for revisions or additions.

Life insurance is primarily for protection but there are many ways in which this protection can be arranged, and considerable study should be made to procure adequate protection under the best possible circumstances. Everyone's insurance is a special problem and should have a special relationship to his income, family obligations, and his personal views and ambitions. Following are some of the polices available.

Term

These policies expire after 2, 5, 10, 15 or 20 years and have no cash values. However, they are convertible within time limits to most other regular forms and offer low rate protection.

Ordinary Life

This is the lowest rate form of permanent protection, and if any general rule can be made, offers the best coverage, particularly to the underinsured.

Limited Payment Life

The popular 20-payment life policy, and similar forms which become paid up at ages 60 and 65, offer advantages for those who want their insurance premiums to cease at a certain time.

Endowment

The same periods are provided in this series as in the above paid-up series. These policies are taken by those who wish to provide protection for specific periods and then want to collect the face value at maturity. These are most frequently used for educational funds or retirement incomes.

Retirement Policies

These policies provide specific retirement amounts at ages 55, 60, or 65 and at the same time have options for cash or paid-up insurance.

Annuities

These policies have no life insurance protection but offer specific retirement incomes for cash payments at various ages from 55 to 65. They may be purchased by a single payment, or by premiums spread over a period of years.

Family Income

These policies are designed to provide specific monthly incomes to beneficiaries during the time when the children are small and dependent and then offer cash or optional income advantages to the wife after that period.

Policies for Special Situations

One of these provides double protection up to age 65. Another, a whole life policy, has a lower premium during its first five years.

Many policies may be paid up in full when they are taken out, or at a later date. These are called single premium policies.

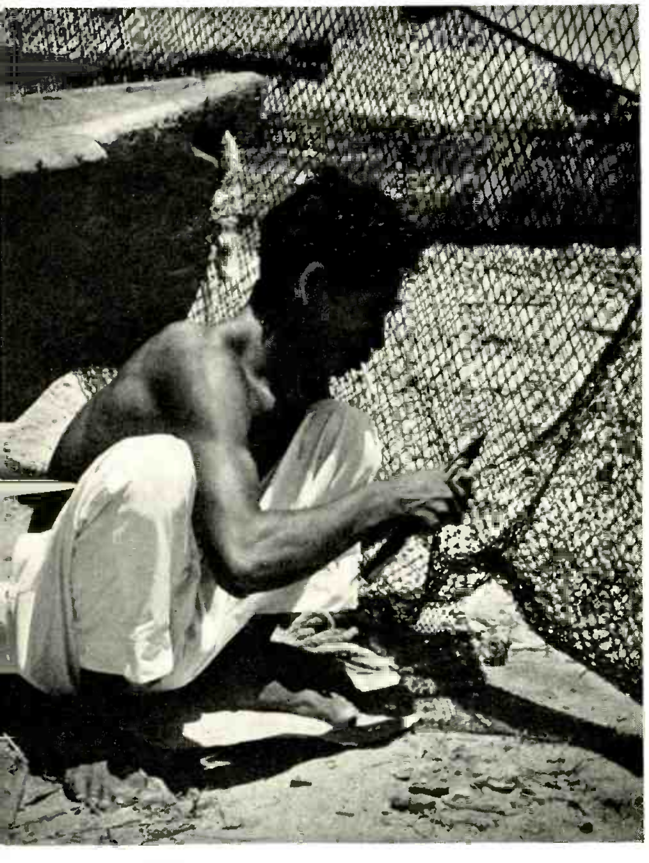
A booklet concerning the Laboratories plan is available from Mr. Bunting and, in addition, he is always ready to discuss insurance problems with members of the Laboratories and to help in any way possible. Mr. Bunting's office in the Laboratories is in Room 476 and his telephone extension on the Laboratories board is 264. Mr. Bunting's assistant is A. Laighton Seaver, Jr., who can be reached at the same office. The advice of the counselors is given without obligation.

Members of Outside Plant Development have been resident at Point Breeze in connection with cable development work since the start of manufacture of cable at that Plant in 1929. Left to right: W. C. Royal, M. C. Biskeborn, G. J. Schaible, R. A. Kempf, J. T. Maupin, R. E. Alberts, Ruth K. Ammons, A. S. Windeler, Audrey S. Beatty, N. V. Firth, R. B. Ramsey, C. Kreisher, C. R. Noble, C. E. Howard, and O. S. Markuson.

Landscape. "Afternoon stroll." W. S. Suydam.

Photographic Salon Firsts.

Miscellaneous. "Apprentice." David Bodle.



Labs Officers to Aid Air Force

At the request of the Secretary of the Air Force, the advisory services of Executive Vice President M. J. Kelly and Vice President D. A. Quarles have been made available on a part-time basis to the Department of the Air Force. They will assist in the organization of research and development in that Department.

Color Television

Differences between the three recently proposed systems of color television were described to capacity audiences—two each at West Street and Murray Hill and one at Whippany—by A. G. Jensen of Television Research. Explaining that any satisfactory system for recording and reproducing scenes in colors requires at least three primary colors, Mr. Jensen pointed out that in a television system the three records are put together for viewing purposes by presenting them in time sequence. The Columbia system scans each field completely in each color; the C.T.I. scans each line in each color; and in the R.C.A. system each line is broken into many groups of three dots: red, green and blue.

Each radio channel of the present black and white system occupies a band six-megacycles wide and if each of three colors were to be given the same repetition rate and hence the same band width, a color system would occupy 18 megacycles. However, repetition of each color picture at 30 frames per second may prove unnecessary and it is thought that satisfactory pictures can be provided if only about half as many pictures are transmitted per second.

By showing color slides Mr. Jensen explained that color television uses the so-called "additive" color process as distinguished from Technicolor and Kodachrome which use the "subtractive" process. In a brief historical review he told of the color television demonstrations carried on during 1928-29 by Baird in England, and Ives at our own Laboratories. These earlier systems were of the so-called mechanical type and employed rotating nipkov discs or rotating mirror assemblies for generating the electrical signal at the transmitter and reproducing the picture at the receiver. As the art progressed, electronic color systems were developed such as the C.B.S. and R.C.A. field sequential systems, first demonstrated about 1940. Further technical developments resulted in an FCC hearing in 1947 at which time C.B.S. proposed a field sequential color television system for commercial standardization. This system was briefly described and Mr. Jensen concluded his talk with a discussion of the so-called simultaneous system proposed at the same time by R.C.A.

Stamp Club Elections

The Bell Laboratories Stamp Club held its annual election of officers on June 12 following a luncheon in the conference dining room at West Street. M. E. Esternaux was elected Chairman for 1950-51; R. Haard, vice chairman; Evelyn Fitzsimmons, secretary; M. A. Specht, librarian; C. J. Keyser, exchange manager; and E. J. Mandable, new issues manager.

The past year has been a successful one for the Club, J. Blanchard, retiring chairman, noted during the luncheon. The Stamp Show and the Educational Lecture program of the Club have interested many new members in the group.

Fastax and Waddell to Wollensak

The Western Electric Company has sold the Fastax Camera business to the Wollensak Optical Company. John H. Waddell has accepted an offer from that firm to supervise production of the camera in its Rochester factory, as well as development and sales.

Developed in the Laboratories some sixteen years ago by William Herriott and his associates* to study the motion of relay springs, bell clappers and other telephone parts, the Fastax camera has been used for a great variety of studies. Mr. Waddell has been associated with this work, both in the Bell System and in military projects, one of which took him to Bikini for the first atomic bomb test there. On that occasion he was a technical adviser to the Air Force on the photographic engineering and had charge of the maintenance of some 57 Fastax cameras and advised many different groups on their application.

Mr. Waddell entered the Laboratories' sound-picture group in 1929, with previous experience in film manufacturing. In the mid-thirties he transferred to Materials Standards, continuing his photographic activities with the high-speed camera group. Some months ago he was transferred to Military Electronics at Whippany. At Wollensak he will be manager of the industrial and technical photographic division, reporting to President E. A. Springer.

Camera Club Salon

The color slide salon of the newly formed Murray Hill Camera Club was combined with a show by members from West Street. There were entered 174 slides from 47 contestants, 19 from New York and 38 from Murray Hill.

Slides were judged by Helen Manzer, Charles Manzer and Frank Gunnell, well known judges of the New York Camera Club Council. Winners were, first prize, W. J. Rutter, *Koko;* second prize, C. M. Harris, *Worm's Eye View;* and third, P. J. Kreider, *Maple Leaves.* Two honorable mentions were won by E. Briechle, and one apiece by J. G. Cisek, F. I. Smith, R. S. Kennedy and W. S. Suydam. The slides were exhibited in the Arnold Auditorium. Chairman of the salon was R. S. Kennedy.

*Record, *April,* 1938, page 279.

Newark News Photo

John Mackay describes one of the miniature animals for his circus to the rest of his family.

J. W. Mackay Carves His Own 3-Ring Circus

The "greatest show on earth" may be stupendous, tremendous and gigantic to scores of small children squirming gleefully on hard bleacher seats, but to J. W. Mackay it is just a saddening reminder of the circus that used to come to town when he was a boy in Syracuse.

Says Mr. Mackay, who works at Murray Hill: "The circus lost all of its appeal for me when it became mechanized. I miss the rumble of the circus wagon wheel."

Four years ago he undertook a fifteen-year project that will keep his entire family circus-minded even if they never set foot inside Madison Square Garden in the springtime. He assembled a collection of research pictures and articles and started to build a complete three-ring circus modeled in miniature on the horse-drawn extravaganza that toured the country before the first truck shows in the mid-thirties.

Mr. Mackay's circus, scaled one-quarter inch to the foot, will include 150 wagons, 85 horses, a menagerie and a tent. It will be set up on a platform in a "circus room" in the wing he will add to his house before his hobby grows much larger. Already, he has finished 24 wagons and dozens of horses, carefully stored in wooden rack cases.

The ticket wagon, the bandwagon, the one carrying the tents and poles, the menagerie cages in which stalk inch-long carved bears and lions, and the calliope that plays *The Blue Danube* through a small music box, all these are brightly enameled and correct in every detail. Mr. Mackay plans to have them move in parade on metal pins in a grooved track when he builds his exhibition platform. His tiny horses wear bright blankets and his elephants have black velvet, gold-trimmed trappings.

Mr. Mackay is a member of the Circus Model Builders and Owners' Association. He recently attended its convention in Auburn, N. Y.

Radiation Patterns of Telephone Instruments

A number of observing readers of last month's RECORD detected what they thought was evidence of "trick photography" in one of the illustrations for the article, *Photographing Sound Waves* (page 304), describing a technique developed by W. E. Kock and F. K. Harvey. The figure that caused the inquiries is shown at the left, below. Close inspection will reveal that the arcs of "sound" appear to originate in the carbon transmitter.

During a discussion of an earlier experiment in which, as shown at the right, a moving microphone and lamp traced out the pattern from a stationary sound source, it was pointed out that the scheme should produce the same pattern if the transducer functions were reversed. So the scanning receiver at the end of the rocking arm (see first figures of original article) was made a sound source and the handset was arranged with the carbon transmitter taking the place of the receiver. As expected the "sound" picture was the same.

If the picture at the left still seems incredible it may help to recall that the apparatus really records a pattern of the phrase distance from either a sound source or pick-up. Directional intensity and phase effects are shown equally well for either a microphone or a loud speaker. Slight differences may be found in the accompanying patterns.

News Notes

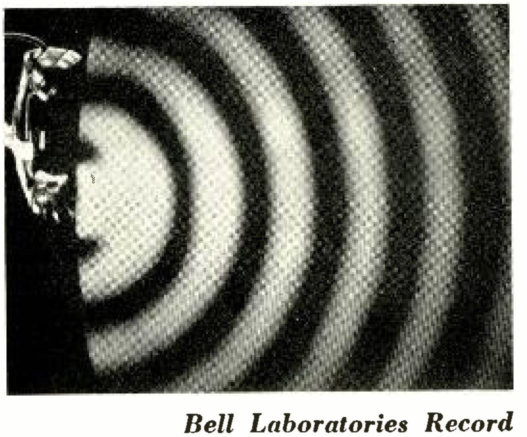
O. E. BUCKLEY has written *A Tribute to Oliver Heaviside* in the July 1950 issue of *Electrical Engineering*. A shorter tribute was presented in a recording by Dr. Buckley at the Heaviside Commemorative Meeting held in London on May 18 by the Institution of Electrical Engineers. After noting some of the early contacts between Bell System engineers and Mr. Heaviside, Dr. Buckley said "I, too, owe a personal debt to Heaviside, for I was one of the many who found inspiration in his work, especially when I was occupied with the development of continuously loaded submarine cable for telegraph and telephone use."

W. T. READ attended the Conference on the Plasticity of Crystalline Solids at Pittsburgh at which he presented a paper on *Dislocation Models of Grain Boundaries.*

W. SHOCKLEY spoke on *New Phenomena of Electronic Conduction in Semiconductors* before the Philosophical Society of Washington.

L. A. WOOTEN and N. B. HANNAY visited the Argonne National Laboratory in Chicago to discuss mass spectrographs.

R. HAMMELL of Military Electronics received the Master of Science degree from Stevens Institute of Technology at the commencement in June.



Can You Title These Pictures?

All have appeared in the Record *during 1949 and 1950.* *Answers on page 378.*

1. The Pioneer family is watching:
   A. Model of coal mine
   B. Insides of a "coke" machine
   C. Aptitude Tester
   D. Life test of coin collectors

2. This man is:
   A. Sampling beer in a brewery
   B. Testing Murray Hill water supply
   C. Gauging river height
   D. Measuring temperature of a glass furnace

3. The girls are sorting in:
   A. A truck between New Jersey locations
   B. A secret vault at Whippany
   C. An elevator at West Street
   D. New mailroom at Murray Hill

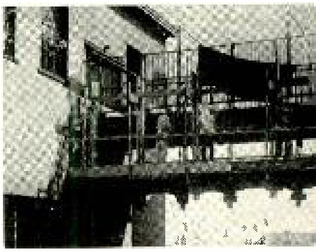
4. The man at the telescope is:
   A. Scoring an archery tournament
   B. Establishing an infra-red link with a blimp
   C. Watching a ball game
   D. Directing a guided missile

5. This quartette is:
   A. Singing "Home on the Range"
   B. Looking at a comic book
   C. Studying a conference program
   D. Discussing golf scores

6. This picture was taken at:
   A. A retirement party
   B. A Pioneers' dinner
   C. A meeting of Life Member Club
   D. Murray Hill restaurant

7. This engineer is looking at:
   A. Another engineer
   B. A computing machine
   C. A retirement souvenir
   D. A filing device

8. The men pictured are:
   A. Contractor's employees repairing a bridge
   B. Research men studying waveguides
   C. Accountants balancing the budget
   D. Long Lines men at a microwave station



9. This cable man is:
   A. Locating trouble with a magnetic pickup
   B. Getting ready to go to lunch
   C. Posing for a picture
   D. Wiping a joint

10. These black-face comedians entertained:
   A. At Pioneers' Party
   B. Deal-Holmdel Annual Dinner
   C. Meeting of Legion Post
   D. Annual Quality Survey

RETIREMENTS

Among those retiring from the Laboratories are W. L. Casper with 41 years of service; S. D. Morrison, 35 years; and K. O. Olson and Robert Pope, 30 years.

William L. Casper

Entering the Laboratories in 1908 with two degrees from Cornell (A.B. 1907; M.E. 1908), Mr. Casper's first important assignment was to study and improve capacitors. A few years later he was head of the group which developed transformers and filters for use in the repeaters for the Transcontinental Line. His work on telephone transformers, both theoretical and practical, led him to prepare, in 1923, the first definitive paper on the subject; it appeared in the *A.I.E.E. Journal* the following year. He also presented the first course on transformers in the Out-of-Hours series.

With the advent of carrier systems, filters ac-

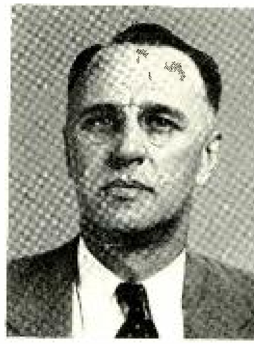
W. L. Casper

Robert Pope

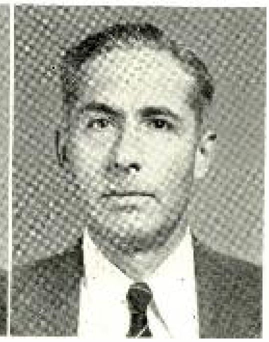
quired new importance as a means of separating bands of high frequencies from each other. Responsibility for this field was given to Mr. Casper, as well as for equalizers and other networks. When World War II broke out, he and his group gave help to many engineers on war work, not only by designing networks for them, but by suggesting how and where networks would be helpful. Mr. Casper also contributed to the design of resistance networks and potentiometers for the M-9 gun director. Twenty patents record his contributions to the communication art.

Since early 1948 Mr. Casper has devoted all of his attention to the problems of reducing the number of varieties of apparatus and equipments designed by the Laboratories and made by the Western Electric Company. His long experience in apparatus design and his keen appreciation of the complexities of the business have enabled him to spearhead this activity in the Laboratories. In cooperation with the Western Electric Company, a number of projects have been completed and others are well advanced, resulting in very substantial economies in the business.

In nearly four decades of leadership, Mr. Casper contributed to the development of many engineers. Always alert to recognize ability, he encouraged these younger men to study, and to give out-of-hour courses because he felt there



K. O. Olson



S. D. Morrison

was no surer way to complete one's grasp of the subject.

Although Mr. Casper's services have been solicited by outside organizations, he has decided that his retirement will be one of leisure, at least for the present.

Robert Pope

After graduation from Stevens Institute, Mr. Pope joined Long Lines Engineering. His principal work was in connection with electrical protection and underground cable sheath corrosion. In 1924 he transferred to the Department of Development and Research of A T & T, continuing along the same lines but from the standpoint of development. He took a leading part in studies resulting in the omission of fuses between aerial and underground cables and in developing improved protection for aerial cables resulting in substantial reduction of lightning troubles. About the time of his transfer to the Laboratories in 1934 he concentrated on corrosion work and pioneered in the development of forced drainage for protection of underground structures against corrosion. He was instrumental in the development of the carbon anode and the use of carbonaceous environments, resulting in a material increase in the life of drainage anodes.

Mr. Pope has presented a number of papers on corrosion problems and is recognized as an authority on corrosion matters. He was a member of the original Board of Directors of the National Association of Corrosion Engineers and served on its Executive Committee.

A small farm in eastern Pennsylvania will be Mr. and Mrs. Pope's new home where they will be near their son and his wife and their two grandsons.

Staats D. Morrison

In 1915, when Mr. Morrison joined the Laboratories, work was actively under way on the Arlington-Paris radio transmissions, and his first job was vacuum pumping on the power tubes. He then transferred to a special research group where he made microphone studies and developed transmitters for airplane and submarine detection purposes during the World War I period. Following the war he became interested in contact studies, particularly the behavior and performance of contacts under conditions of varying pressure, voltage and current. He did considerable work on the protection of contacts by shunted gas-discharge tubes; on the use of the tubes for acoustic shock protection; and on the use of rectifier gas tubes for party line ringing.

Mr. Morrison then became concerned with the development of television. He was one of the early workers on scanning by perforated discs and the use of neon lamps for receiving, a line of development which culminated in the 1927 demonstration of television. Subsequently he worked on general television research, particularly circuits, and assisted in the 1937 demonstration over the coaxial cable between New York and Philadelphia.

Since 1942 Mr. Morrison has been at Whippany where he has prepared parts lists of military apparatus, for instruction books and for the procurement of spares. He is a graduate of Cooper Union with the class of 1921.

Karl O. Olson

Karl Olson started out as a civil engineer from Dartmouth (B.S. 1914, C.E. 1915) and practiced that profession for five years with various railroads. Then he decided that his career lay in telephony and joined the New England company in 1920 as an outside plant engineer. Eight years later, the Laboratories were looking for a man with his experience to work on quality assurance and Mr. Olson came to New York and joined us. During the following years he has been devising suitable inspection procedures to ensure that the Telephone Companies get material that is up to specifications; and investigating various reports from Laboratories Field Engineers of difficulties which use has turned up.

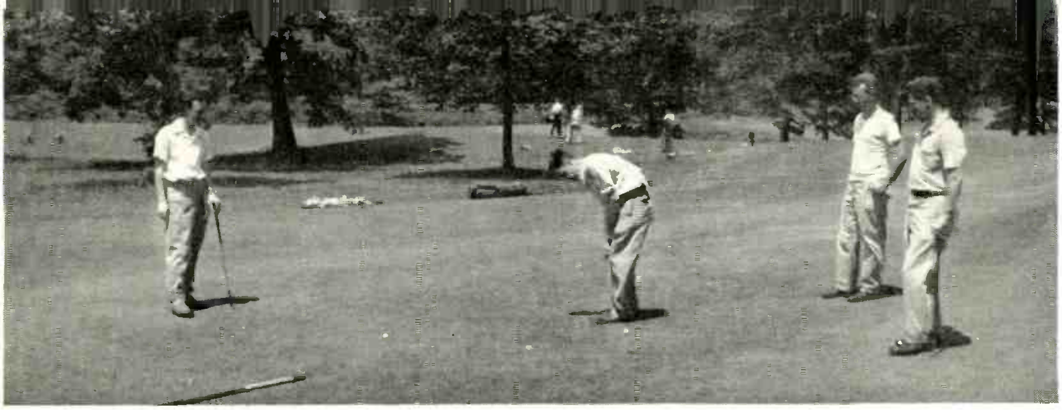
Mr. Olson was an outstanding track athlete in college, and captain of his team. Sports have always been one of his interests; others are gardening in summer and television in winter. With his wife, he expects to stay on in Summit.

News Notes

W. Babington attended a meeting of A.S.T.M. Committee B-6 on Die Castings in Atlantic City.

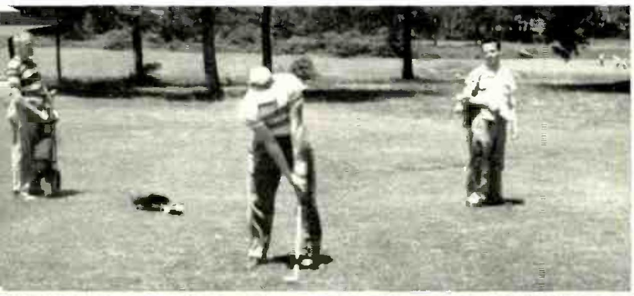
I. V. Williams attended meetings of A.S.T.M. Committee B-7 on Light Metals and Committee A-1 on Steel. Mr. Williams was reelected chairman of Committee B-7.

The Murray Hill Symphony Orchestra closed a satisfying 1949-50 season with a picnic and informal musical program for members, their families, and other guests, on June 13. For the outing part of the program nearby Seeley's Pond in the Watchung Reservation served admirably until dusk. After adjourning to the Arnold Auditorium, members and groups of members of the orchestra presented the evening's musical entertainment. Announcement of the newly-elected officers for next season was made: H. F. Dienel is chairman; E. C. McDermott, vice-chairman; E. E. Mott, treasurer; and Mrs. M. G. Pugh, secretary.



THE GOLF TOURNAMENT IN NEW JERSEY

Over seventy members of the Laboratories participated in the Golf Tournament, held on June 17, at the Essex County Country Club in New Jersey. Low net prize winners in Class "A" were: T. C. Barlow, first; J. F. Hanley, second; C. E. Luffman, third; A. H. Jankowski, fourth; and E. L. Fisher, fifth. Kickers' prizes went to F. Tanner, J. M. Niedzwiecki and H. S. Winbigler. Class "B" low net, C. W. Christ, first; D. L. Viemeister, H. T. Reeve, second; J. A. Word, fourth; and S. J. Brymer, fifth. Kickers, H. T. Casey, H. G. Petzinger and J. P. Prendergast.



News Notes

At a conference of the Mechanics Research Group held in the Arnold Auditorium at Murray Hill on June 14, *New Multiple Path Interference Methods for Measuring Ultrasonic Velocity* was discussed by G. W. Willard and *Use of Barium Titanate Transducers in Measuring Wear, Forces, Flux Densities, and Strains in Solids* by R. F. Wick.

Experiments on the Initiation of an Electric Arc was the subject presented by L. H. Germer and F. E. Haworth at a conference of the Contact Physics Research Group held in the Arnold Auditorium June 21.

Professor D. D. Eley of the University of Bristol, England, was a visitor at Murray Hill on June 15. In the course of his visit he spoke at a conference on *The Chemical Bond and Catalysis.*

At a conference to discuss the work of the Solid State and Physical Electronics Research Groups held at Murray Hill on June 7, talks on *Semi-Conductor Surface Phenomena* by W. H. Brattain and *Bombardment Conductivity in Germanium Barrier Layers* by K. G. McKay were given.

Dr. M. Szwarc of the University of Manchester, England, in the course of a visit to Murray Hill on July 6, spoke on *Determination of Bond Dissociation Energies.*

Professor John von Neumann of the Institute for Advanced Study, Princeton, has concluded a series of lectures on *Complicated Automata* given at conferences held at Murray Hill.

"Telephone Hour"

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

August 7	*Michael Rabin*
August 14	*Nelson Eddy**
August 21	*Ezio Pinza**
August 28	*Leonard Pennario*
September 4	*John Charles Thomas*
September 11	*Bidu Sayao*
September 18	*Lily Pons*
September 25	*Zino Francescatti*

* From Hollywood

U. B. Thomas and W. W. Bradley conferred at the Naval Research Laboratory in Washington and at the National Battery Company in Depew, New York, on research programs concerning storage battery grid corrosion.

K. G. Compton, E. K. Jaycox and J. Crabtree attended the Atlantic City meetings of the A.S.T.M. Mr. Jaycox attended sessions of Committee E-2 on Spectroscopy.

J. J. Martin attended A.S.T.M. meetings at Atlantic City on tests and specifications for electrical insulating materials.

A. Mendizza started a new atmospheric exposure site at Miami. He also inspected corrosion specimens placed along seven miles of bridges on the mainland to Key West as well as exposure test samples at Kure Beach, North Carolina. Mr. Mendizza and S. M. Arnold also set up new atmospheric exposure sites in Steubenville, Ohio. While there they inspected corrosion specimens in that area.

August Service Anniversaries of Members of the Laboratories

40 years
H. W. Baker
W. G. Breivogel
O. A. Friend

35 years
B. P. Hamilton
G. H. Heydt
S. P. Shackleton

30 years
H. J. Fisher
C. E. Flaig
M. E. Fultz
Gilbert Haege
R. C. Hersh
C. F. Larkin
A. V. Loog
Elizabeth McKewen
Alfred Melhose
Donald Robertson
A. G. Shepherd
A. R. Thompson
Arthur Volz
M. A. Warren
J. B. Worth
L. F. Wright

25 years
M. W. Baldwin, Jr.
E. H. Bedell
H. L. Brown
H. W. Bryant
J. J. Butler
C. J. Calbick
John Donoghue
Morris Fritts
A. J. Grossman
H. W. Hermance
B. A. Kingsbury
W. A. Klute
C. J. Meden
H. N. Misenheimer
Edward Murphy
J. G. Nordahl
J. F. Polhemus
C. W. Ramsden
W. L. Tierney
Fred Ufer
K. G. Van Wynen
Marie Wright

20 years
R. W. Apetz
C. L. Black
A. K. Bohren
E. C. Borman
O. E. DeLange
G. B. Engelhardt
G. H. Eschenauer
W. R. Fahringer
Bonafede Forte
R. W. Friis
Hugh Gill
S. C. Hight
E. L. Kuntze
F. D. Leamer
L. A. Meacham
Marion Merck
J. L. Merrill, Jr.
S. O. Rice
Marie Seibel
J. C. Sullivan
G. K. Teal
H. M. Thomson
E. F. Wulf

15 years
W. G. Domidion, Jr.
W. J. Gallagher
P. J. Harrington
C. F. Loomis
D. F. O'Sullivan
C. C. Rock
Edwin Watkinson

10 years
R. C. Benkert
W. H. Beyer
E. J. Flannery
P. J. Kamps
J. J. Kuhn, Jr.
Frederick Meyer
J. K. Mills
F. L. Onions
John Scharf
D. R. Scheiderman
L. W. Stammerjohn
W. S. Suydam

Recent Deaths

ANDREW S. LAWRENCE, June 16

From the time "Andy" Lawrence joined the Development Shops in 1927 as an instrument maker apprentice, he showed qualities of leadership. An excellent student, he supplemented his training on the job by studying evenings. After graduating from Washington Irving High School, he studied mechanical engineering at New York University.

Meanwhile, he had completed his apprenticeship and in 1932 was promoted to instrument maker. In 1936 he became a supervisor and the following year was promoted to foreman.

Because he was particularly interested in younger men and successful in handling them, Mr. Lawrence was given the supervision of apprentices whom he instructed in Shop Practices in the four-year Junior Mechanic Training Course of which he was a graduate. With the coming of the war, he was placed in charge of accelerated courses for training men and women in small bench and machine work, an essential part of the Laboratories' expansion program to help the war effort. He instructed them in Blueprint Reading, Shop Practices, and Shop Mathematics, and supervised their shop work. Later in the war he was responsible for most of the night workers in the Development Shops at West Street.

A. S. LAWRENCE
1909-1950

R. C. FIELD
1892-1950

In 1947, Mr. Lawrence transferred as supervisor of the Branch Shop at the Graybar-Varick Building where he was responsible for all Development Shop operations originating there. In that capacity he acted as consultant on machine shop practices for such developments as the Key West-Havana cable recently placed into service and for newer teletype development projects. He directed fabrication of parts of prototype equipment for the Boston-New York radio relay system, of mobile radio equipment, and particularly of the present equipment now in the field for test on the TD-2 system path-loss-measurements for the New York to San Francisco radio relay system.

Mr. Lawrence died suddenly during the night at his home in Flushing. He was an enthusiastic gardener and fisherman and was also interested in outboard motoring. His wife and an infant son survive him.

RICHARD C. FIELD, June 23

Before he joined Western Electric at Hawthorne as a draftsman, Mr. Field had been a surveyor in Florida and had done machine and tool designing with other concerns. He left Hawthorne for a time, but rejoined the Bell System as a draftsman for the Laboratories. His early work was in connection with the movietone project and with cable splicing. He also did design work on dials, on friction-roll-drives for dial systems, and on molds for station set parts.

During the war Mr. Field was engaged on Navy projects, particularly on *Sonar* and on various types of submarine detection. Since then he had been engaged in the design of special tools for Laboratories use and in newer types of dials.

Mr. Field had many outside interests and hobbies and he spent much of his free time studying subjects related to them. He was an accomplished violinist, and was proficient in photography and in jewelry craft.

News Notes

A. C. WALKER gave talks on *Growing Piezoelectric Crystals*, before the Rutgers University *Crystal-Growing Symposium* and before the Lehigh Valley Section of the American Chemical Society at Palmerton, Pennsylvania.

R. D. HEIDENREICH attended a *Symposium on Thin Films* sponsored by Armour Research Foundation in Chicago. Mr. Heidenreich served as chairman for the session on *Formation of Films.*

MARY E. CAMPBELL of the Chemical Laboratories received a degree of Master of Science in Chemistry from the Polytechnic Institute of Brooklyn.

W. A. SHEWHART attended the fourth national convention of the American Society for Quality Control, June 1 and 2, in Milwaukee.

Answers to the picture-quiz on page 373 of this issue: 1D; 2C; 3C; 4A; 5C; 6B; 7C; 8A; 9C; 10B.

Model Railroad Club

Members of the Model Railroad Club journeyed to Pelham Manor on June 29 where they were guests of the Westchester Model Club. In the former New Haven station there, the Club has a layout of 3500 feet of track with switches, station and signals. A crew of twenty is required to operate this complicated system on a tight "railroad" timetable.

News Notes

R. A. CHEGWIDDEN, V. E. LEGG, and J. H. SCAFF visited Hawthorne to discuss magnetic materials.

H. PETERS attended the A.S.T.M. meeting at Atlantic City in connection with rubber testing.

W. O. BAKER, I. L. HOPKINS, W. P. MASON and R. BURNS presented discussions on the mechanical properties of plastics from research and engineering viewpoints at the M.I.T. Summer Conference on Plastics. MR. HOPKINS spoke on *Complex Stressing of Polymers* and MR. BAKER on *Reactions of Polymers and Mechanical Waves.*

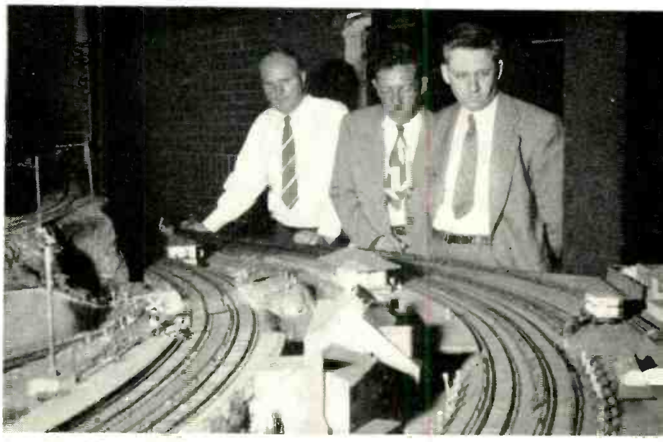
G. R. GOHN presided at the second session of *Testing, Quality Control and Appearance* at the A.S.T.M. Convention in Atlantic City. Mr. Gohn was also re-elected to the Advisory Committee of Committee E-9 on Fatigue.

A. G. JENSEN and M. W. BALDWIN, JR. were speakers at a meeting of the Western Electric Science Engineering Club in Newark. Mr. Jensen spoke on *Color Television* and Mr. Baldwin on *Television Picture Fidelity.*

MEMBERS OF THE Laboratories presenting papers at the Electron Devices Conference at the University of Michigan, Ann Arbor, were: A. M. CLOGSTON, *Binary Electrostatic Storage;* R. C. FLETCHER, *Equivalence of Field Solution Method and Normal Mode Method of Treating Traveling Wave Tubes;* J. B. LITTLE, *6-mm. Helix Traveling Wave Amplifier;* S. MILLMAN, *6-mm. Spatial Harmonic Traveling Wave Amplifier;* J. R. PIERCE, *Gain Calculations in Traveling Wave Tubes;* L. R. WALKER, *The Easitron, A Microwave Amplifier;* W. G. PFANN, *Transistor Effects at p-n Boundaries;* and M. SPARKS, *n-p-n Transistors.* The conference was sponsored by the I.R.E. and A.I.E.E. D. HAGELBARGER and A. V. HOLLENBERG also attended.

M. W. BALDWIN spoke on *Television Picture Fidelity* at Holmdel on June 2 at the last meeting for the Deal-Holmdel Colloquium.

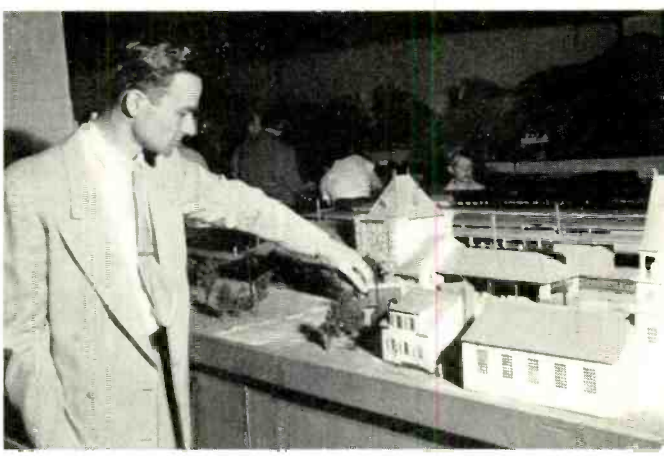
N. J. EICH conferred in Haverhill to discuss a packaged transformer unit for the No. 5 crossbar system.



Joe Caroline (Whippany), J. R. Power (Murray Hill) and Charlie Haas (West Street) watch for Old 97 to come 'round the bend.

R. G. Ramsdell (West Street) and Joseph E. See, President of the Westchester Club.

H. H. Hagens (West Street), Chairman of the Club, parks a "truck" at a model of the station where the exhibit was held.



Charles Norton answers a customer's call in the New York Travel Service while Helen Brockman, at his desk, checks transportation just purchased, and Mary Reiners makes out checks.

New York Travel Service

Members of the Laboratories travel far more extensively than their coworkers realize. Exception to the rule are C. J. Norton and Mary Reiners of the New York Travel Service whose job it is to procure transportation and hotel reservations. In New York alone last year they purchased $131,800 worth of transportation for 2,400 travellers from the Laboratories. Railroads accounted for 1,600 trips, airplanes 380, with the remainder of the trips divided between boats and buses. This year so far overseas travel mounted, with nineteen travellers on overseas trips, accounting for $14,000 worth of business.

An interesting feature of the West Street Travel Service is the flight departure control board shown on the wall on the left of the photograph. Used primarily in poor flying weather, the board enables Mr. Norton to advise travelling employes of weather and flight conditions in advance, and to cover trips with alternate railroad reservations in the event of flight cancellations.

Legion Post Installation

New officers of Bell Telephone Post 497 of the American Legion were installed at the thirty-first installation meeting of the Post on June 8 at Hotel Lexington followed by a buffet supper. New York County Commander Paul Rutheiser conducted the installation of officers, shown in the photograph below. They are left to right, J. H. King, *Sergeant at Arms;* F. J. Osolinik of the Laboratories, *Third Vice Commander;* R. C. Kenney, *Second Vice Commander;* G. J. Mc-

Installation of Legion officers at the 31st annual dinner.

Ardle of the Laboratories, *First Vice Commander;* A. W. Draper, *Commander;* T. S. Diab, *Assistant Adjutant;* R. A. Loos, *Adjutant;* E. J. McCormack, *Chaplain;* and E. C. White, *Service Officer.* Other members of the Laboratories holding office are C. E. Merkel and A. J. Desio of the *Executive Committee,* and W. A. Bollinger, *County Delegate.*

News Notes

V. E. Legg, R. A. Chegwidden and J. H. Scaff visited Hawthorne for the discussion of specifications of magnetic materials. Mr. Legg also attended in Atlantic City a meeting of the A.S.T.M. Committee on magnetic material.

W. R. Neisser visited the Shadeland plant of the Western Electric Company at Indianapolis for production and design discussions of the new 500-type combined telephone set.

R. E. Sherman made a trip to Haverhill on cost reductions in the manufacture of the N-1 carrier-frequency transformers.

A. D. Hasley attended a meeting of the R.M.A. sub-committee on Transformers and Reactors held in Chicago on June 15 and 16.

L. W. Giles visited Winston-Salem and Burlington about problems relating to code and D-specification reductions.

A. J. Christopher and D. A. McLean visited Hawthorne and Archer Avenue on capacitors.

P. S. Darnell, A. J. Christopher, R. M. C. Greenidge, E. M. Boardman and B. Slade conferred on resistor redesign problems at Haverhill; and R. S. Duncan and H. A. Stone, on the manufacture of ferrite core coils.

F. J. Given, K. G. Compton, P. S. Darnell, R. O. Grisdale, W. J. Clarke and D. R. Brobst visited the Tonawanda Plant of the Western Electric Company to discuss enameled wire.

T. H. Chegwidden's visit to Winston-Salem concerned magnetic amplifiers and regulators.

J. H. Bower attended the fourth annual Battery Research and Development Conference arranged by the Power Sources Branch of the Signal Corps Engineering Laboratories. The conference, held at Asbury Park, received a report on the progress of the Signal Corps battery research and development program.

L. F. Wright inspected panel offices in the Chicago area.

L. A. Dorff attended the Spring Assembly Meeting of the Radio Technical Commission for Marine Services at Washington. As a member of the special committee on Selective Ringing, Mr. Dorff presented a paper on a *Proposed Universal Numbering Plan for Marine Radiotelephone Service.* He also visited the Naval Radio Station at Annapolis.

E. F. Watson visited Chicago for conferences with the Teletype Corporation with regard to the new No. 28 teletypewriter.

L. C. Roberts participated in telegraph tests at Key West, Florida, on the new and old submarine cables to Cuba.

W. H. Yocom of Transmission Development received the Master of Science degree from Stevens Institute of Technology on June 10.

This tower is a familiar landmark at Whippany. It is one of two built back in the days of broadcast development; in World War II it was used for radar tests. It is now in use for propagation tests being made by Transmission Engineering.

J. F. Laidig visited Toledo, Ohio, in connection with operational tests of the TE microwave radio system between Toledo and Detroit.

R. S. Caruthers and L. Pedersen observed the performance of signaling equipment during lightning storms in Madison, Florida. Tests are being made in connection with the development of a new carrier telephone system.

R. D. HEIDENREICH was chairman of a session of the *Symposium on Thin Films* held June 8-10 in Chicago.

C. KITTEL spoke on the *Theory of Ferromagnetism* before the Magnetics Colloquium at the General Electric Research Laboratory in Schenectady, New York.

At a conference at the Massachusetts Institute of Technology W. P. MASON gave a talk entitled *Mechanical Properties of Polymers at Ultrasonic Frequencies.*

H. C. MONTGOMERY spoke on *Experiments Relating Noise Correlation to Hole Lifetime in Germanium Filaments* at the IRE-AIEE Conference on Electron Devices, University of Michigan, Ann Arbor, Michigan.

W. T. READ gave a talk on *Effect of Stress Free Edges in Plane Shear of a Flat Body* at a meeting of the Applied Mechanics Division of the ASME held at Purdue University.

M. B. McDAVITT attended sessions of the Commercial Conference of the Ohio Bell Telephone Company, Southwestern Area, at Cedar Point. While there, he addressed the Conference on Laboratories activities.

JOHN DAVIDSON, JR., is one of a committee of four lay experts recently appointed by the Mayor of Montclair to revise fire, health and building codes for the town.

A. A. HANSEN visited the Lancaster, Pa., and Hamburg, N. Y., No. 5 crossbar office in connection with field trials of simplified maintenance facilities.

C. H. ERVING investigated traffic studies at Philadelphia.

L. J. SCOTT, E. BAUSCH, K. M. FETZER, L. P. JOHNSON, and O. J. MORZENTI discussed schedules for No. 5 crossbar equipment at Hawthorne.

M. E. MALONEY made special observations of the operation of the A4A toll installation during its first heavy load on May 14 at Albany.

O. C. HALL studied coin box trunk circuits for step-by-step offices at Albany.

D. H. WETHERELL visited the Illinois Bell Telephone Company in connection with the No. 1 crossbar system.

R. C. DAVIS and D. H. WETHERELL went to Hawthorne in connection with the No. 1 crossbar, panel and step-by-step systems. Mr. Davis presided at the Telephone Switching session of the A.I.E.E. Summer and Pacific General Meeting at Pasadena, California, on June 14. During this session, R. E. COLLIS presented a paper, *Crossbar Tandem.*

"Sorry, sir, we clean forgot to put a door in your new office."

W. H. BURGESS and E. J. ZILLIAN spent fifteen days with the 514th Troop Carrier Wing at their annual summer encampment at Stewart Air Force Base, New York. Both are members of an air crew in their Reserve Unit. Lieutenant Burgess is a pilot, and Lieutenant Zillian, a navigator on C-46 Curtiss Commandos.

E. ST. JOHN visited R. W. Cramer Company at Centerbrook, Conn., to discuss switchboard clocks.

M. SALZER visited No. 5 crossbar offices at North Troy and Freeport, N. Y., and the International Business Machines Company, Endicott, N. Y., with reference to record cards.

J. J. KUHN, J. F. BALDWIN and R. A. HECHT were at Point Breeze to discuss manufacturing questions on switchboard plugs.

W. K. OSER and C. C. LAWSON discussed wire development problems at Point Breeze.

R. P. ASHBAUGH spent several days at Hawthorne discussing general cables.

FIELD TRIALS of the prelashing method of installing aerial cable were conducted at Lakewood, N. J., and Cooperstown, N. Y., the latter trial involving also the initial installation of alpeth sheath cable having polyethylene-insulated conductors. The following members of Outside Plant Development participated in one or both of these trials: J. A. CARR, F. V. HASKELL, S. M. SUTTON, W. J. LALLY, J. B. HAYS, J. W. KITTNER, O. L. WALTER, A. S. WINDELER, and V. H. BAILLARD.

J. H. SHUHART and J. F. SHEA at Carroll, Iowa, observed the installation of cable vibration dampers.

E. B. CAVE appeared before the Board of Appeals at the Patent Office relative to an application for patent.

J. BARDEEN addressed the Physics Colloquium at the General Electric Research Laboratory on the subject *Superconductivity*.

At the meeting of the Acoustical Society of America held at Penn State College, G. W. WILLARD gave a talk entitled *New Methods for Measuring Ultrasonic Velocity in Solids.*

W. P. MASON presented a paper by himself and R. F. WICK entitled *Use of Barium TitanateTransducers for Producing Large Amplitudes of Motion and High Forces at Ultrasonic Frequencies.*

D. B. PENICK was among those in the Psi Chapter of Eta Kappa Nu Association at the University of Texas whose biographical material was displayed to honor the twenty-seven electrical engineering graduates of the University so listed in the 1948 edition of "Who's Who in Engineering."

J. H. KING, W. C. KLEINFELDER, D. T. SHARPE, D. C. SMITH and F. F. FARNSWORTH observed field trials of a newly developed splice closure and terminal combination for Alpeth cable and of methods for splicing cable with polyethylene-insulated conductors at Cooperstown, N. Y.

M. W. BOWKER went to the Hartford and New Haven areas in connection with gas flow and leak detecting tests on aerial cables.

T. A. DURKIN and J. H. GRAY, were in Haydenville, Ohio, in regard to clay conduit production.

A. P. JAHN, in Sellersville, Pa., discussed a new type of device for indicating low gas pressures in cables. He attended the annual meeting of the American Society for Testing Materials in Atlantic City.

R. H. COLLEY and F. F. FARNSWORTH participated in conferences in Montreal with engineers of the Bell Telephone Company of Canada on problems relating to installation and joint use of greensalt treated red pine poles.

G. Q. LUMSDEN and J. LEUTRITZ, Jr., inspected the treated wood specimens undergoing accelerated outdoor exposure at the Orange Park, Florida, test plot.

H. H. NAGEL of Systems Engineering Power Development group received the Bachelor of Science degree from Newark College of Engineering. At the same ceremony his wife received a diploma, magna cum laude, "certifying that she is a graduate from the trial and tribulation of putting her husband through the College." The Nagels have two small daughters.

V. B. PIKE and ROBERT POPE visited several cities in the Southern Bell territory to investigate cases of corrosion of underground lead cable sheath. They also spent several days in Dover, Delaware in connection with a cable corrosion study conducted by the Bell Telephone Company of Pennsylvania.

L. H. CAMPBELL, A. H. HEARN and G. Q. LUMSDEN witnessed the initiation of treatments at the plant of the Taylor-Colquitt Company, Spartanburg, S. C., combining the rapid vapor drying of southern pine poles and the greensalt treatment of the poles.

A. H. HEARN and C. R. BREARTY, with engineers of the Michigan Bell Telephone Company, examined poles which were treated with copper naphthenate and creosote in 1946 and 1947, and which were later set in lines in Michigan.

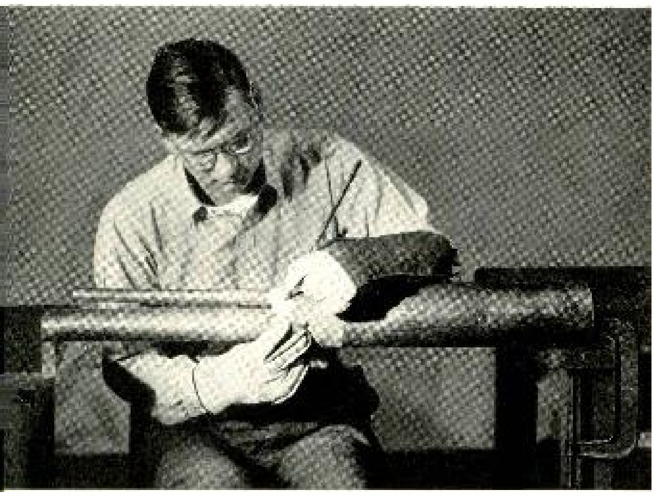
L. R. SNOKE, in company with engineers from A T & T and The Bell Telephone Company of Pennsylvania, examined right-of-way near Lansdale, Pa., undergoing tests aimed at determining relative efficacy of herbicides in the control of brush.

M. A. FROBERG and J. B. KELLY conferred with engineers of the Westinghouse Company at Buffalo, on selenium rectifiers.

H. T. LANGABEER was in Willoughby, Mayfield Heights and West Lake, Ohio, in connection with the new No. 5 crossbar office power plants at those locations.

F. W. ANDERSON, J. K. MILLS and W. V. FLUSHING conducted noise tests at the Glenalden No. 5 crossbar office in Philadelphia on ringing and coin control batteries and emergency alternating current supplies.

"If we could dock it in front of the building, it would be quicker than the ferry."



To make the illustration in the facing advertisement J. M. Jackson of Outside Plant demonstrated the art of sealing a cable joint while J. Popino snapped the shutter.

V. T. Callahan conferred with engineers of the General Motors Corporation at Detroit and Cleveland on designs for automatic and manual diesel engine alternator sets, and with Hercules Motors Corporation engineers at Canton, Ohio, on automatic gasoline engine designs.

L. A. Leatherman conducted discharge performance tests on nickel-cadmium engine starting batteries at Dover, Delaware, and York, Pa.

W. L. Betts conferred with engineers of the Holtzer Cabot Company at Boston upon new ringing machine designs.

R. R. Gay at Haverhill discussed the manufacture of a new power supply for key telephone systems.

A. M. Zillian and R. H. Miller discussed problems relating to the installation of A4A equipment in Baltimore with representatives of the Chesapeake & Potomac Company.

K. K. Darrow spoke on *The Atom From Lucretius to the Present* before the American Physical Society meeting, June 21-23, in Mexico City.

While on Vacation in the Southwest, Henry Kostkos spoke at the request of the Mountain States Telephone and Telegraph Companies to the members of their Public Relations Department on the Bell Laboratories' display program. Mr. Kostkos consulted with the Illinois Bell Telephone Company in Chicago on display problems pertaining to the Chicago Fair and the Science Museum projects. Several displays for these exhibits were engineered and constructed under Laboratories supervision.

Harriet Filmer, Ruth Haff and Marie Wright have received certificates from Cornell University, New York State School of Industrial and Labor Relations, for having completed successfully the course given by Cornell for the Transcription Supervisor's Association of New York.

H. S. Wertz interviewed the Primary Examiner at the Patent Office in Washington relative to an application for patent.

The following members of the Patent Department have received their law degrees—E. W. Adams, Jr., S. N. Turner and D. H. Wilson, Jr., from New York University Law School, and R. A. Buckles, Jr., from Fordham University Law School.

J. A. Baird and J. J. J. Kernahan of Military Electronics were graduated from local colleges in June. Mr. Baird received the Master of Science degree from Stevens Institute of Technology, Mr. Kernahan, the Bachelor of Science in Electrical Engineering degree from Newark College of Engineering.

Engagements

Mary-Kay Ault—*Charles M. Morris
*Rosemary Brazil—Andrew P. Nimmo
*Marion Eich—*Thomas G. Woods, Jr.
Marion Preuss—*Richard E. Levesque
Muriel Pugh—*George H. Baker
Geraldine Sawyer—*Louis R. D'Amico
Barbara Tompkins—*Edward G. Spack

Weddings

*Gertrude Alefeld—Herbert Goddard
*Elena Benvenga—Lawrence P. Deldin
Louella Coumbe—*Robert E. Anderson
*Madeline Gabay—Robert Smith
*Ethel Gere—Edgar G. Paradise
*Helen Gino—Robert Kroszner
*Mabel Glidden—John A. Cooney
*Jann Goehner—*Philip T. Packard
*Joan Holohan—Stanley Berlicki
Doris Lambert—*John T. Bangert
*Jean McDonald—*Joseph A. Ceonzo
*Helen Miller—Frank Tyczkowski
Mary Plauka—*Nean Lund
*Della Scarola—Edward J. Stevens
*Rita Thoubboron—Lawrence J. Ryan

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