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F. K. HARVEY
*Transmission Research*

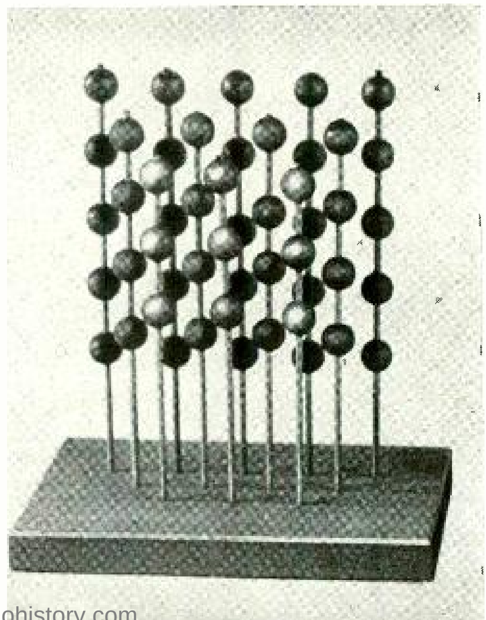
# *Focusing sound with microwave lenses*

When you walk along the new concrete sidewalk around Abingdon Square, you can well think of it as a "continuous medium." So also is the Jones Beach boardwalk to you, although an ant might well have a different opinion. To your eye, a perfect piece of optical glass looks like a continuous medium of another kind, although experiment shows that some kinds of particles go through it with ease. Air, too, looks "continuous," but the blue of a clear sky shows that something has happened to some light rays and not to others. As a matter of fact, Max Born has shown that Maxwell's famous equations for both light and radio rays will apply equally well if it is assumed that the medium is not continuous, but consists rather of an assemblage of separate particles. This viewpoint has enabled us in the Research Department to produce several new devices that are proving helpful in the communications art.

Long ago it was discovered that a convex lens would bring light to a focus. Eventually science came up with the explanation: the particles in the glass are so much denser than in the air that light waves are slowed in the center of the lens more than at the sides. So a series of wavefronts are curved more than they were, and are drawn to a focus.

The wavelength of visible light is very short indeed—0.00006 cm to quote a round figure. Born's theory required the "particles" in glass and air to be still smaller, which we know to be true. For a radio wave whose length is two or three centimeters the particles could be perhaps a centimeter in diameter. Figure 1 shows an array of spherical particles which slow down microwaves, and since the particles are arranged in a lens-shape pattern, they bring the waves toward a focus. A similar setup using flat circular disks is shown in Figure 2.

*Fig. 1—These metal spheres act as a lens for waves about two or three cm long*





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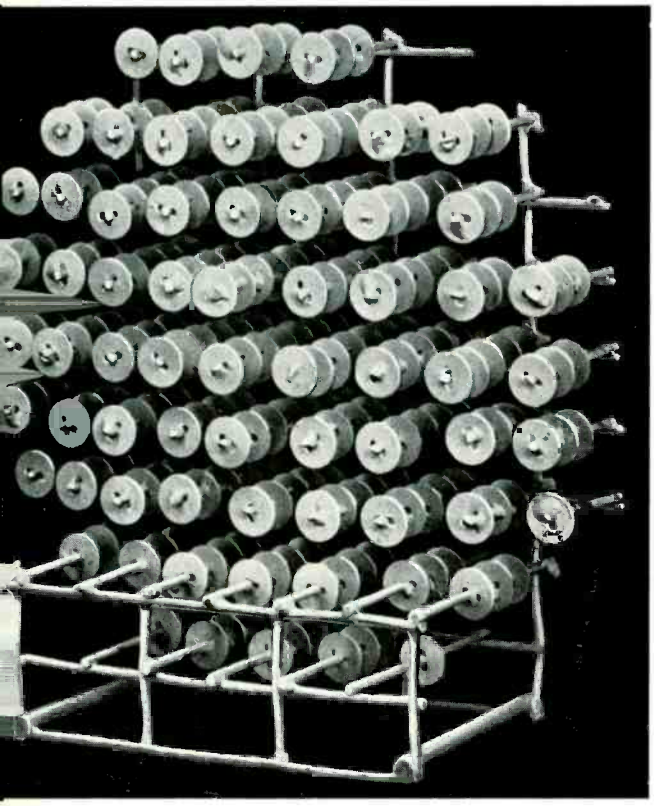

*Fig. 2—This arrangement of metal disks will also act as a lens. Note that rods in the center carry 7 disks, rods at the edge carry three or one*

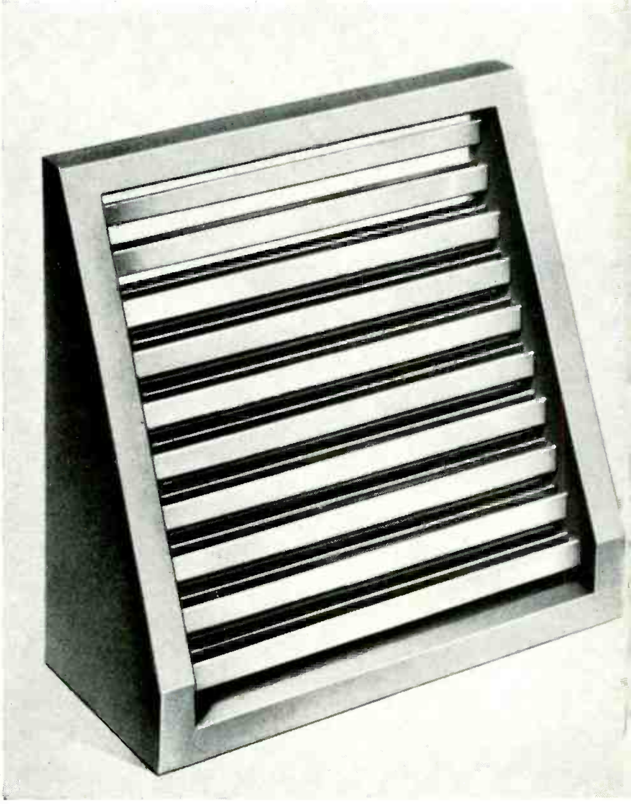

*Fig. 3—This arrangement of strips acts as an acoustic prism. The discrimination or selectivity depends upon the size of the prism*

Similarities had already been observed between the phenomena of electric and acoustic waves of about the same length, so it was suggested by W. E. Kock, who proposed the microwave lenses, that acoustic experiments be tried. As predicted, lenses meant for 3 cm microwaves were found capable of focusing sound waves of the same length. Directional characteristics were similar, also. The frequencies associated with the two types of waves were vastly different, of course, being 10,000 megacycles and 11.5 kilocycles, respectively.

What happens can be explained by considering what goes on at the surface of the sphere. In the electrical case, the surface is nearly a perfect conductor, and electric currents are set up which re-radiate their energy practically without loss. In other words, the spheres are good reflectors. For the acoustical case, the spheres are so hard—*i.e.*, immovable with respect to the air—that they again are good reflectors. In both cases the re-radiated wave combines with the original wave to produce a new wave which will have a lower velocity inside the array.

Another approach lends itself more easily to a computation of the focusing produced by a given array. In this picture, the extreme nature of the elements (perfectly conducting in the electric case and perfectly rigid in the acoustic case) is used to arrive at a mean value for the mixture of obstacle and original medium. In the electromagnetic case, the relative dielectric constant is unity for free space and infinite for a perfect conductor. An array of conductors in free space thus appears to have a dielectric constant greater than unity. Consequently its index of refraction is also greater than unity. Similarly, a rigid or immovable object has, for our acoustic consideration, an infinite mass, so that the combination of rigid (infinitely dense)



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spheres immersed in air (whose relative density is unity) results in a new medium having an index of refraction greater than unity. If the object is suitably shaped, it can act as a converging or diverging lens, or as a prism.

Our theory is not complete, however, without some sort of frequency correction. As the frequency is increased so that the important obstacle dimensions are no longer small compared to the wavelength, a resonance is approached. The air spaces bounded by the obstacle begin to act like little half-wave organ pipes and the air motion in their vicinity becomes more vigorous. This causes the effective density of the new medium to increase as the frequency is raised, thus slowing down the wave velocity until transmission stops and complete reflection occurs. Beyond this point transmission is possible, but only in higher order models.

When the prism of Figure 3 is analyzed acoustically it is found that the deviation through the prism tends to be constant at low frequencies, but increases rapidly near resonance, or cutoff, producing "dispersion." This is shown on Figure 4. A prism of this type could be used as a sound spectrograph to separate the components of a complex wave. The discrimination or selectivity would depend upon the size of the prism. The refractive index is, of course, proportional in a general way to the deviation angle, so that a lens of this construction shows a "chromatic" abberation at wavelengths close to cutoff, but can be considered a broadband device for longer wavelengths that are appreciably removed from cutoff.

A delay mechanism that can be considered truly broadband would have a constant refraction index up to some limiting frequency. Such a device has recently been developed at Holmdel for microwaves using a path delay principle. For example, the 30-in. diameter lens shown in Figure 5 is composed of an array of slanted plates. In a medium of this type, the delaying action is obtained by guiding the entering wave through a longer path between parallel plates slanted at some desired angle

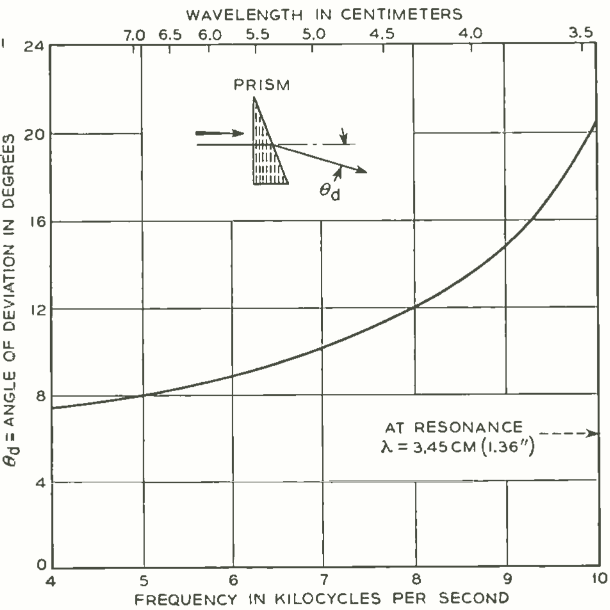


*Fig. 4—Characteristic of a prism which disperses sound waves. The deviation through the prism tends to be constant at low frequencies, but increases rapidly near resonance, producing "dispersion"*

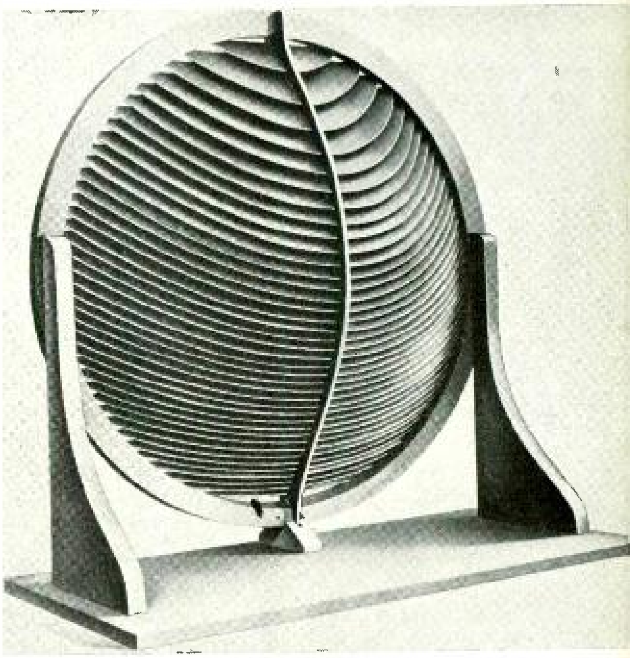

*Fig. 5—A thirty-inch acoustic lens of slanted plates. The contour of this lens is adjusted by a ray method to obtain equal path lengths from the focus and through the guiding, slanted plates to a common plane wave-front*



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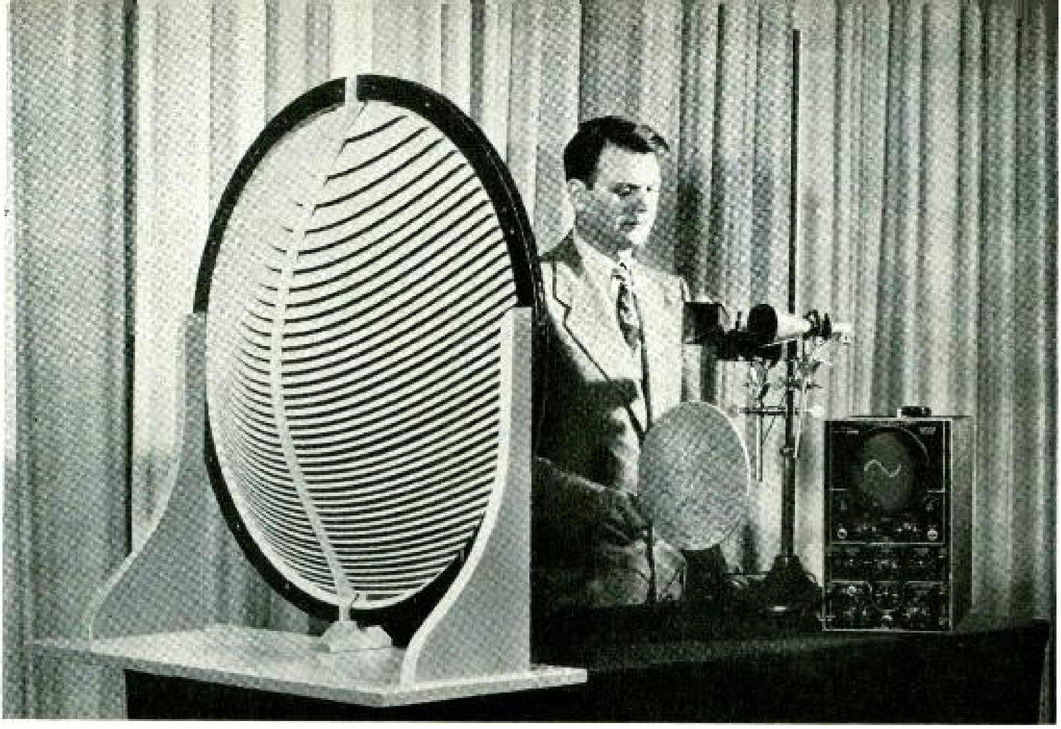

*Fig. 6—A slant plate lens in position for simultaneous focusing of acoustic and electric waves*

with respect to the original wave direction. The index of refraction is simply the reciprocal of the cosine of this angle. The contour of the lens is adjusted by a ray method to obtain equal path lengths from the focus and through the guiding, slanted plates to a common plane wave-front. This lens operates equally well for acoustic waves and microwaves. The limiting frequency is reached when the plate separation is ½ wavelength; at this point a higher mode can propagate which affects transmission in the normal mode.

In Figure 6, the slant plate lens is set up to intercept 3 cm acoustic waves and 3 cm vertically polarized microwaves simultaneously. It focuses these waves on adjacent receiving devices, one a small circular horn feeding a microphone connected to an oscilloscope, and the other a small rectangular wave-guide horn feeding a crystal detector which operates a relay and lamp combination. The existence of the two types of energy can be demonstrated by placing various baffles in front of the receiving devices and observing their associated indicators. For example, neither receiver responds when a metal baffle in interposed; only the microwave receiver responds when a wooden baffle is interposed; only the acoustic receiver responds when an open conducting grid oriented to reflect vertical polarization is interposed; but both receivers respond when the grid is oriented

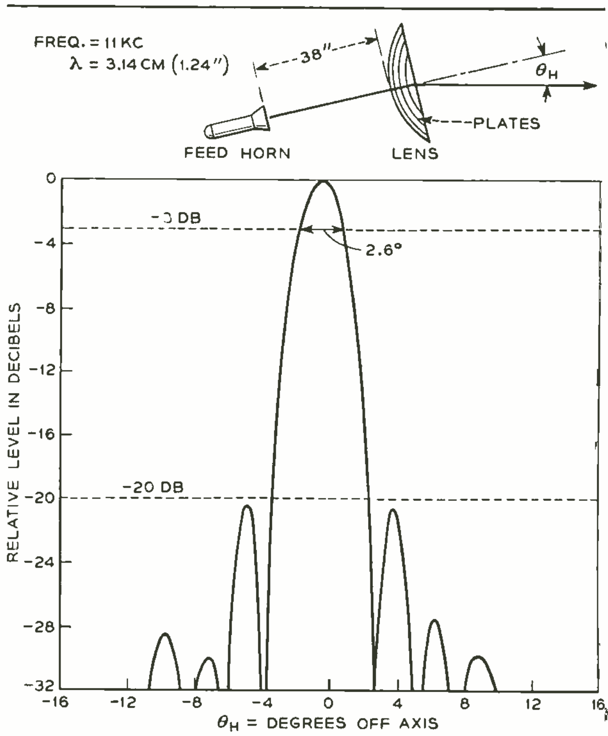


*Fig. 7—Directional pattern of a thirty-inch slant plate lens*



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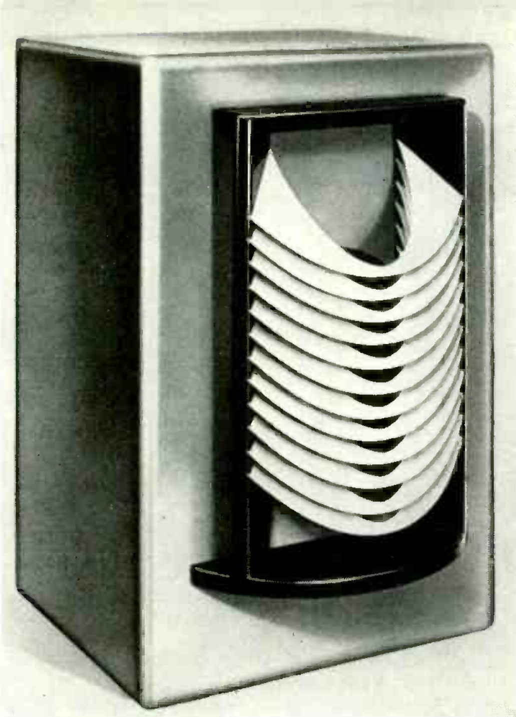

Fig. 8—*Diffusing lens attached to cone-type loudspeaker*

for transmitting vertical polarization. As in optical lenses, the focal "point" is a convenient fiction. In the focal plane there exists a diffraction pattern which consists of a central circular area (in which about 80 per cent of the energy is concentrated) surrounded by rings of alternate minima and maxima. When a plane wave strikes an f/1 lens such as used here, the diameter of the central spot is roughly 2½ times the wavelength. For 3-cm waves this diameter is then nearly 3 in. This suggests that a 3-in. diameter horn on the receiver is a reasonable choice for use in conjunction with the lens. Another method of arriving at this conclusion is to consider a feed horn at the focus "illuminating" the lens with energy. The diameter of the feed horn is then chosen so that its beam width sufficiently covers the lens. At 3 cm this also turns out to be 3 in. The slant plate lens with a 3-in. feed horn affixed to it at the focal point was tested acoustically on 3.14-cm waves. The result is shown in Figure 7; the beam width of 2.6 degrees for this combination is within 0.1 degree of that predicted theoretically, while the gain over an isotropic radiator is approximately 4,500 to 1.

All the lenses previously mentioned have been convergent types designed for focusing energy. Let us consider a possible application for a divergent lens which diffuses

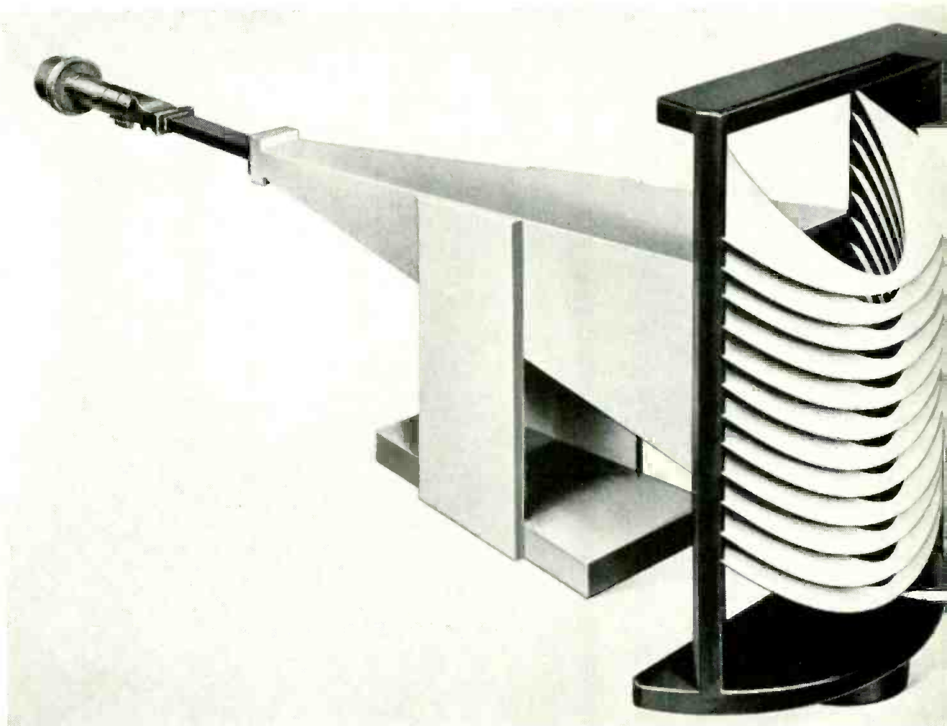

Fig. 9—*Diffusing lens attached to a horn-type loudspeaker*



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energy. In Figure 8 is shown such a lens attached to a cone-type loudspeaker. It is a convexo-concave lens cylindrically shaped to spread energy in the horizontal plane. At the higher frequencies, wherever the speaker by itself tends to become directional, measurements show that the lens acts to broaden the sound beam. However, many such speakers, because of cone breakup, tend to exhibit some diffusing effect of their own as the frequency increases. A more pronounced effect is observed by the listener when a long horn is used to feed the lens because the lens was designed to accept a plane wave and diffuse it over a broad angle. (See Figures 9 and 10.) At the aperture of such a horn the wave-front is nearly plane over a wide range of frequency. A horn with a 6-in. aperture having half-power beam widths of 28, 14 and 10 degrees at 4, 8, and 12 kc, respectively, was found to have a fairly constant half-power beam width of 50 to 60 degrees at all these frequencies when used in conjunction with the lens. This suggests the use of a single horn and lens combination to achieve diffusing effects now obtained by multi-cellular and sectoral horns.

The complete lack of dispersion in the broadband slant plate refracting structures makes them particularly useful in audio-frequency applications where the range of frequencies covered may extend over many octaves.

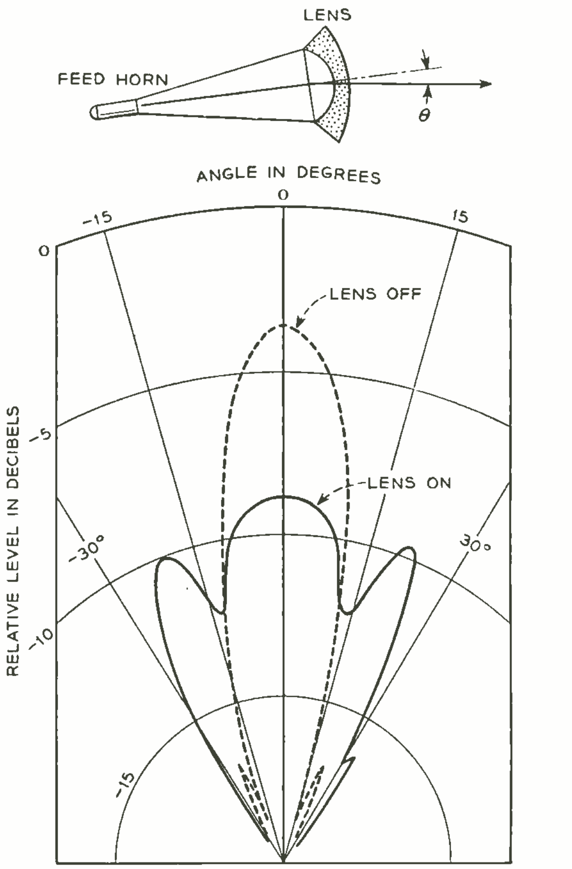


*Fig. 10—How a diffusing lens widens the coverage of a horn-type loudspeaker. These curves are for 8 kc, and are representative of the improvement observed at other frequencies*

**THE AUTHOR:** F. K. HARVEY joined the Laboratories in 1929 and since then has been concerned with acoustical measurements. He made Rayleigh disk calibrations of microphones; measured acoustic impedances of various materials and of small orifices; investigated supersonic attenuation in air and other gases; made reverberation measurements to obtain the absorptive properties of acoustic materials; and measured transmission loss through various wall constructions. During this time he studied at New York University and received the B.E.E. degree in 1939. As World War II approached he turned his attention to air raid alarm systems. He measured the output and directional characteristics of several experimental high-powered sirens, climaxing with the Victory model used extensively during the war. He also assisted in the development of a locator for gun sounds and of a vibrating reed indicator for aircraft. More recently he has been measuring the acoustical characteristics of various refracting structures, many of which have been taken over directly from the microwave field.



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H. M. KNAPP
*Switching Apparatus*

# *The UB relay*

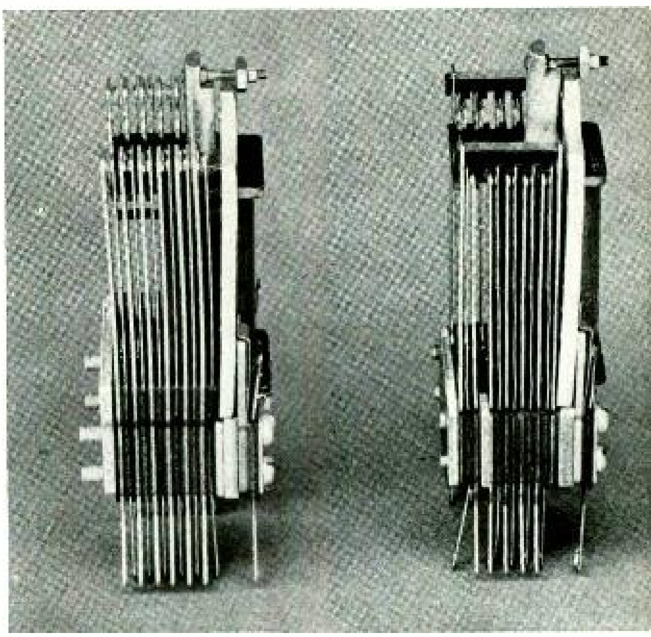
In a crossbar dial office there are in the neighborhood of 70,000 relays for 10,000 subscribers' lines. More than half of these are of the U type.* The UB relay has recently been introduced, on a limited basis, as a replacement for the U where freedom from locking contacts and stability of adjustment are of particular importance. Its major field of application will be where the number of operations is high—of the order of several millions a year or more. At the present time, it is used extensively in the new automatic message accounting system, where relay operations exceeding twenty-five millions annually are quite common. Although in appearance and major structural features the UB is essentially the same as the U, Figure 1, and the two relays are interchangeable physically, they are not always the same circuitwise. Because of this, the UB is being restricted initially to those applications where its characteristics are of particular advantage.

The advantage of the UB lies in the method of actuating the contacts. With make contacts of previous relays, the spring carrying the moving contacts is tensioned away from the fixed contact on the spoolhead spring, and exerts a force to hold the armature against the back-stop when the relay is unoperated. A stud, moved by the armature, presses against the contact spring a short distance back of the contact to close the contacts when the relay is operated. This is indicated in the upper part of Figure 2 for a single set of contacts.

In contrast with this arrangement, the UB relay employs a phenol fibre card instead of a stud to operate the contacts, as shown in the lower part of Figure 2. The moving contact spring itself is pretensioned against the fixed contact to give the desired contact force of between 20 and 30 grams. The card is held by two card springs that are tensioned away from the fixed contact, and in slightly greater amount than the moving contact spring is tensioned toward it. As a result, when the relay is unoperated, the card holds a make contact away from the fixed contact. When the relay operates, the armature pressing against the top of the card pushes it toward the fixed contact, and thus allows the contact to close. A break contact on the UB relay is identical with the make, except that the card opens the break on operation of the relay and permits it to close on release. No balancing force is needed in this case.

It will be noticed that with previous relays, as indicated in the upper part of Figure 2, the deflection of the contact spring in closing slightly tilts the moving contact with respect to the fixed contact. This is also true when the contact opens, and thus in both closing and opening there is a small component of relative motion of the contacts perpendicular to the direction of motion of the armature; the contacts slide in being pressed together.

*Fig. 1—U relay at the left and UB at the right*



*Record, *May*, 1938, *page* 300.



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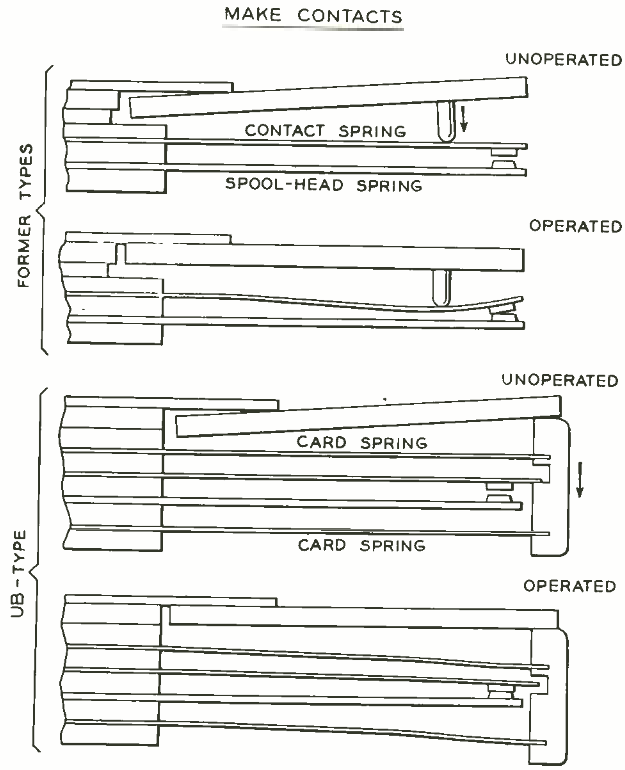


*Fig. 2—Simplified diagram indicating the contact operation of former types of relays, above, and of the UB type, below*

As a result of slight arcing as the contacts open an electrical circuit, there is a transfer of metal from one contact or electrode to the other. This building up and wearing away leaves both contacts roughened. If the opening motion were along a perpendicular to the contacts, this roughening would, ordinarily, have little effect; but with a sliding motion at the contact, small projections on one contact may bind or lock mechanically in a cavity on the other and thus prevent the contacts from opening when they should. In the UB relay, where the contacts are operated without sliding motion, this action is to a large extent avoided.

The likelihood of locking with the UB relay is further decreased because the restoring force is greater and is applied closer to the contact, and because of the impact of the card on the spring when the relay releases. With the contact closed, there is a clearance between the contact spring and the bottom of the slot in the card, and thus when the card hits the spring in opening, it is already moving and has acquired kinetic energy. This energy is available as impact to overcome any tendency of the contacts to stick.

The comparative freedom from dirt troubles obtained with the UB relay is an additional advantage that card operation made possible. The moving springs of double-contact relays are forked, as shown in Figure 3, and each tip of the fork carries a contact—thus providing two contacts for each spring. Should a small particle of dirt hold one contact open, the other contact, because of the independent flexing of the two tips, should still close with substantially the same force. With stud-operated relays, however, the possible length of the tip is limited by the position of the operating stud, indicated in the diagram, and thus the amount of independent flexing of the two tips is similarly limited.

With the UB relay, on the other hand, there is no operating stud, and thus the slot between the tips can be made longer. With the U-type relay, for example, the slot is 0.33 inch, while with the UB it has been made 0.94 inch. Since stiffness varies inversely as the cube of the length, the independence of the tips on the UB relay is twenty-three times greater than that of the U relay. In the Philadelphia accounting center, only half as much trouble from dirt has been experienced with the UB relay as with the U relay.

One of the major advantages of the UB relay is its greater stability of adjustment. With any relay, the pressure of the contacts tends to decrease with wear—wear at the contacts themselves and at certain other critical points in the structure. With the UB relay, however, both the wear and the decrease in pressure with wear are less than with previous relays.

With most types of relays, wear of approximately the same amount takes place at the contacts. Although there is some wear at the card on the UB relay, particularly at the top where the armature pushes it, it is small and does not appreciably affect the contact pressure, which is determined by the pretensioning of the spring.

With the former types of relays, on the



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other hand, there is wear of the operating studs as well as of the contacts, and since the pressure at the studs is relatively high, and there is some sliding because of the flexing of the spring, the wear is relatively large. Moreover, with a large spring pileup, there may be several wearing points in series and the wear adds up in its effect on the last spring. For a U-type relay with six make contacts, the loss in travel because of stud wear after 30,000,000 operations is over 6 mils, while for a U relay with six break contacts, it is over 9 mils. Card wear for the UB relay similarly equipped, and for the same number of operations, is negligible. The effect of this wear in requiring readjustment is obvious in Figure 4.

Although this reduced wear of the UB relay is an important factor in decreasing the need for readjustment, a factor of even greater importance is the much smaller rate with which pressure falls off with wear. Force is applied to the contact spring of a UB relay only at or near the free end; the spring is thus a cantilever and the ratio of force to deflection is small—about 0.09 gram per mil of deflection. With previous relays, on the other hand, the spring, once contact is made, acts as a beam—supported by the pileup at one end and by the fixed contact at the other. The operating stud deflects the beam by pressure applied a short distance back of the contact. Under these conditions the ratio of force to deflection is much higher, being about 2 grams per mil of deflection for the U relay. This is illustrated in Figure 5. The shape of the preformed spring of the UB relay is shown at (c)—the end is down about 294 mils below the position it will assume when assembled, indicated at (d). In moving through this 294 mils, a force of 25 grams has been developed, which will be essentially the pressure on the fixed contact when the card releases the spring. When the contacts have worn 10 mils, which is about the maximum permitted, the pressure will still be above 24 grams, since it drops 0.09 gram per mil of deflection.

With the U-type relay, there is no pressure when contact is first made as shown at (a). The pressure is built up to 25 grams by deflecting the spring as shown

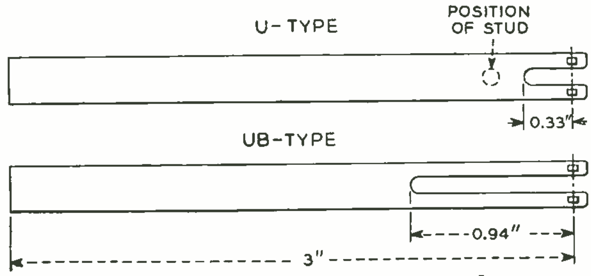


*Fig. 3—The springs of double-contact relays are forked at the end and have a contact on each tine, but the length of the tines is much greater with the UB than with the U relay*

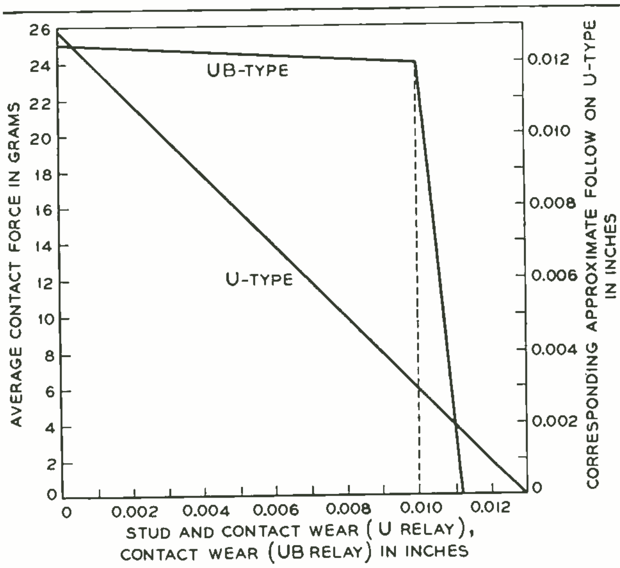


*Fig. 4—Change in contact pressure with wear for "make" contacts of the U relay and of the UB relay*

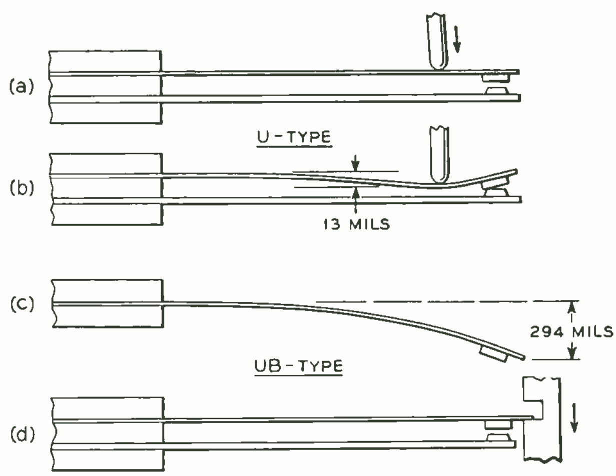


*Fig. 5—Simplified diagram indicating spring actions of "make" contacts of the U relay and the UB relay*



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at (b). The much higher ratio of contact pressure to deflection with this beam action—2 grams per mil—requires a deflection of only about 13 mils to build up the pressure to 25 grams. When the combined wear at the stud and contacts is 10 mils, only about 5 grams of pressure will remain. A combined wear of only 2½ mils will reduce the pressure to 20 grams. The drop off of pressure with wear of the UB relay, on the other hand, is so slight as to be negligible, until the contact wear has been great enough to allow this spring to rest against the lower lip of the card in the operated position. This accounts for the sudden drop of the curve for the UB relay in Figure 4. Since it is desirable to maintain good contact pressure, it is obvious that stud-operated types will require adjustment at much more frequent intervals than the card-operated UB type.

A still further advantage of the UB relay is that it requires less hand effort in adjusting. The contact springs are preformed in dies for tension, and thus the hand tensioning after assembly is avoided. An important contribution in this connection is the method of preforming the springs suggested by D. C. Koehler. During the early development stages, the springs were formed between two smooth, curved surfaces shown in the upper part of Figure 6. Considerable variation in tension was encountered, however, because of differences in the spring-back of the various springs when removed from the forming tool. This effect was minimized by using two sharp bends, as shown in the lower part of the illustration. The bends are so located that the resulting shape of the spring approximates that of the elastic curve for a cantilever spring. This was done so that the spring will be reasonably straight and parallel with the mating spring when it is held in position in the assembled relay. The contact force distribution of springs formed by the two methods is shown at the right of the illustration.

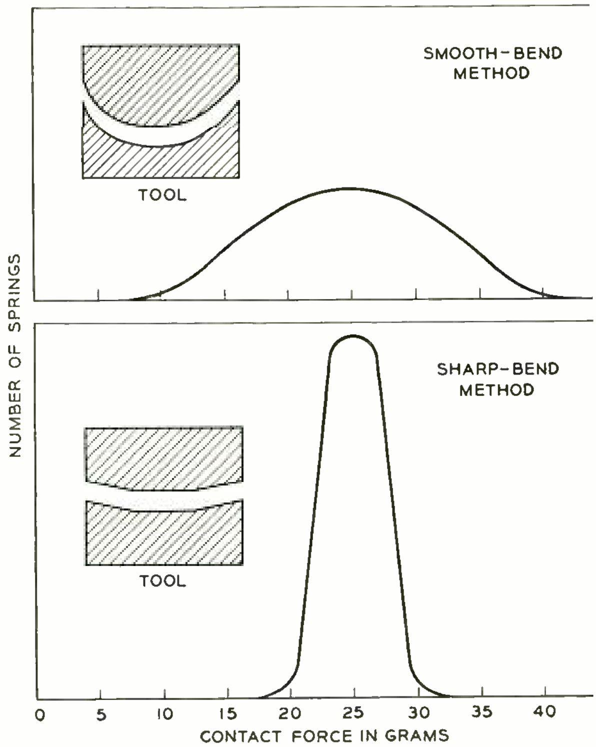


*Fig. 6—Frequency distribution of contact force with early and final methods employed for preforming springs of UB relay*

**THE AUTHOR:** H. M. Knapp graduated from Stevens Institute of Technology with a degree in mechanical engineering in 1928, and at once joined the Technical Staff of these Laboratories. With the Apparatus Development Department he was engaged in precious metal contact studies until the war, and then supervised the mechanical design of magnetic fuses for the Bureau of Naval Ordnance. Since the war he has been in charge of a group working on relay development—one project of the group being the UB relay described in this issue.



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# *Dr. Shewhart receives first impression of medal in his honor*

In the early nineteen-twenties, the late R. L. Jones was put in charge of Western Electric inspection engineering. To his new department he soon took Walter A. Shewhart, who had been with him in Transmission Engineering and who had been applying statistical theory to interpret the somewhat erratic behavior of the carbon transmitter of those days.

Dr. Shewhart had been thinking about statistics as a means of finding out things, and within a few weeks—the date was May 16, 1924—he submitted the first quality control chart with a memorandum which said it was " . . . designed to indicate whether or not the observed variations in the per cent of defective apparatus are significant. . . ." That was the birth of Quality Control.

There were plenty of opportunities in Western Electric plants to try out Dr. Shewhart's idea, and its usefulness was well enough established for a paper to be published in the *Journal of the American Statistical Association* in 1925. One of Dr. Shewhart's technical memoranda came to the attention of Dr. Karl Pearson, famous British founder of mathematical statistics. At Dr. Pearson's suggestion, Dr. Shewhart gave a series of lectures at the University of London in 1932, stirring the interest of British industry. In 1938 Dr. Shewhart gave a similar series before the graduate school of the Department of Agriculture in Washington; the lectures were later published by that Department. Acceptance outside the Bell System was powerfully accelerated by World War II, when the need of rapid inspection methods for Government purchases brought his ideas into widespread use. Thousands of engineers were trained in wartime courses in this country and abroad, and application of the art is now world-wide.

The new art needed a forum where its problems could be discussed, and the American Society for Quality Control was organized in 1946. Walter Shewhart was elected the Society's first Honorary Member. The following year, the Society established the Shewhart Medal in his honor. Fittingly, the Society has presented the first replica to him, with the citation "for his distinguished leadership in the development of statistical methods for the control of manufacturing processes, thus laying the foundation for the new profession of Quality Control."



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# *Trunking plan for No. 5 crossbar*

W. B. GRAUPNER
*Switching Equipment*

A basic objective of the trunking plan for any switching system is to permit interconnections to be made between the subscriber lines in the same office, and between the subscriber lines and the trunks to and from other offices. In a crossbar system, these connections are made by crossbar switches, which establish a path by interconnecting a series of links and junctors. The number of links and junctors provided must be great enough not only to handle the largest number of calls likely to be in progress simultaneously, but to make it unlikely that a call will find all connecting paths busy when the line or a suitable trunk is idle.

In the No. 5 crossbar system, the trunking plan is simple and yet very flexible. Only two types of switching frames are required: the line-link frame and the trunk-link frame. These basic frames consist of two bays of ten crossbar switches each—the two bays being interconnected in much the same manner as the primary and secondary bays of the No. 1 crossbar system. Instead of being called primary and secondary bays, however, they are called line and junctor bays on the line-link frame, and junctor and trunk bays on the trunk-link frame.

The arrangement of the line-link frames is indicated in Figure 1. The switches of the junctor bay have their horizontal multiple cut so as to give the equivalent of two crossbar switches of ten verticals instead of one switch of twenty verticals. One-half of each switch is used for junctors, and the other half, for lines. The horizontals of the right half of the ten switches in the junctor bay are connected directly across the horizontals of the line bay, and thus provide what is in effect a crossbar switch with thirty verticals. The subscriber lines are connected to twenty-nine of these verticals of each row of switches, and thus each such basic line-link frame will accommodate as many as 290 lines. The one vertical of each switch not used for lines is employed for "no test" connections.

Provision is also made for extending this horizontal multiplying of the line switches to additional or supplementary bays, which may have switches of either

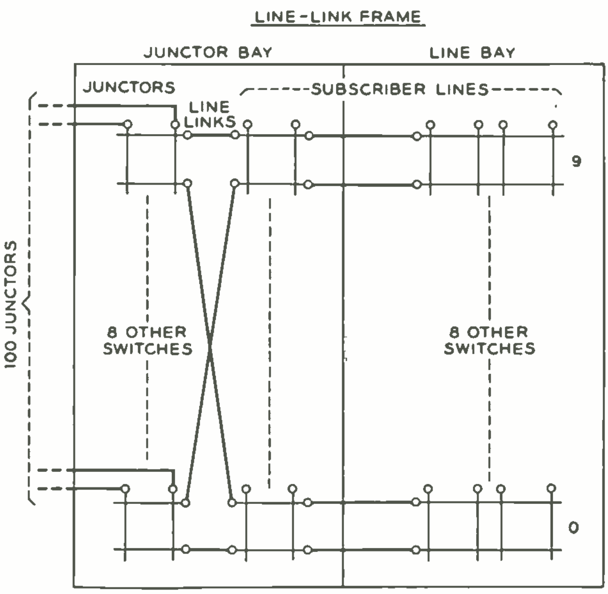


*Fig. 1—Line-link frame for No. 5 crossbar*

ten or twenty verticals. To what extent supplementary bays are employed depends on how much the particular lines are used. With lines having high calling rates or long holding times, lines on the basic frame may provide sufficient traffic, and thus supplementary bays may not be required; while with lines of low calling rates, the capacity of a line-link frame may be increased to as



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much as 690 lines by the use of supplementary bays. In each case the number of bays is adjusted to give an adequate load for the junctors by which the line-link frames are connected to the trunk-link frames.

Verticals on the left half of the switches on the junctor bay are connected to junctors. Since each of these ten half switches has ten verticals, there are 100 junctors from each line-link frame. Over them pass all calls from or to the lines associated with that frame.

The horizontals of the junctor switches are connected to the horizontals of the line switches to provide the "primary-secondary" linkage as indicated in the diagram. Here each crossbar switch is represented by its top and bottom horizontal and by its first, tenth, eleventh, and twentieth vertical, and only the top and bottom switches of a bay are shown. Each of the ten horizontals of a line switch connects to a different junctor switch in regular order, as indicated. Each line switch thus has one link to each of the ten junctor switches. In this way every line has access to every junctor.

Since the ability to meet a wide variety of conditions is one of the features of the No. 5 system, provision has been made for subscriber lines to have as many as thirty classes of service. Each such class of service identifies the type of line, such as flat rate, message rate, or coin service. Covered also by the class are the number of parties per line—single, two, four, eight, or ten—various calling zones, and other factors that affect the type of service or the rates paid. Lines of any of these classes may be connected to any line-link frame, the only restriction being that all the lines in the same vertical file of a bay, that is the corresponding verticals of each of the ten switches of a bay, be of the same class. Cross-connecting strips at the top of each line-link frame permit the class of each file of verticals to be identified to the marker.

The arrangement of the trunk-link frame is shown in Figure 2. The wiring for the "primary-secondary" linkage between the trunk and the junctor switches connects to the verticals instead of the horizontals, but the arrangement is similar in effect to that of Figure 1. In this frame, also, the switches of the junctor bay have their horizontal multiple cut to provide the equivalent of two switches of ten verticals. In this case,

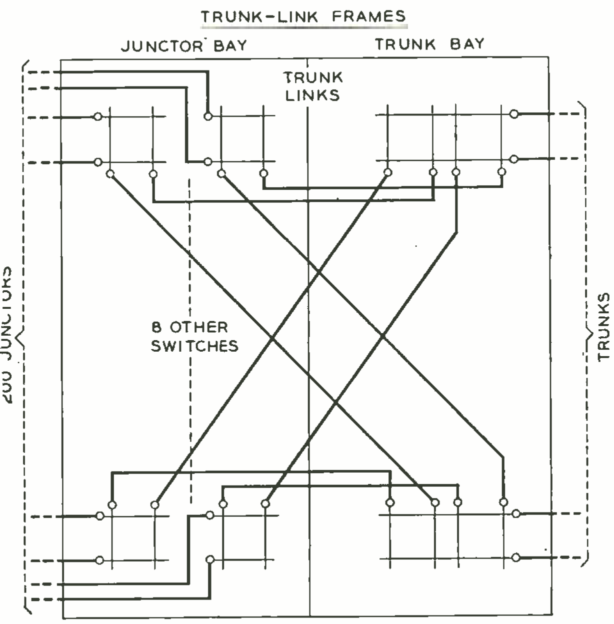

*Fig. 2—Trunk-link frame for No. 5 crossbar*

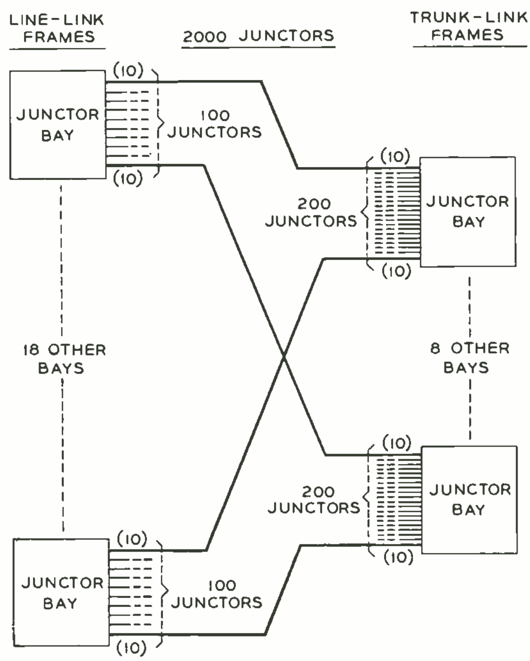

*Fig. 3—Distribution of junctors*



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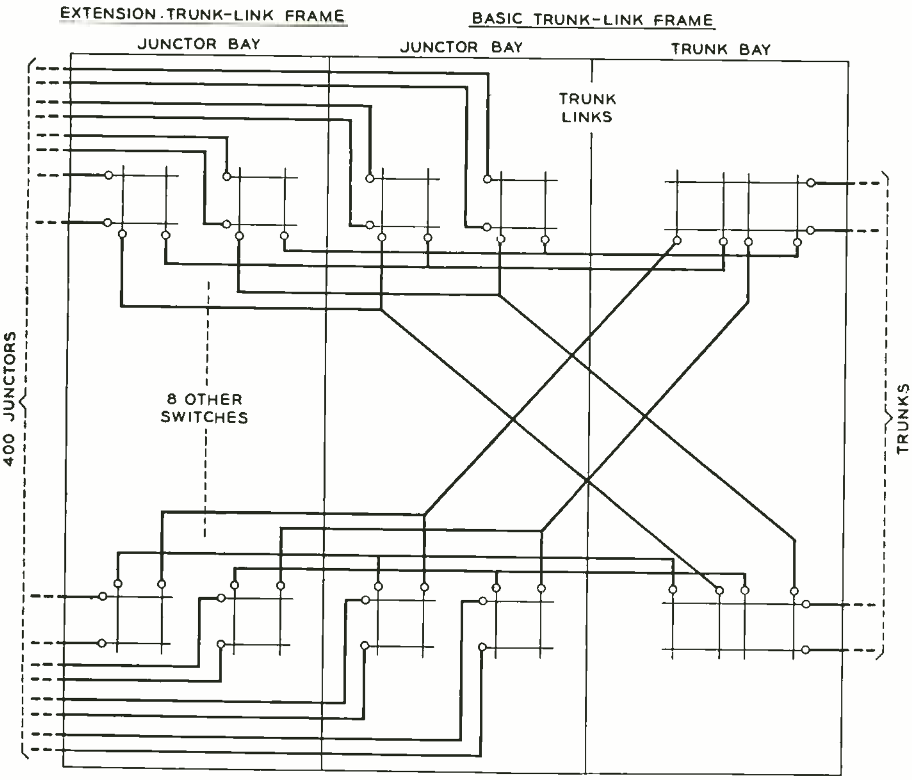


*Fig. 4—Trunk-link frames where extension bays have been employed*

the split is made to provide terminations for 200 junctors, which connect to the twenty horizontals of each of the ten junctor switches. Each twenty vertical-trunk switch has access to each half of the split junctor switch over one link. The trunks connect to the horizontals of the trunk switches. These latter switches are of the six-point type already described in the RECORD,* and thus each horizontal is capable of providing terminations for two trunks. The two lower horizontals of each switch are used to select one or the other of the two trunks associated with each of the upper eight horizontals, and thus there are terminations for sixteen trunks on each switch or 160 on a bay.

Of these 160 trunk terminations, a few—perhaps five or six—will be used for originating registers; the rest will be used for outgoing, incoming, or intraoffice trunks. Not more than 120 of the terminations on a frame may be used for outgoing trunks, however, and not more than 80 for incoming or the incoming end of intraoffice trunks. Intraoffice trunks require two terminations on each frame: one for the connection going back to the calling subscriber and one for the connection going forward to the called subscriber. The trunks to a particular destination are distributed as evenly as possible over all the trunk-link frames. The marker is able to select any idle trunk on any of these frames to complete a call, so that all trunks to any destination, regardless of their number, are in one efficient group. Another advantage of this arrangement is that when trunk frames are added, in the course of normal growth, the additional trunks required can generally be assigned without disturbing the existing trunk distribution.

Since each trunk-link frame provides 200 junctors, and each line-link frame only 100, there are normally twice as many line-link as trunk-link frames. The junctors between line-link and trunk-link frames are distributed in much the same manner as are the links in each frame. Each line-link

*RECORD, *January,* 1942, *page* 114.



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frame has a group of junctors to each trunk-link frame. For twenty line-link and ten trunk-link frames, the distribution is indicated in Figure 3. One junctor from each of the ten switches of a line-link frame connects to each trunk-link frame. In Figure 3, each line represents ten junctors, one from each switch of each line-link frame to each of the ten switches of each trunk-link frame. All calls, either outgoing or incoming, are connected over a circuit consisting of a line link, a junctor, and a trunk link, with the marker selecting the combination of junctor and links that is used for each call.

In the junctor arrangement indicated in Figure 3, where there are twenty line-link and ten trunk-link frames, there are ten junctors from each line-link frame to each trunk-link frame, since the 100 junctors from each line-link frame provide ten groups of ten. This is the smallest inter-frame group that will keep the probability of a call finding all possible paths busy to the low value desired. The number of junctors from each line-link frame to each trunk-link frame, however, depends on the number of trunk-link frames, since with *n* trunk-link frames, the 100 junctors from each line-link frame will be divided into *n* groups, and the number of junctors in each group will thus be 100 divided by *n*. As long as the number, *n*, of trunk-link frames is not more than ten, there will be ten or more junctors per group, and thus the requirement of at least ten per group is met. If there were more than ten trunk-link frames, however, this requirement would not be met with the type of distribution shown in Figure 3.

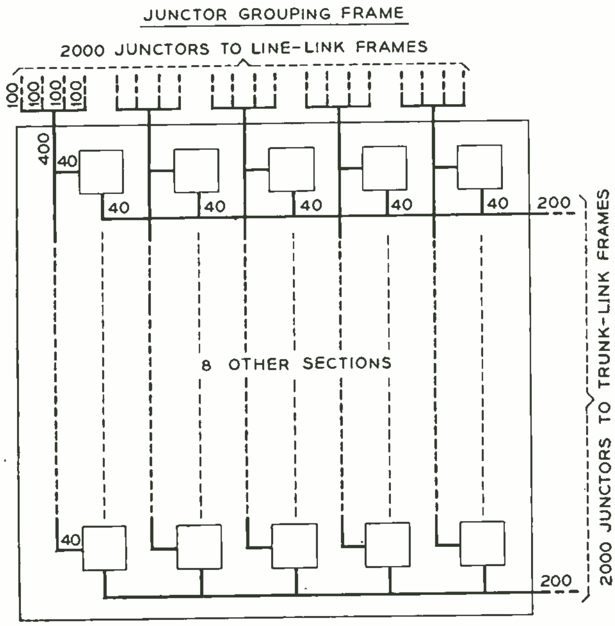

*Fig. 6—Junctor grouping frame*

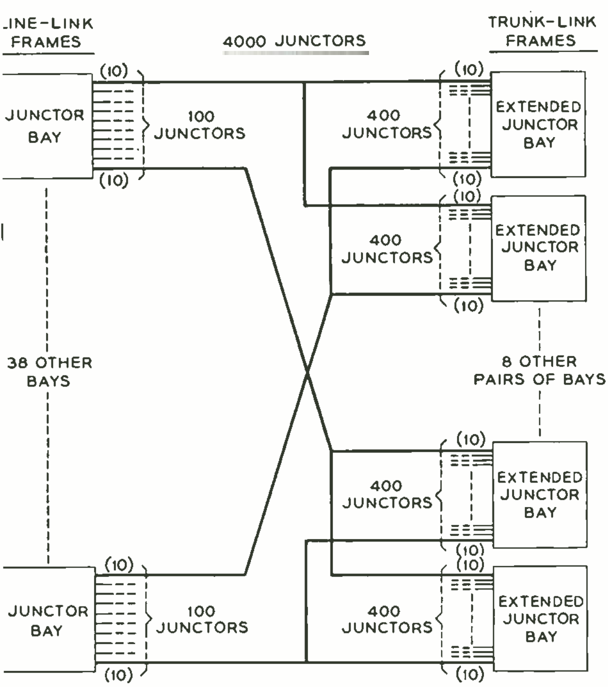

*Fig. 5—Distribution of junctors when extension bays are used with the trunk-link bays*

When more than ten trunk-link frames are required to meet the needs of an office, each junctor from a line-link frame, therefore, is multipled to two trunk-link frames, which has the effect of doubling the number of junctors from the line-link frames. Then each line-link frame can supply a group of ten junctors to as many as twenty trunk-link frames, which is the maximum number for which a No. 5 crossbar office is designed.

With twice as many line-link as trunk-link frames, there would be forty line-link frames for an office having twenty trunk-link frames, and thus a total of 40 x 100 or 4,000 junctors from the line-link frames. Since each of these junctors connects to



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two trunk-link frames, there must be terminations on the twenty trunk-link frames for 8,000 junctors, which is 400 per frame—twice the number shown in Figure 2. To secure these additional junctor terminations, extension bays are added to the trunk-link frames, and are connected to them as indicated in Figure 4. These extension frames are arranged like the regular junctor bays of the trunk-link frames, and the verticals of the junctor bay and the extension bay are multipled. In this way terminations for 400 junctors are provided for each trunk-link frame. When such extension frames are used, the trunk-link frames are grouped in pairs, and each junctor from a line-link frame is connected in multiple to junctor terminals on both frames of a pair. This arrangement is indicated in Figure 5.

If there were always twenty line-link frames and ten trunk-link frames, the junctor terminals on the line-link frames could be permanently connected to the junctor terminals on the trunk-link frames—ten on each line-link frame being connected to each of the ten trunk-link frames. Since the number of frames in an office may vary over a fairly wide range, however, and may change from time to time, a junctor distributing bay is provided to which the junctors from both line-link and trunk-link frames are connected. Here they may be interconnected by jumpers in the best way for each set of conditions.

This junctor grouping frame consists of fifty terminal blocks arranged in five columns of ten each, as indicated in Figure 6. Each terminal block provides double ended terminals for forty junctors—one end of each terminal projecting to the front of the bay and the other, to the rear. Junctor cables from four line-link frames are run vertically down the front of the frame adjacent to each column of terminal blocks, and ten junctors from each of the four cables are connected to the terminals of each block. Junctor cables from the trunk-link frames run horizontally across the rear of the bay; the 200 junctors from each frame are connected to the terminals of

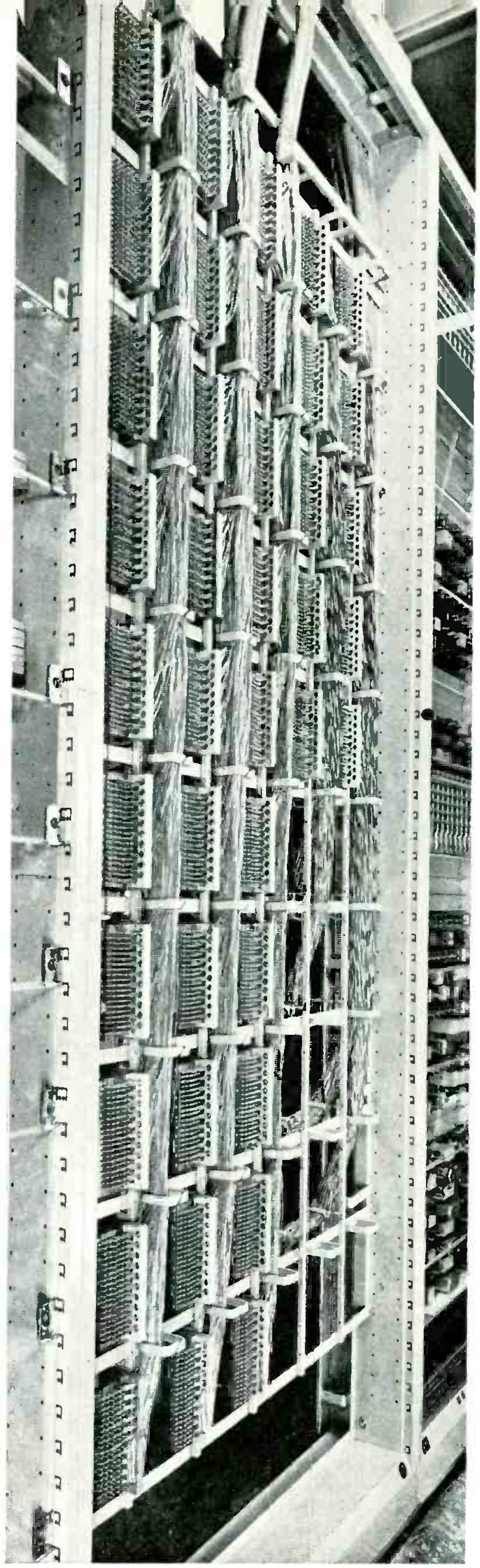

*Fig. 7—A junctor grouping bay in the crossbar office at Media, Pennsylvania*



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each of the five blocks in one row. A front view of the junctor distributing bay in the Media Office is shown in Figure 7.

If there were twenty line-link frames and ten trunk-link frames, all the terminals would be filled and each junctor from the line-link frames would be permanently connected to a junctor from the trunk-link frame, in the manner already outlined. If there were a smaller number of frames, such as eight line-link frames and four trunk-link frames, the two left-hand columns of blocks would have junctors connected to their front end, and the four upper rows would have junctors connected to the rear terminals. The blocks in the two left-hand columns of the upper four rows would have junctors connected both front and rear, while the lower six blocks in the two left-hand columns would have junctors connected only at the front, and the blocks of columns three, four, and five of the upper rows would have junctors connected only at the rear. Jumpers are run from the upper right-hand section of the bay to the lower left-hand section to distribute the remaining junctors properly. When extension bays are used for the trunk-link frames, there would be two of these junctor grouping bays. The groups of 100 junctors from the line-link frames will be distributed to both of the junctor grouping bays, and the junctors from one trunk-link frame of each pair will go to one junctor distributing bay and those from the other frame of the pair to the other distributing bay—the junctors from the two frames of a pair being terminated on the same row of blocks.

Since the traffic capacity of the 200 junctors on a trunk-link frame is double that of the 100 junctors on a line-link frame, there are, in general, twice as many line-link as trunk-link frames. The size and number of the line-link frames required for a specific job is determined from originating and terminating peg-count and holding-time data from which the total load in CCS* is computed. By dividing the frame capacity, 1200 CCS, by the average originating and terminating CCS per line, and adding a provision for spare lines, the number of lines which a frame may serve can be determined, the actual size being governed by the fact that they are furnished in increments of 100 lines only. The number of frames of this size is obtained by dividing the total number of lines to be equipped in the office by the number per frame. Where no special requirements have to be met for terminating trunks, the number of trunk-link frames required will be one-half the number of line-link frames. Under certain conditions, trunk-link frames may be required merely to provide terminations for a large number of small trunk groups on which traffic is light. In this case, a greater than proportional number of trunk-link frames would be provided.

*100 Call-seconds. See RECORD, *March*, 1939, *page* 222.

**THE AUTHOR:** W. B. GRAUPNER was graduated from Armour (now Illinois) Institute of Technology in 1937 and received a B.S. degree in electrical engineering. He then joined the Technical Staff of the Laboratories and worked with the Quality Assurance Department for five years. During the war years he worked in the Systems Development Department on equipment designs for land radar, flight trainers, and radar test sets. Since V-J Day he has been active in the design of equipment for the No. 5 crossbar system.



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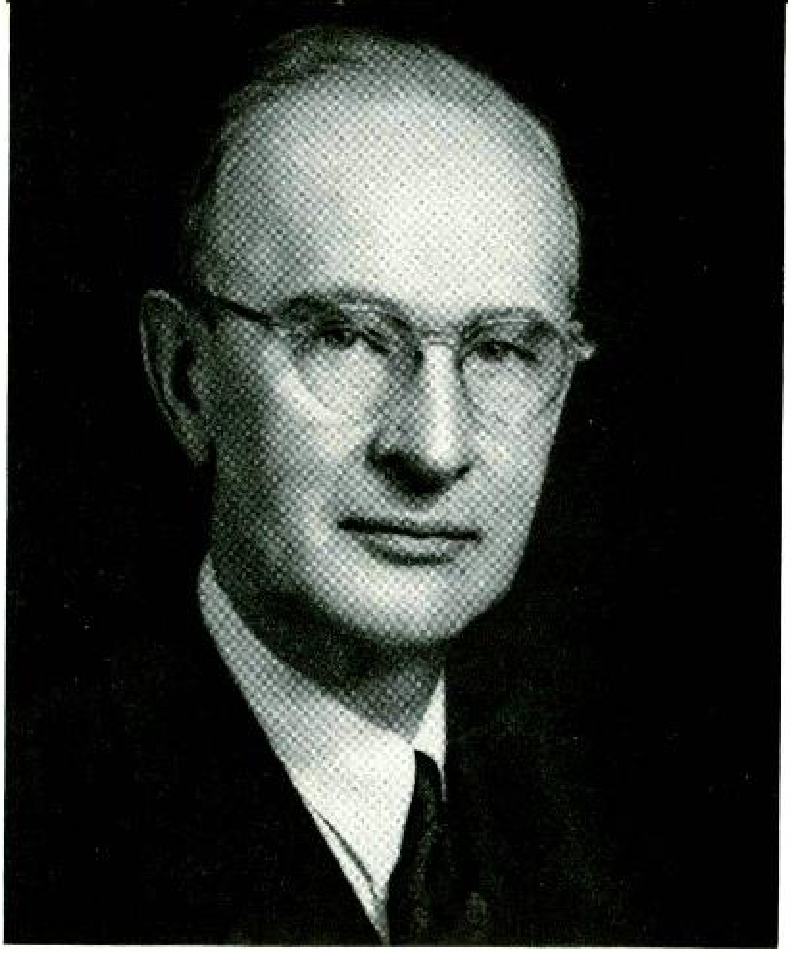

# Otto B. Blackwell Retires

By Thomas Shaw

Otto Bernard Blackwell began his 43-year Bell System career in the Transmission and Protection Division of the A T & T Engineering Department at its Boston headquarters shortly after acquiring his S.B. degree in Electrical Engineering at Massachusetts Institute of Technology in June, 1906.

It was especially auspicious that Mr. Blackwell was recruited by Dr. Frank B. Jewett himself for service in his department, which was destined to make many outstanding pioneering advances in telephone transmission. In 1914, two years after Dr. Jewett's transfer to the Western Electric Company, Mr. Blackwell was appointed head of Jewett's former department in A T & T, and had supervisory responsibility for transmission development and engineering, and for protection and inductive interference prevention. When the A T & T Department of Development and Research was organized in 1919, he became Transmission Development Engineer.

In 1934 the D & R was consolidated with the Laboratories, with Mr. Blackwell as its Director of Transmission Development. The following year he was appointed Manager of Staff Departments, retaining supervisory responsibility for transmission and protection developments. In 1937 he became vice-president in charge of all of the technical departments, including Research, Apparatus, and Systems, in addition to Transmission and Protection, and relinquished his earlier responsibilities for the Staff Departments. A general top-level reorganization early in 1940 made him responsible, as vice-president, for all of the non-technical departments including Patent, Personnel, Legal, and Publication, and the Staff Departments previously referred to. Simultaneously, he gave up supervisory responsibility for the technical departments.

Although Mr. Blackwell had been a member of the A T & T staff for five years when he retired, his entire career was connected with the Laboratories. Because he has a host of friends here, the Editors of the Record welcome the opportunity to publish this account of his career.



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Late in 1944, following the retirement of Dr. Jewett, Mr. Blackwell returned to the A T & T as an assistant vice-president, and also became a member of the Laboratories' Board of Directors. During this concluding period of his career, he has been responsible for the review and recommendations concerning proposed authorizations for work to be performed by the Laboratories for the A T & T. For nearly a year prior to retirement, he was the only active member of the technical staff that moved from Boston to New York in 1907.

Mr. Blackwell made many important personal contributions to the advancement of the art. Among the best remembered is his early work in the commercial development and use of quadded toll cables, notably the apparatus and technique for measuring capacitance unbalances, and the so-called capacitance-unbalance test-splice procedure used in installing the cables. In the evolution of the "four-wire" type of (repeater) circuit, he was the first to recognize that its most advantageous field of use would be on long-loaded nineteen-gauge toll cables. Subsequently, he predicted the serious crosstalk problems that would arise, and specified adequate control procedures. He also made basic contributions to the art of attenuation equalization in long four-wire circuits, and was first to propose the use of terminal echo-suppressors in place of mid-circuit suppressors. In the evolution of the increasingly important but more prosaic transmission maintenance work, Mr. Blackwell was responsible for the introduction of transmission measuring sets and techniques.

Six patents of outstanding commercial importance resulted from Mr. Blackwell's work on the problems just mentioned, two of them being joint with others. Sixteen additional patents record his other inventive efforts, making a total of twenty-two (including eight joint patents), in fifteen different categories.

The organization units which worked under Mr. Blackwell's creative leadership during the 1908-1940 period played a very important part in all the revolutionary developments which first made universal telephone service economically practicable throughout the Bell System, and then by radio links brought about the inauguration of world-wide telephony. Following the initial conquests of geographical distance, the development emphasis shifted to facility cost reduction and to further improvements in transmission performance standards. The application of electronics and of high-frequency techniques to these objectives established fertile roots from which the art will continue to grow.

Mr. Blackwell played a leading part in formulating the basic transmission-economics philosophy which served to guide the fundamental development work above summarized. It is also noteworthy that many of the most creative engineers now working on transmission problems owe much to the experience gained in working for him.

Mr. Blackwell's important achievements in telephone transmission work were not wholly concerned with the development aspects. For example, in 1912 he was responsible for the preparation of the first comprehensive transmission engineering bulletin for field use. Several years later, he took the initiative in planning the first transmission school for teaching field people how to handle their transmission problems. Such schools became more and more necessary in the training of personnel as the art became more complicated, and are now commonplace features in all important phases of telephone engineering.

To sum up, Mr. Blackwell's achievements have earned for him a top rank in the roster of nationally known communication engineers.

Mr. Blackwell is the author or co-author of several important technical articles bearing upon the development work for which he was responsible. He is a Fellow of three technical societies: A.I.E.E., I.R.E., and the Acoustical Society of America; and is also a member of the American Physical Society and the American Association for the Advancement of Science. He served as vice-president of the A.I.E.E. for the New York Section during the period 1936-1938, and was for many years on A.I.E.E. committees, including technical program, communications and Institute Headquarters. At one time he was a member of the Standards Council of the A.S.A. He served on joint committees of the Edison Electric Institute and Bell Telephone System, and was for some time Chairman of the Bell System Representatives of the Joint Subcommittee on Development and Research.

Important personality factors in Mr. Blackwell's distinguished career have been his intellectual integrity, his keen analytical ability, his modesty and his consideration for others. In his personal contacts, and at formal and informal gatherings, his native dry wit always found an appreciative audience.

The Blackwells will continue to live in Plandome, Long Island. As becomes a man of Cape Cod ancestry born on Cape Cod, he has a boat on the waters of Long Island Sound. The recent installation of a number of power tools in a basement workshop will provide an outlet for his creative energy. Also, he is an earnest photographer when his young grandson is within range.



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Bartlett T. Miller

William C. Bolenius

# New Directors Elected

Bartlett T. Miller and William C. Bolenius, vice-presidents of the American Telephone and Telegraph Company, have been elected to the Board of Directors of Bell Telephone Laboratories to fill vacancies created by the resignations of O. B. Blackwell and K. S. McHugh. Mr. Blackwell, as assistant vice-president of the A T & T, retired on August 31, and Mr. McHugh, until recently a vice-president of A T & T, is now president of the New York Telephone Company.

Mr. Miller has been with the Bell System since 1910. He is a native of Johnsville, Kentucky, and began his career in the Traffic Department of the Colorado Telephone Company. He later transferred to the New England Telephone and Telegraph Company, of which he became a vice-president in 1944. In 1946 he was appointed assistant vice-president, A T & T, and in 1947, vice-president.

A native of Auburn, New York, Mr. Bolenius has been with the Bell System since 1921 when he started as a traffic inspector with the New York Telephone Company. He became vice-president and general manager of that company in 1943 and in 1946 became vice-president of the Wisconsin Telephone Company, later becoming president. Since July, 1948, he has been vice-president in charge of Personnel Relations of A T & T.

## New York to Boston Dialing Now in Service

The first step in introducing dial operation from New York to Boston took place on August 22, when a group of seven one-way terminal circuits at the New York Company's 50th St. office in New York was converted to dial into the New England Company's local crossbar system in Boston. Since then, 22 circuits at four other New York Company offices have been converted, and 65 more are expected to be changed over shortly.

A special study of calls going through all the No. 4 switching systems shows an improvement over the last few months. The per cent of attempts satisfactory on the first try climbed from 89.7 in March to 92.6 by the end of July.

## International Students Visit Murray Hill

A State Department visaed group of students from Great Britain, Switzerland, Scandinavia, Austria, France, Italy and Pakistan visited Murray Hill on August 19, accompanied by H. E. Sporer of A T & T. After an introductory talk by R. K. Honaman, the group learned a few facts about typical Murray Hill laboratories and received information about several Laboratories' specialties from W. C. Jones, E. E. Schumacher, W. E. Kock, A. R. Brooks, and H. B. Ely.

Under the aegis of the International Student Service of the World Student Service Fund, a number of foreign delegates, of which this group was a part, were conducted through



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various Government departments in Washington, D. C., and through the T.V.A. establishment in Knoxville, Tennessee. The inclusion of Bell System points of interest in the overall itinerary bespeaks the esteem in which Bell Telephone endeavors are held.

## R. W. King Retiring

R. W. King, assistant to the president, retired at his own request on September 30.

Coincident therewith, Dr. King's duties, as co-editor of the Bell System Technical Journal with J. O. Perrine of A T & T, were assumed by P. C. Jones who became associate editor, while Dr. King's duties as secretary of the Frank B. Jewett Fellowship were assumed by M. B. Long.

## Dr. C. J. Gorter at Murray Hill

Dr. C. J. Gorter, Professor of Experimental Physics at the University of Leyden, revisited the Murray Hill Laboratory in August and spoke in the Arnold Auditorium on the subject of *Temperatures Below One-Tenth Degree Kelvin.* Dr. Gorter is director of the Kamerlingh Onnes Laboratory for the investigation of low temperature phenomena.

## Part-Time Graduate Study Plan

Following the fall announcement of the continued availability of the Part-Time Graduate Study Plan, seventeen members of the Laboratories applied for participation and their enrollments have been approved. This marks the twenty-seventh year of the Plan.

## Quartz Crystals on the Cover

The quartz crystals shown on the wire frame on the cover of this issue were grown in a steel autoclave at 400 degrees C. and a pressure of 15,000 pounds per square inch in only six days. This represents a distinct achievement in quartz crystal growth—first reported in the September, 1948, issue of the RECORD—because several such crystals can be grown simultaneously in one experimental run. Other crystals shown are among the largest and most nearly perfect ever grown in the laboratory. The girl is Susan Waddell, a messenger in the Area Staff Department at Murray Hill.

A similar photograph in full color and another one of a single crystal, also in color, have been entered by A. C. Walker in the Photography-in-Science Salon held under the auspices of the American Association for the Advancement of Science and the Smithsonian Institution. The exhibit is in the Institution's building in Washington.

MAURICE B. LONG

# New Treasurer Elected

Maurice B. Long has been elected Treasurer of the Laboratories. He succeeds William Fondiller who has resigned as Treasurer while continuing as Assistant Vice President. In addition, Mr. Long has been appointed assistant to Executive Vice President M. J. Kelly.

Mr. Long, after receiving the B.S. degree from the University of Nebraska in 1917, joined the National Bureau of Standards as an assistant physicist. He entered the Laboratories in 1919 and for the next few years was closely associated with the development of the first commercial carrier telegraph system installed between Harrisburg and Chicago and the first telephoto system between New York and Chicago. From 1925 until October, 1930, he was educational director. Then, as assistant director of publication, he coördinated the Bell System exhibits at the Chicago and New York World's Fairs and the Expositions at Dallas and San Diego.

The Murray Hill Project Department, of which Mr. Long was head since its inception in September, 1939, has served its purpose and was discontinued as of August 31. J. G. Motley and J. G. Segelken have assumed their regularly assigned duties as Murray Hill Plant Engineer and Murray Hill Plant Relations Manager, respectively. L. P. Bartheld, formerly of the Murray Hill Project Department, assumed his regularly assigned duty as New York Plant Operation Manager on May 1, 1949. All other members of the Murray Hill Project Department have assumed duties previously assigned under Area Management.



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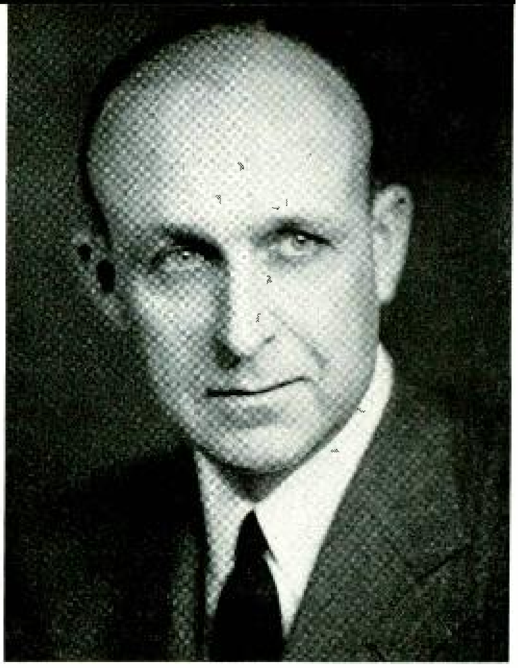
Halsey A. Frederick



Arthur C. Keller

# H. A. Frederick Retires, A. C. Keller New Director

Shortly before completing his graduate work for the degree of E.E. at Princeton, Halsey Frederick visited the Western Electric Engineering Department (now Bell Telephone Laboratories) where he became acquainted with such notables as F. B. Jewett, J. L. McQuarrie, and E. H. Colpitts. Evidently the visit was a most pleasant one, for, prior to his graduation, Mr. Frederick was offered a position.

His first job, in the Research Department (September, 1912) under R. L. Jones, was to study the motional impedance of the famous Shreeve electromechanical repeater. In 1914 he transferred to the Transmission Development Department, where he designed the No. 528 operators' receiver. This receiver, of improved quality, was one of the earliest to use silicon steel for pole pieces, and to get away from the use of a molded hard rubber case.

He became head of the telephone instruments development group in the Research Department in 1920, where, for the next fifteen years, he directed the development of the first handset telephone for large scale use in the Bell System. Other major developments during this period include instruments for the subscribers' combined set, the Western Electric public address system, and the high quality disc record in use today.

In 1935 Mr. Frederick transferred from his position of Director of Transmission Instruments Development in the Research Department to that of Director of Electromechanical Apparatus Development in the Apparatus Development Department. Here he was concerned with apparatus phases of the several types of machine switching systems—panel, step-by-step, and crossbar—including new designs of relays, switches, and contacts. Materials Engineering was also included in his department. In addition, development of the subscribers' combined set was completed in 1936.

When war came, many of the engineers under his direction were assigned to projects for the Armed Forces. The mechanical designs of a number of famous devices were produced, among which are the M9 gun director, computing bomb sights, the optical proximity fuse, control apparatus for rockets, and the Fastax high-speed motion picture camera. Outstanding work was also done in providing substitute materials for use in the Bell System to replace war-scarce and strategic materials.

Since the war, as Director of Switching Apparatus Development, Mr. Frederick has been responsible for designs of new types of relays, the trouble recorder for crossbar offices, card translator for the nation-wide dialing program, apparatus for automatic message accounting, and numerous cost reduction studies on existing machine switching apparatus.

Always active in his home community, Mr. Frederick was Mayor of Mountain Lakes, N. J., for 12 years. In retirement, he will continue as President of the Boonton National Bank, and President of the Boonton Hospital Association.

He is a graduate of Princeton University, magna cum laude, B.S. 1910, and E.E. 1912, having received the Sayre Fellowship in 1911 and the Munn Fellowship in 1912. He is a



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Fellow of the Acoustical Society, Fellow of the American Physical Society, Fellow and Life Member of the A.I.E.E., member of the A.A.A.S., the Princeton Engineers Association and the Morris County Engineers Association.

Succeeding H. A. Frederick as Director of Switching Apparatus Development is Arthur C. Keller, who, recently, as Switching Apparatus Engineer on Mr. Frederick's staff, has been in charge of fundamental studies and design of switching apparatus. Mr. Keller joined the Laboratories in 1917 as a laboratory assistant. Later he received the B.S. and E.E. degrees from Cooper Union and the M.S. with honors from Yale; he has also taken graduate courses at Columbia. His career, until World War II, was concerned principally with telephone transmitters, receivers, loudspeakers, sound recording and reproduction, including sound motion pictures and electrical transcription for broadcasting. This background was valuable in World War II when he had an active part in the development of underwater sound devices for submarine detection and signaling. Two awards from the Navy recognize his personal contributions and leadership of a group.

Following the war, Mr. Keller returned to the field of switching apparatus, where, as Switching Apparatus Engineer, he was responsible for new relay and crossbar switch developments, vibrating reed selectors, and other electromechanical devices.

Mr. Keller is a charter member and Fellow of the Acoustical Society, and a member of the A.I.E.E., I.R.E., S.M.P.E. and Physical Society. In the I.R.E. he has been chairman of the Electro-Acoustics Committee and a member of other committees. In his home town of Bronxville he is active in civic affairs.

His contributions are recorded in 23 issued patents and in a number of published papers.

## "The Telephone Hour"

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

| | |
|---|---|
| October 3 | *Gladys Swarthout* |
| October 10 | *Guiomar Novaes* |
| October 17 | *Ezio Pinza* |
| October 24 | *Jascha Heifetz* |
| October 31 | *Bidu Sayão* |
| November 7 | *Jussi Bjoerling* |
| November 14 | *Robert Casadesus* |

# The Bell Telephone System

*Following up a three-column news story which appeared in its issue of August 22, the* Wall Street Journal *commented editorially as follows:*

In yesterday's issue, Mr. Bridge wrote of the research being carried on by the Bell Telephone System and the improvements which have grown out of that.

The Bell System is not supposed to act that way. It is a monopoly. By all the rules monopolies should be sitting in their chairs getting fat. A monopoly has control of the supply of a goods or service and those who want it must come to the monopoly and pay the monopoly's price. Why strive?

But what does the Bell System do? Constantly, it is trying to see how things could be made better and cheaper, how the telephone can be made more efficient and better looking and how one wire can carry more messages.

Some ten years ago we hired a telephone. In those ten years everything has gone up in price. But until recently that telephone cost us just the same as in 1939. Then a few cents were added to the monthly bill. If we wish to call long distance the toll is actually less than in 1939.

That is a queer way for a monopoly to act.

That is not the end of this unorthodox conduct by the Bell System. By all rules it should be around gobbling up all independent telephone companies. But there are some thousands of them in the country. The Bell System should be, according to our best monopoly chasers, sitting up nights plotting ways for the undoing of these independent companies.

Well, it happens that we also rent a phone from one of these small companies. In the dozen years since we had that phone, the charge has not been raised at all. The old hand-cranked instrument has been replaced by a handset. The manager of the company says he will soon have automatic dial operation. Of course he could not have done any of those things if it had not been for research by the Bell System.

We think that there ought to be anti-monopoly laws and we think that they are a restraining influence in the right place. If the need for their strengthening can be shown we would be for that too.

But we think that the best safeguard against monopoly is that Americans are not monopoly minded. They still compete when there is nothing to compete with.



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# Golden Anniversary for Mary A. Douglas

Mary A. Douglas

Rounding out a half century of Bell System service, "Maimie" Douglas, in her own words, "always enjoyed coming to work and always got along well here." Recommended by a neighbor after graduating from P. S. 3 on Hudson Street, she came to work at the Western Electric Company, 57 Bethune Street, just fifty years ago. She had only one interview—with the shop superintendent; there was no medical examination.

The little girl from the neighborhood found that she enjoyed the rhythm of the machines, the intricacies of winding coils and the satisfaction of work well done, so she stayed for fifty years. The hours in those early days were from 7:30 a.m. to 5:15 p.m., with three-quarters of an hour for lunch. There were other definite requirements—a girl had to wear a hat entering the building and she did not work in her street clothes. To this day Miss Douglas changes into a housedress before starting her day's work. She was assigned to the eighth floor along with several hundred other girls. There was a freight elevator, but no one, least of all "Maimie," thought of using it. They all walked—up as well as down—and thought nothing of it.

*When Mary Douglas came to work for Western Electric fifty years ago the building was comprised of Sections B and C. She was hired in a small office in the courtyard, shown below*

After a month's training, Miss Douglas acquired sufficient skill to be assigned regularly to winding coils. Her standard rate was $4.25 a week but her nimble fingers often wound enough coils to more than double that amount. She recalls with pride the first time she earned $10 in a single week. Western Electric used to pay amounts of that size in gold. The appearance of a shiny gold piece in a pay envelope—seen by all—was the mark of a good worker.

Though the forelady frowned on it, the girls used to sing as they sat facing each other in pairs at their benches, and often their voices drowned the hum of overhead belts and motors. Then as now, Miss Douglas brought her lunch and she usually supplemented it with a can of soup or beans warmed on a gas plate at her bench. A grocer from Washington Street, opposite the building, came through to take orders for sandwiches, and bakery boys from a French shop at Jane and Hudson Streets paraded through swinging baskets of cakes, cookies and pies.

The day's work done, Miss Douglas and her friends found their social life revolved for the most part around the church, where they enjoyed dances, euchre parties, and, particularly, the fairs. Each church in the village had an annual fair and, regardless of creed, everyone went. Miss Douglas used to work in fair booths at St. Joseph's, on Sixth Avenue, the church to which she has always belonged.



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She was born in the Village, the third and only surviving daughter of John and Mary Gallagher Douglas, who had emigrated from Ireland and established their home close by the place they stepped off the boat. Her father died while she was just a tot and her mother soon after.

Throughout her life Miss Douglas has lived in only three houses, all of which are within walking distance of her work. Every morning for fifty years, she has passed the church on her way to work and she has never missed morning Mass.

But that isn't her only record; she has never had an accident in fifty years of work; she wound coils for thirty-eight years before she used glasses—and then only on work of the finest nature; and she was not absent in forty consecutive years.

In the early days a six-day week was standard and vacations with pay came only some years after she joined the company. In summer she would stay up half of Saturday night loading picnic baskets for a Sunday sail up the Sound or to Rockaway. She also went to the theater frequently. Transportation was plentiful; there were horse cars on West, Washington, and Greenwich Streets, as well as a crosstown car from 14th Street through Abingdon Square, across Bleecker Street to the East Side.

Nowadays Miss Douglas enjoys reading, doing a bit of crocheting, or listening to a few select radio programs. Her main interest, however, is people, and she has a wide circle of friends and acquaintances. Some of her closest friends have been with the company nearly as many years as she has; some have retired but she sees them regularly, not only at Pioneer meetings, but also at frequent visits to each other's homes.

Miss Douglas' life has been a full one. In addition to her work, which means so much to her, and her many friends, she has been "grandmother" to her nieces' and nephews' children. On festive occasions, like Thanksgiving and Easter, her family gathers in her Barrow Street home for her famous holiday dinners. She loves to cook and her family and friends love her cooking.

Miss Douglas works at a very special winding machine. Just about a year ago, she was out on a brief sick leave. In celebration of her return, her friends painted her machine gold! Miss Douglas will reach retirement age in January. She says it will be quite a change for her but during the ensuing years she plans to visit her friends at Bell Telephone Laboratories often.

## News Notes

**Tom K. Smith**, Chairman of the Board of The Boatmen's National Bank of St. Louis, and a Director of the A T & T, visited the Laboratories on August 16. **Dr. Buckley** escorted him on his tour.

**Harvey Fletcher** sailed for Europe on the *Queen Mary* on July 7 and returned on the same ship August 25. Mrs. Fletcher and their son, Harvey, accompanied him. Another son, Paul C., who had been in the British Isles for two years, returned home with them. They visited England, Italy, Switzerland and France. Dr. Fletcher attended the Fourth International Congress on Otolaryngology in London, and at the audiology meeting presented a paper, *A Method of Calculating Hearing Loss for Speech From an Audiogram*. Dr. Fletcher will receive the Society of Motion Picture Engineers' Progress Medal Award, which will be presented October 12 in Hollywood.

*Sections A and D of 463 West Street were nearing completion shortly after the time Mary Douglas joined the Bell System*

**W. E. Campbell** and **K. G. Compton** conferred at the Koppers Research Laboratories in Pittsburgh on fractionation and analysis of creosote.



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## Lighting at Murray Hill

*The main Apparatus Drafting Room, recently completed at Murray Hill, provides notable convenience and facility for the draftsmen. The readily adjustable drawing tables, improved chairs and reference tables (described in the* Record *for November, 1944, page 603) supply ideal drafting conditions under a combination of fluorescent and incandescent lighting which markedly eliminates shadows*

*Every drafting room scene contains its usual quota of immediate board discussions and this foursome, left to right, H. Anderson, J. C. Hoffmann, P. A. Shaw and M. C. Nielson, typically settles a detail. After photographing the main room, left, S. O. Jorgensen, staff photographer, snapped this one*

## Doll and Toy Committee Opens Campaign

Christmas in October may seem far fetched, but actually Christmas is uppermost in the minds of the Doll and Toy Committee who are now preparing to fill the stockings of hundreds of children in orphanages, boarding homes and hospitals.

The photograph directly below shows Muriel Walter of the Doll and Toy Committee during the 1948 Christmas distribution of toys at St. Vincent's Hospital. For 1949, Fay Hoffman is chairman at West Street; Mollie Radtke, Graybar; Wilma Cadmus, Davis; Marjorie Broderick, 14th Street; Muriel Rafter, Murray Hill; Gertrude Rooney, Whippany; Laura Fenimore, Deal; and Helen Conklin, Holmdel.

## Bowling Leagues

The membership on the various executive committees of the Bell Laboratories Club bowling leagues is as follows:

*New York–Men:* Murray E. Brandin, general chairman, and W. J. Seeger, Jr., general secretary-treasurer. Group A–A. T. Calvano, chairman, and H. J. Keefer, secretary-treasurer; Group B–C. G. Schenck and M. J. Wean; and Group C–H. R. Vail and J. W. Johnson.

*New York–Women:* Muriel Walter, general chairman; Virginia Merrill, secretary; and Gloria Carstensen, treasurer.



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*Murray Hill—Men:* John H. Golden, general chairman, and H. W. Nelson, general secretary-treasurer. Group A—J. P. Schweitzer, chairman, and G. W. Galbavy, secretary-treasurer; Group B—W. C. Michal and R. S. Boughrum; and Group C—F. J. Schnettler and W. J. Carroll.

*Whippany—Men:* F. W. Steele, general chairman; C. F. Phelps, secretary-treasurer of Group A; and H. F. Gartner of Group B.

## Unique Scaffolding

Some months ago it was noticed that the concrete encasing the steel beams supporting the bridge from 11-H Auditorium to 10B roof at West Street was developing cracks. Closer examination from a swinging scaffold showed that the concrete was disintegrating as the cement had not bonded well to the gravel due to a salt condition. This may have been caused by the gravel taken from salt water not having been washed thoroughly or to the addition of excess salt to the concrete mix to prevent it from freezing when it was placed.

*Lunch hour at West Street, with Ruth Cooper of the Restaurant serving Lenora De Vita, while Rita Tornvall, Rosemary Lagas, Dorothy Delaney and Cecelia Boland await their turn*

The swinging scaffold was not adequate for economical completion of the work, so a rigid scaffold was constructed. Six wooden "U" sections were made on Basement B roof, located eight stories below, hoisted to the bridge and bolted to beams laid across the bridge. Planking was then laid on the "U" pieces and guard rails fastened to the sides. The scaffold was enclosed with wire mesh to prevent pieces of concrete from falling. The concrete was removed from the sides and bottoms of the steel beams of the bridge. After installing wire mesh about the beams, new concrete was poured, restoring the protective coating.

*To make repairs to the bridge from 11-H to 10B roof, six U sections of this scaffold were fabricated on Basement B roof, hoisted into position, and bolted to cross beams on the bridge. Planking was then laid on the bottom rails and guard rails and wire mesh installed on the sides*

*The Technical Information Center at Whippany is built around a collection of reference books, magazines, catalogs, and instruction bulletins. Elizabeth Watrous, in charge of the Center, is talking to H. A. Helm. Seated in the foreground is J. S. Parsons with R. W. Blackmore at the right*



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# RETIREMENTS

Recent retirements from the Laboratories include F. F. Lucas, with 47 years of service; J. B. Draper, 43 years; E. L. Vibbard, 38 years; C. S. Rhoads, 30 years; W. T. Breckenridge, 29 years; Herbert Maude, 28 years; and H. C. Rusher, 6 years.

### Francis F. Lucas

Frank Lucas began his career as a groundman in the Hudson River Telephone Company and rose to be a district wire chief. Later he joined the Engineering Department of the Southern Bell Telephone Company, and finally the Western Electric Company. While superintending the buying of timber for that company, he purchased a microscope with which he began to experiment in his own kitchen in order to acquaint himself more thoroughly with the product he was buying.

F. F. Lucas

C. S. Rhoads

This laboratory was the forerunner of that in Section 6-H at West Street, whose photomicroscopic equipment, in many cases developed by Dr. Lucas himself, has done outstanding work in metallography and biology.

At the outset of his work, Dr. Lucas found the limit of magnification generally accepted at 1,500 diameters. He has successively increased it, first to 3,500, then to 5,000, and most recently to about 6,000, in coöperation with the scientific staff of the Zeiss works at Jena, Germany. One of his achievements has been the evolution of techniques which make practicable the use of ultra-violet light in high-power photomicroscopy. His development of "optical sectioning" has made it possible for him to produce complete plan views of organic cells and metallic crystal agglomerations. For these achievements he has received two medals from the Royal Photographic Society of Great Britain, the Henry Marion Howe Medal of the American Society for Metals, and the John Price Wetherill Medal of the Franklin Institute. In 1931, Lehigh University awarded him the honorary degree of Sc.D. His Howe Memorial Lecture before the A.I.M.M.E. in 1931 was "The Art of Metallography."

From time to time Dr. Lucas has been called into consultation by various Government agencies. During World War II he investigated for the Navy the microstructure of paint films for ships' hulls, and for the Public Health Service he made a motion picture film on the life cycle of the syphilis spirochaete.

Dr. Lucas is a member of the American Chemical Society, the Franklin Institute, the A.S.T.M., the A.I.M.M.E., and the American Society for Metals; he was the A.S.M.'s delegate to the World Engineering Congress in Tokio in 1929. He is a fellow of the A.A.A.S.

A well-equipped laboratory of his own, in which he has made contributions to medicine and biology, will afford Dr. Lucas an opportunity to work on cancer research during his retirement.

### Charles Stanley Rhoads

In and out of the Bell System, Stanley Rhoads' career has had plenty of variety. After two years at Purdue, he entered the Central Union Telephone Company in 1905, soon becoming wire chief at Indianapolis. For the next fourteen years he worked for makers and users of railway communication equipment, finished his studies at Purdue, and for a time was a member of the Laboratories. "Panel" was being introduced in New York City when he rejoined the Bell System in 1922, and after taking the Telephone Company's training course, he was assigned to reorganize the course and head it for a time. After serving as wire chief of two New York dial offices, he advanced through various Plant jobs, including a division plant superintendency, until he was methods and results man on the staff of the chief engineer of the Upstate Area.

In February, 1944, Mr. Rhoads transferred to the Laboratories to work on "TM 11-486," the manual on telephone engineering, which was so useful to the Armed Forces. After some months as an expert consultant on communication systems at the Army War College, he joined our Patent Department to handle relations with outside inventors. He is something of an inventor himself, having his own name on twenty patents.

On retirement Mr. Rhoads joined the Navy's Special Devices laboratory at Sands Point, Long Island, where he is the technical director of some 450 civilian employees. This organization develops training aids, such as the



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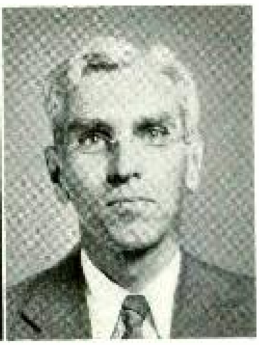
PBM-3 trainer, which the Laboratories developed under contract from Special Devices during the war. He will continue to reside in Yonkers and follow his two hobbies—golf and painting—as opportunity offers.

### Edward L. Vibbard

Some thirteen years of telephone plant work was Edward Vibbard's background when he came to the Laboratories in 1919. He had started with the connecting company in Johnstown, New York, and had worked for the Pacific, New York, and C. & P. Companies. His first job here was on the early 22-type repeater circuits; in 1921 he went into panel circuit analysis in the laboratory and in 1925 was put in charge of a group. In the next few years they tested the automatic distribution call indicator, the call distribution B board and the sender tandem system.

Nineteen twenty-nine brought Mr. Vibbard a change to circuit design, at first on panel, later on crossbar; he specialized on routine test circuits. During the war he designed test circuits for the M9 gun director, then shifted to computers, working on the relay interpolator, a ballistic computer for Fort Bliss, and one for the Naval Research Laboratory, and general purpose computers for Langley Field and Aberdeen. Since then his work has been on accounting center circuits for AMA and on a central office translator circuit.

Mr. and Mrs. Vibbard have bought a trailer, with which they expect to spend the coming



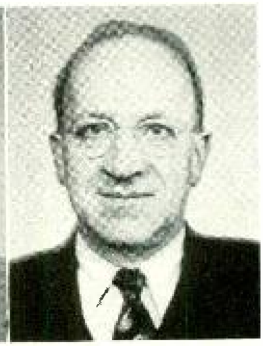
E. L. Vibbard — W. T. Breckenridge

winter in the Southwest; then next year migrate northward. Some time they may buy a house and settle down, but they expect their wanderlust to continue for a couple of years at least.

### Wilbur T. Breckenridge

The telephone runs in Wilbur Breckenridge's family; his father and his uncle started their careers with the Providence Telephone Company in the early eighties. After graduating from Brown (B.S. 1915), Mr. Breckenridge took a General Electric student course, then was for two years with Bethlehem Steel. Entering Western Electric's Inspection Department in 1919, he was for two years a resident inspector and then came to New York.

Transferring to the A T & T in 1923, Mr. Breckenridge participated in a number of important power-plant developments. One was the change-over from the specially built



J. B. Draper — H. C. Rusher

d.c. generator to the use of commercial-type generators with filters. Another was the development of automatic voltage regulators for d.c. machines and of the earliest fully automatic power plants. He came to the Laboratories in 1934 and soon was given charge of the Power Laboratory and of preparation of Bell System Practices on power plants. In the latter work he came into contact with many kinds of plants for local, toll and repeater offices as well as the J, K, and L carrier stations and the radio relay stations.

### John B. Draper

Entering the New York Telephone Company as a substation inspector in 1905, Jack Draper was later assigned to the Cortlandt Office, then several other Manhattan offices, and finally was assigned to equipment engineering. Transferring to the Laboratories in 1918, he worked on the development of a start-stop signaling system between Philadelphia and New York, and later worked on the development of terminal circuits for the first radio link to Catalina Island. After some years in manual current engineering, Mr. Draper, in 1928, joined the PBX group, where he worked on the design of both manual and dial PBX circuits. More recently he has been engaged in the design of circuits for step by step central offices as well as in the adaptation of community dial offices obtained from outside manufacturers for use in the Bell System.

On retirement Mr. Draper will pursue his avocation of selling automobiles in his home town of Rockville Center.



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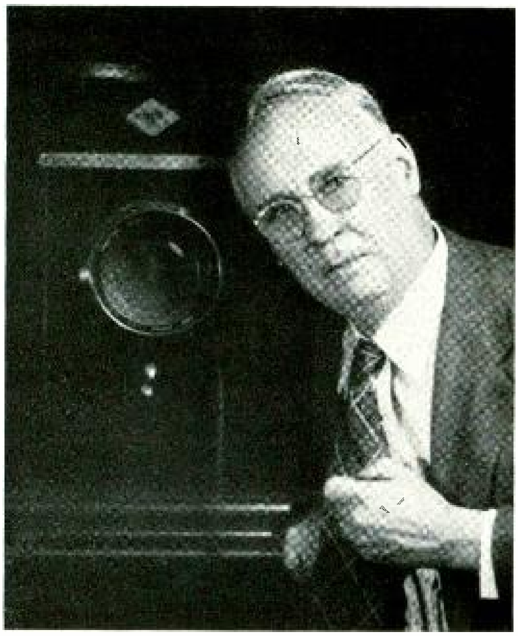
## H. C. Rusher

When Howard Rusher got his journeyman's ticket back in 1903, it was customary for a young machinist to "hit the road." So the next nine years saw him in some thirty-odd toolrooms. Then he married and settled down as toolroom foreman for an adding machine company.

He came to the Laboratories at Murray Hill in 1942 as an instrument and tool maker on military work. In February last, with the transfer of the last of these projects to Whippany, Mr. Rusher went into a branch shop which serves the Chemical Laboratories.



*Herbert Maude—self portrait*

## Herbert Maude

After spending his boyhood in England, Herbert Maude knocked about for a while, practicing his trade of photography. His first visit to the United States was in 1906; he came here to live in 1912, and was the official photographer at Cornell for three years, then a laboratory man with a movie company in Texas for a year. In 1920 he joined the Laboratories as a photographer, and has watched (and helped!) the Laboratories' negative file grow to nearly a hundred and seventy-five thousand. He has seen flash bulbs replace magnesium powder, emulsion speeds quadrupled. Personally, he has contributed a camera for taking magnified views of very small objects. He also contributed to the adaptation of a hydraulic lift device in an adjustable table which is now in use in the Photograph Department.

An artist at heart, Mr. Maude has taken up painting because that medium aids an imaginative composition. There is close control of color and emphasis and perspective, and the painter can readily select and add those things that help with his story. In retirement Mr. Maude hopes to live in the New England hills, whose rich pictorial material allures him.

# News Notes

K. K. Darrow visited the University of California at Berkeley, Stanford University, the California Institute of Technology, the University of Washington at Seattle, and Shell Development Laboratory at Emeryville, California. He spoke on *Electricity in Metals* before staff members of The Pacific Telephone and Telegraph Company at San Francisco, and before the Shell Development Laboratory staff at Emeryville.

D. A. McLean, H. G. Wehe, J. R. Weeks, A. J. Christopher and R. K. Evenson were in Chicago in connection with the manufacture of metallized paper capacitors.

W. Babington visited Hawthorne to discuss die castings.

R. A. Chegwidden and V. E. Legg went to the Western Electric Plant at Haverhill to discuss problems related to magnetic materials.

G. R. Gohn conferred on creep and fatigue testing at the Canada Bureau of Mines, Ottawa, and the Aluminum Laboratories, Ltd., Kingston, Ontario.

M. W. Baldwin, Jr., and W. T. Wintringham recently conducted a three-day test on the effect of carrier synchronization in television broadcasting. The tests took place in the RCA Laboratories in Princeton, N. J., under the auspices of the Joint Technical Advisory Committee.

A. G. Jensen is a member of a recently formed RMA committee on color television. This committee has been preparing technical data to present to the FCC at the forthcoming hearing on television allocations.

R. E. Poole visited the Sandia Laboratory in Albuquerque in August with George Landry of the Western Electric Company.

Problems relating to the No. 5 crossbar system were discussed at various locations by W. Buhler, E. L. Erwin, K. M. Fetzer, J. E. Greene, H. W. Hermance, R. E. Hersey, G. A. Hurst, H. J. Keefer, C. F. Knepper,



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C. S. Knowlton, H. T. Langabeer, F. K. Low, C. W. Mattson, W. I. McCullagh, O. J. Morzenti, J. A. Potter, L. J. Purgett, W. H. Scheer, D. H. Smith, W. O. Wagenseil, W. Whitney and L. A. Yost.

V. E. Legg, F. F. Siebert and B. E. Stevens discussed transformer core material applications with General Electric engineers and observed manufacturing practices at their plant in Pittsfield, Massachusetts.

C. A. Brigham conferred at the Power Equipment Company, Detroit, on power coils for a regulated metallic rectifier.

C. V. Taplin visited the Illinois Bell Telephone Company to discuss maintenance problems in No. 1 crossbar system.

W. A. Shewhart, J. E. Karlin and C. E. Brooks in Detroit participated in conferences with the Michigan Bell people on the effect of numbering plan changes on customer dialing performance and methods of obtaining and using service observing data.

F. W. Anderson visited Allentown on problems relating to power rectifiers.

J. W. Bell is at Kansas City in connection with first crossbar tandem job in that city.

W. F. Malone and E. M. Smith visited the Madison, Decatur and Clearbrook No. 1 crossbar offices at Lansdowne, Pa., in connection with automatic message accounting equipment.

D. H. Wetherell at Hawthorne discussed with Western Electric Company engineers studies concerning the replacement of panel translator senders with decoder senders in the New York area.

W. W. Brown visited Hawthorne regarding operators' chairs and relay rack unit designs.

W. J. Kopp, with A. M. Dowling of A T & T, studied transmission design problems in Chicago relating to toll connecting trunks.

F. W. Amberg and Esther Rentrop are conducting tests of open-wire crosstalk on a line near Petoskey, Michigan.

M. A. Weaver, B. C. Griffith and R. S. Tucker assisted the Illinois Bell Telephone Company in Chicago on crosstalk problems.

E. F. Watson, W. Y. Lang and W. F. Vieth attended conferences with the Teletype Corporation in Chicago.

U. S. Berger visited the Philadelphia office of The Bell Telephone Company of Pennsylvania on the microwave system.

J. R. Townsend, B. S. Biggs, G. N. Vacca and C. V. Lundberg visited Point Breeze to discuss rubber insulation.




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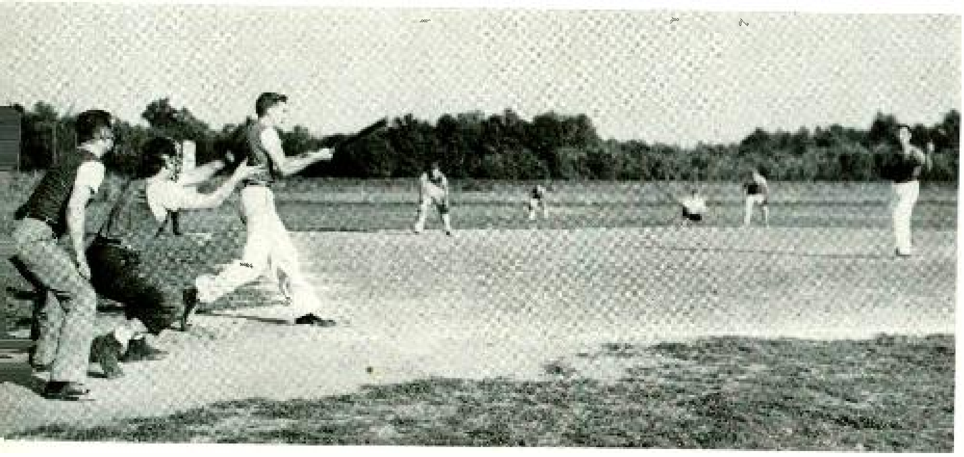

*The "All-Star" Softball Team, composed of players chosen by ballot by the softball fans of Whippany, distinguished themselves on August 24 by holding the "Regular" Laboratories' team, which plays in the Morristown Softball League, to a ten-inning 3-3 tie in an after-hours contest*

W. A. PHELPS, T. A. JONES and R. H. RICKER were in Washington and Annapolis in connection with field tests of improvements which have been developed for radio-telegraph systems of the U. S. Navy.

H. H. NAGEL of the New York Area Staff Department has completed his work for a B.S. in E.E. degree from the Newark College of Engineering, and will receive the degree at commencement next June.

P. R. BROOKMAN of the Plant Engineering Department has received a B.E.E. degree from the Polytechnic Institute of Brooklyn.

W. S. BALLANTYNE of the Military Electronics Department has received a B.S. in E.E. degree from the Newark College of Engineering.

W. H. C. HIGGINS and J. F. KEARNS, with A. W. Duffield, C. E. Budd and G. R. Wirth of Western Electric, and W. R. Bylund of the New York Ordnance, went to Washington recently to discuss various ordnance problems with Dr. W. Jorgansen, Colonel R. C. Crane and Major E. A. Lynn.

A. J. AIKENS, R. M. HAWEKOTTE and A. E. VALL conducted tests of atmospheric static voltages on an open-wire line near Thomasville, Georgia.

## This Month's Ad

In the facing advertisement, W. C. Sturzenegger of Outside Plant's Chester laboratory exercises an ear of incredible sensitivity as he detects "trouble" in a special cable which terminates just beyond the edges of the picture. To meet the photographic requirements of the advertisement, Mr. Sturzenegger had the pole and cable specially set up and then posed while S. O. Jorgensen, poised on a truck, snapped the shutter. The belt-mounted amplifier will be featured in a forthcoming article in the RECORD by J. B. Hays.

AN ARTICLE in a series on career women in the Summit, New Jersey, area featured PHYLLIS TAYLOR of Murray Hill Personnel, in the August 18 issue of the *Summit Herald*.

## October Service Anniversaries of Members of the Laboratories

**40 *years***
D. D. Miller
M. P. Sherwood

**35 *years***
R. C. Fisher
N. Y. Priessman

**30 *years***
G. W. Ames
G. B. Baker
W. H. Berthold
Walter Connick
J. W. Dehn
Frank Gray
Elith Hansen
G. T. Morris
E. B. Payne
J. M. Peabody
R. P. L. Piltan
D. A. Quarles
P. C. Smith
C. R. Taft
C. C. Taylor
J. R. Townsend
Louise Van Bergen

**25 *years***
A. D. Benning
G. F. Doppel
J. F. Hargreaves
R. J. Lewis
Ann Reilly
George Sawyer
J. H. Shepard, Jr.
M. T. Slacum
H. V. Wadlow

**20 *years***
H. D. Breiner
C. E. Clutts
C. J. Custer
L. K. Degen
Margaret Denio
C. M. Hill
T. S. Huxham
H. C. Jonas
John Kalbskopf
Thomas Keegan
A. O. Koestle
C. C. Lawson
Nicholas Lazo
B. B. Mann
James McGovern
Michael McMahon
H. J. Michael
J. E. Reade
L. R. Schreiner
H. L. Thal

**15 *years***
Thomas Bateman
J. F. Brennan
H. E. Kern
Christine Scanlan
M. V. Sullivan

**10 *years***
A. E. Anderson
Ewald Bausch
Richard Cook
D. R. Frantz
A. S. May
Madalyn Motto
R. E. Prescott
Mary Spina



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