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A Message *from* President Leroy A. Wilson *to the* Members *of the* Laboratories

Telephone service begins with technology and continuously through the years it has been the widening of technical horizons that has made possible the expansion and improvement of the service. The greater the range and usefulness of the service, the more extensive and intricate our technical knowledge and physical equipment have first had to be. But I would emphasize that although technology must come before the service, the service *idea* comes before the technology. The great success of the Bell Telephone Laboratories in advancing the art of telephony has come out of the continuous underlying motive of providing telephone service—more service, more dependable and steadily improving service, and new services which make possible the communication of intelligence in more and more ways. The service motive has always been the foundation of everything we do and I am sure that this will continue to be the foundation of your success in the future.

As we approach the mid-point of the Twentieth Century it is interesting to look back and see how telephone science and telephone service have advanced hand in hand in the years since the century began. To recall just a few of many outstanding developments within this period, we may think of the telephone repeater and the establishment of transcontinental service; the advance in radiotelephony and the creation of world-wide overseas service; the inauguration and development of fast, accurate dial service, with more than 70 per cent of all Bell telephones now on a dial basis; and the origination and extension of carrier telephony, making possible the economical handling of vast numbers of toll and long distance calls.

Coming down to more recent years, technical developments of the greatest significance have continued to make possible steady advances in service and to discover new horizons for the future. New toll switching systems have opened up the field for long distance dialing, both by operators and by telephone users, and direct nationwide dialing in the years ahead will help to revolutionize our conception of how good telephone service can be. Broad band radio relay and coaxial systems, already carrying television images as well as telephone conversations, provide the means for transmitting intelligence on an entirely new scale. Automatic message accounting makes a tremendous contribution to service both in the direct dialing of telephone connections and on the accounting side. New instruments, new materials in outside plant, new tools for construction and maintenance—all are aimed at, and all are contributing successfully to, the thing we are all here for, by which I mean the rendering of the best and most economical telephone service to the American people that it is possible for us to provide.

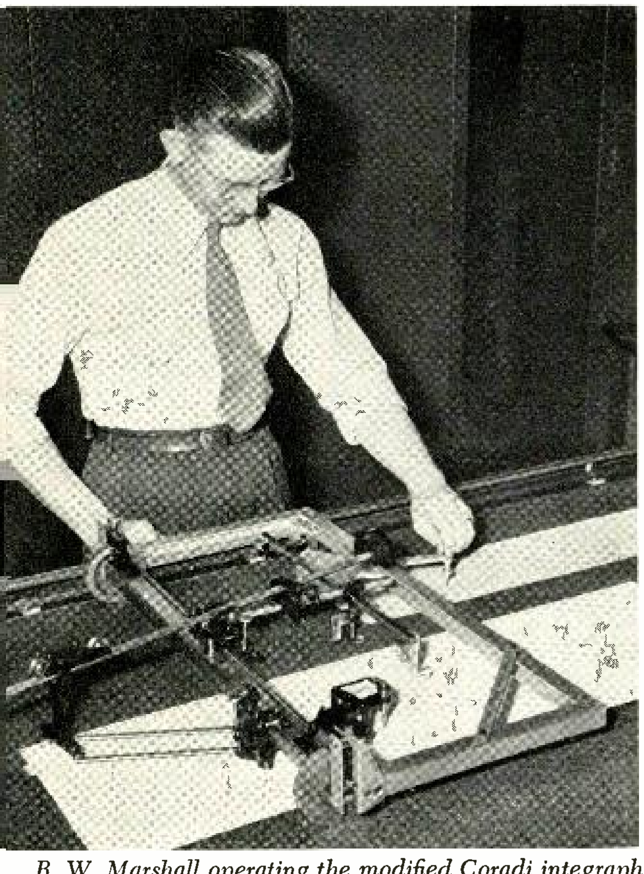
You and your predecessors at Bell Telephone Laboratories have done so much in the years behind us that it is impossible not to foresee great progress in the years ahead. The needs and opportunities are very large—not only in the long-term future, but also in the years immediately before us. I am confident that telephone science, animated as it always has been by the service idea, will continue to enable us to make telephone communication always better, more extensive and more valuable tomorrow than it is today. And I am confident also that in Bell Telephone Laboratories we shall continue to have the people, the skills, the organization and above all the inspiration to accomplish that end.

This message was read by Dr. Buckley to a conference of the supervisory staff as part of his annual review of the Laboratories' operations on January 5.

An integraph for semi-curvilinear coordinate paper

R. W. MARSHALL
Transmission Development

In studies of television transmission over coaxial cable, it was necessary some time ago to determine phase distortion by integrating curves representing envelope delay as a function of frequency. What was desired was a second curve that would be proportional to the integral of the original curve. There are a number of devices available for determining the integral of curves, and one of them—the Coradi integraph—actually draws the integral curve with considerable accuracy, and thus would be exactly what was wanted. Like all mechanical integraphs, however, it determines the integral by measuring the area under the curve, which is proportional to the integral when the original curve is on a chart with straight perpendicular coordinates, and when the ordinate and abscissa scales are linear.



R. W. Marshall operating the modified Coradi integraph to determine phase distortion.

The curves of envelope delay against frequency, however, are drawn with a graphic instrument, and as with many graphic instruments for portable applications, the pen is on an arm corresponding to the pointer of an indicating meter. Instead of moving perpendicularly across the chart, it moves along an arc of a circle, giving a chart of the general type shown in Figure 1. With such a chart, the perpendicularity of the axes is not retained and the deflections are linear along the arc rather than along a line perpendicular to the longitudinal axis of the chart. The magnitude of the deflection is thus $R\Theta$ where Θ is the angle of deflection of the meter pen and R is the length of the pen arm. The ordinate y on a perpendicular axis is thus $y = R \sin \Theta$. As a result, the horizontal rulings on the chart are more closely spaced at the edges of the chart than at the center. The vertical distance between the lines marked 80 and 100, for example, is less than that between those marked 0 and 20.

If the lengths of the arcs over which the recording pen travels were used for a replotted curve with ordinates perpendicular to the axis of the chart, the area under the replotted curve would be proportional to the integral. Thus, the integral curve drawn by the Coradi integraph from such a replotted curve would be propor-

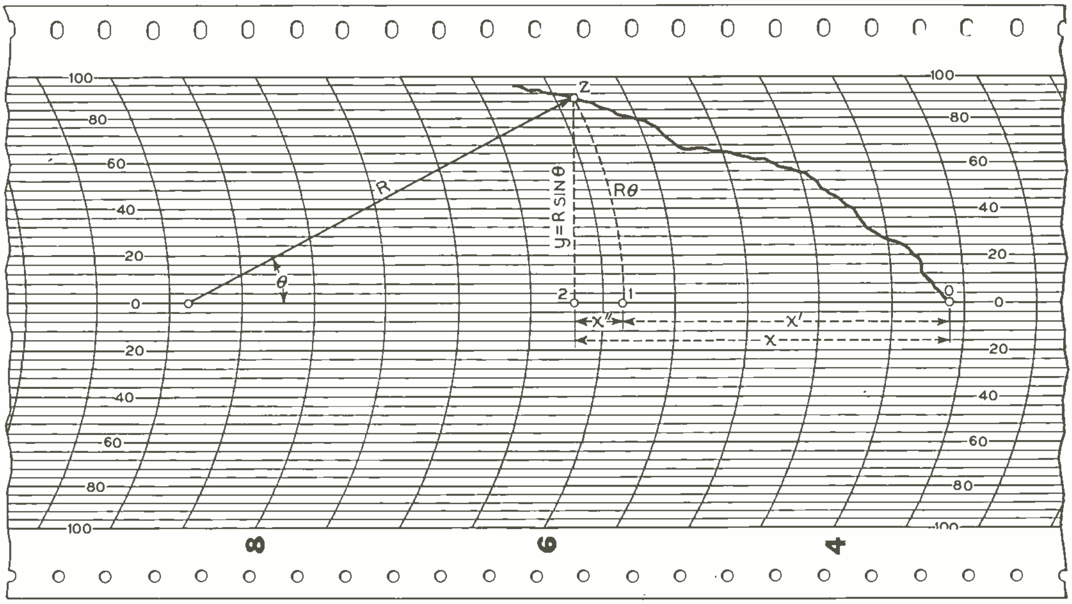


Fig. 1—A section of chart paper used for recording envelope delay against frequency.

tional to the true integral of the curve.

The Coradi integraph is shown in Figure 2. It is supported by two wheels, A and B on a fixed shaft, and by a caster wheel C. The chart carrying the curve to be integrated and a chart on which the integral curve is to be drawn are laid parallel to each other on a table, with the wheels A and B spanning, and rolling parallel to the charts. Guided by the hand, the tracing point D is made to follow the curve to be integrated; as it does so, an inking pen E draws the integral curve. The arm Q carrying the tracing point is rigidly attached at right angles to arm F, and before starting an integration, the integraph and the charts are set so that when the tracing point is on the zero axis of the chart, arm F is directly opposite the pivot support G. Consequently, the distance of F one way or the other from G is always equal to the y ordinate of the curve to be integrated. It is the transverse motion of arms F and Q and their longitudinal motion as wheels A and B roll along the length of the chart that causes pen E to draw the integral

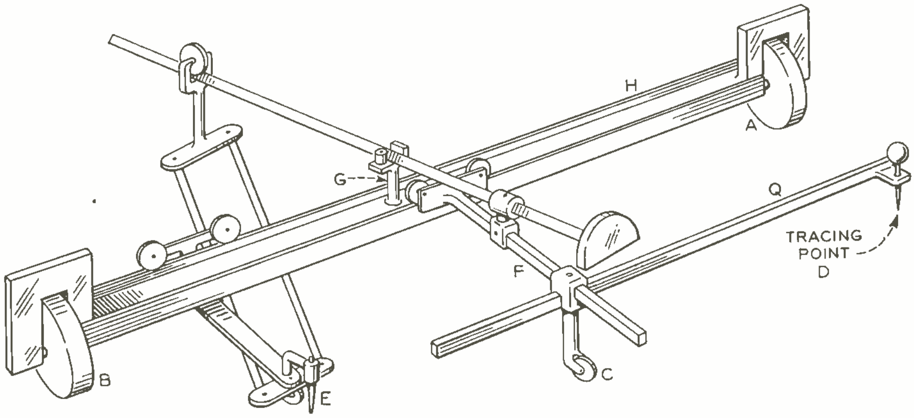


Fig. 2 – Simplified sketch of the Coradi integraph.

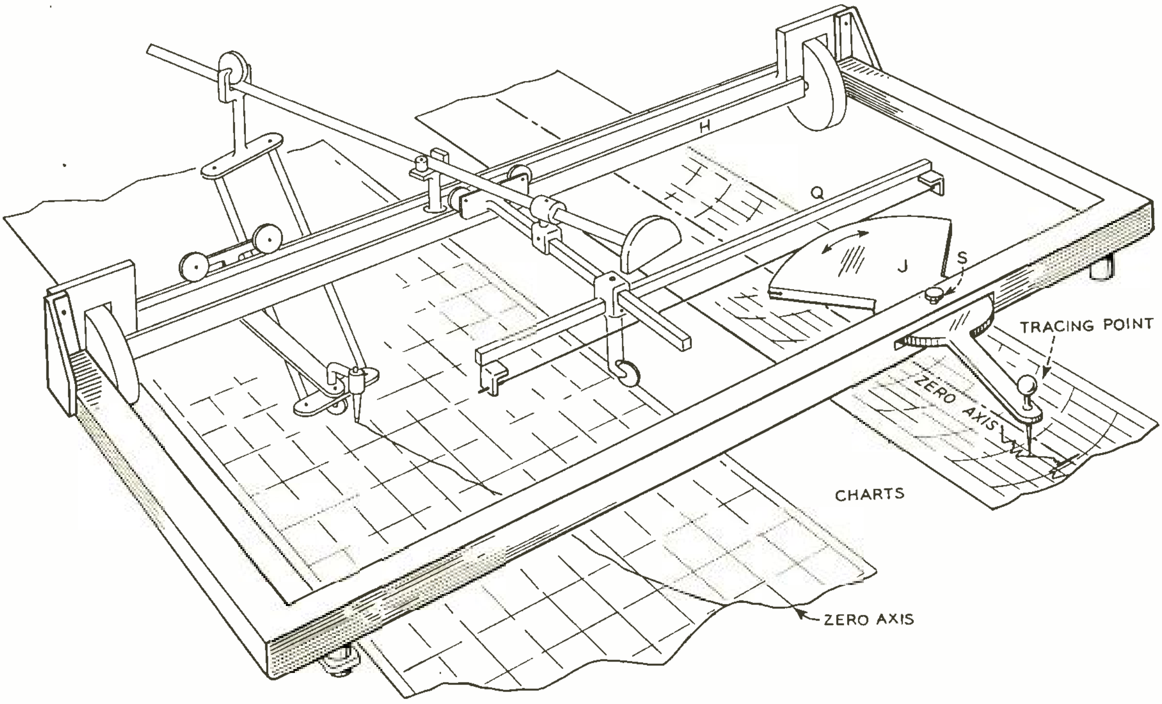


Fig. 3—The Coradi integraph with an attachment that enables it to integrate curves on charts.

curve shown in Figure 1. This integraph, used with a curve replotted as described in the previous paragraphs, would give a true integral curve. To avoid the labor and time of replotting the curve and then integrating it, however, an attachment was designed for the Coradi integraph that would, in effect, replot the curve and accomplish the integration at the same time. This attachment is shown in Figure 3.

It consists of a rectangular U-shaped bracket attached to frame H of the integraph, and carries rollers under its outer corners for support, and an arm J pivoted to the bracket at S as shown. At its outer end, this latter arm carries the tracing point that was originally attached to arm Q of the integraph, and at its inner end is a sector of a circle centered at S. The radius of this sector, and the distance of the tracing point from S, are both equal to R—the length of the pen arm on the graphic meter. Wires attached to each side of

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THE AUTHOR: R. W. MARSHALL received the Bachelor of Electrical Engineering degree from the University of Minnesota in 1934. Attending Columbia University on an A.I.E.E. Scholarship, he obtained the M.S. degree in 1935. He remained on the faculty at Columbia until joining the Laboratories in 1936. Prior to his war work on radar test equipment, principally echo box test sets, he had participated in various phases of carrier systems development. He is now engaged in over-all system studies on the coaxial cable L-1 carrier development. He is a member of the I.R.E.

S. W. ALLISON
Switching Development

Combined key set for d-c and multifrequency key pulsing

Key pulsing* by direct current was developed about twenty years ago to permit operators at switchboards to send pulses to a local office more rapidly than was possible with dials. A ten button key set is employed, and the operator merely presses one button after the other for each digit of the number wanted. The pulses from the key set, which are not suitable for actuating the dial equipment, go only to a sender in the same office as the key set; the sender transmits pulses of the desired type—such as revertive or dial pulse—to the called office.

More recently, to meet the needs of nationwide dialing, for which operators may dial over long toll lines, the multifrequency pulsing system† was developed. With this system, the key set sends out two frequencies simultaneously for each digit, and since the frequencies are in the voice range, they will pass over any circuit that will carry speech. Many of the switchboards where multifrequency key pulsing will be used, however, already have d-c key pulsing to reach offices in their local area. To change to multifrequency key pulsing exclusively would not be economical because many of the local offices are not equipped to receive multifrequency pulsing, and the changes needed would be extensive. On the other hand, it would be undesirable to have two key sets at the switchboard positions and to make the operators determine which to use on each call. Instead, therefore, circuits have been developed to permit the same key set to be used with both types of pulsing. The operator merely plugs into the desired trunk and proceeds in the usual manner to key the number. The circuit will recognize from conditions found on the trunk whether d-c or multifrequency pulsing is required and will send out the proper type of pulses as the operator pushes the buttons of her key set. The operator need not, and generally will not, know what type of pulses are being sent out; her operations are similar for both types.

The situation is complicated by the fact that key sets are used on many types of switchboards, and that they must be used with many different types of trunks. To permit the key set circuit to recognize when it must send out d-c pulses and when multifrequency pulses, there must be a distinguishing condition, or "mark" on the trunk circuits requiring the two types of pulses. Not only do the mark conditions found on d-c and multifrequency trunks differ for different types of trunks, but sometimes there are no differences, and modifications in the circuit have to be made. As a result of this situation, a single key pulsing circuit cannot be used; a number of different circuits have had to be developed to meet the conditions found at the different boards. In their general principles, however, the circuits are similar, and that used for the No. 3-type toll board, which is widely used for both toll and DSA positions, well illustrates the general method of attack.

On all multifrequency pulsing trunks at this board, ground is found on the ring conductors, and remains there while the trunk is in use. On all d-c key pulsing trunks, on the other hand, ground is found on the ring conductor when the KP key is operated, but shortly thereafter a relay operates and removes the ground and connects battery. At the same time it connects

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*Record, *November,* 1943, *page* 110.
†Record, *December,* 1945, *page* 466.

battery to the tip conductor which had been open before that time. To differentiate between the two types of trunks, therefore, it was necessary to incorporate a delay feature in the key set circuit to give the relay in the d-c key pulsing sender time to operate before the key set circuit determines which type of pulsing source to connect to the key set. The circuit provided is illustrated in Figure 1.

The tip and ring leads from the plug are connected to the key pulsing circuit through front contacts on relays TK and F. The former of these is operated by the "talk" key, which must always be operated before the KP key is operated. Relay F, on the other hand, is operated by the KP key, and will be operated just before the operator is ready to pulse out her signals. The wiring of the keys within the key set must be different for the two types of pulsing, and this change is brought about by bringing the leads from the key set to a group of relays that arrange the wiring in one way when the relays are operated and in another when they are released. To simplify the drawing, only three leads are indicated coming from the key set and only on relay, MF1, is indicated to do the switching. When relay MF1 is not operated, the key set will be connected to the d-c key pulsing source, and the two leads of the pulsing circuit will be connected through front contacts of relay SA1 and back contacts of the MF relay to the tip and ring leads of the plug—through the F and TK relays as already mentioned. When MF1 is operated, on the other hand, the key set will be connected to the multifrequency pulsing source, and the pulsing leads will be connected through a repeat coil and front contacts on the MF relay to the T and R leads of the trunk. For d-c key pulsing, therefore, relay SA1 must be operated, and relays MF and MF1 released, while for multifrequency key pulsing, relays MF and MF1 must be operated.

When the plug is inserted in a d-c pulsing trunk, and relays TK and F are operated, ground from the KR relay in the sender cir-

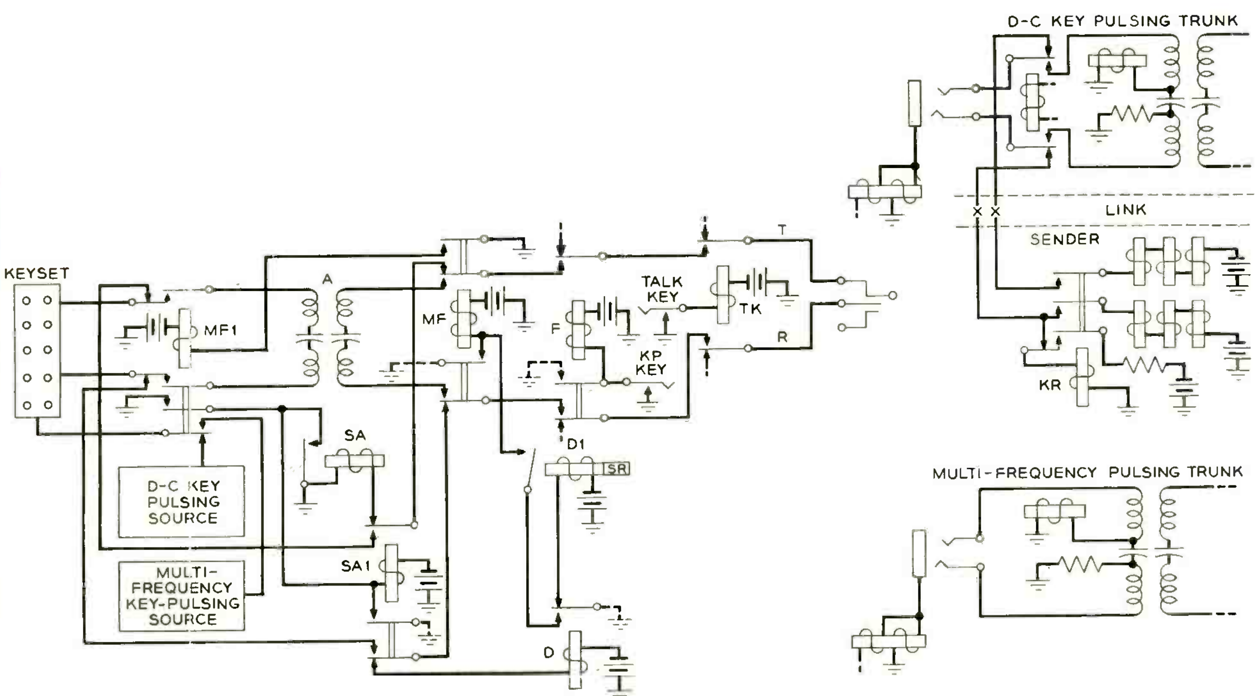


Fig. 1—This combined key pulsing circuit, first designed for the No. 3-type switchboard, has proved so advantageous that it also has been modified for other DSA and toll boards.

cuit, passing over the ring conductor and through back contacts on relays MF and SA1, operates relay D. The circuit for operating the slow-release relay D1 was closed through contacts, not shown, when TK operated, and thus D1 will be operated and its core fully saturated when the operator plugs into the jack of the trunk. This is to insure that its release time will always be the same. When D operates from the ground on KR, relay D1 starts to release, but because of its slow-release characteristics, it requires between 0.3 and 0.5 second to close its back contact. In the meantime, current through the winding of D operates relay KR, thus removing ground from the ring lead and connecting battery to both the ring and tip leads through the pulse-receiving relays. As a result, D at once releases, reestablishing the operating circuit of D1, which reoperates before its back contact has made. At the same time battery on the tip lead operates relay SA, which in turn operates SA1, thus establishing the circuit for d-c key pulsing. The operation of SA1 also lights—through contacts not shown—the "sender" lamp in front of the operator to indicate that a sender has been connected and is ready to receive pulses.

When the plug is inserted into a jack of a multifrequency pulsing trunk, ground over the ring lead also operates D as before. This ground in the multifrequency pulsing trunk is not removed, however, and thus D remains operated and D1 releases as a result after its slow-release interval of 0.5 second or less has elapsed. When this happens, MF is operated, and as soon as the "KP" signal has been sent to prepare the receiving circuit for receiving pulses, it in turn operates MF1. When MF1 operates, ground on one of its front contacts operates SA1, thus closing a path to light the sender lamp.

As already mentioned, this particular circuit was designed for the No. 3-type switchboard which was the first toll board to be equipped with the combined key pulsing circuit. Its use has proved so advantageous that circuits have also been designed for other DSA and toll boards. Because of the different "mark" conditions found on the trunks of these other boards, the other circuits are not exactly like that described above, but they perform the same functions and are indistinguishable as far as operation of the board is concerned.

THE AUTHOR: S. W. ALLISON received his Sc.B. degree from Brown University in 1915 and then joined the Engineering Department of the Western Electric Company. After serving in World War I as a Second Lieutenant, he returned to West Street to undertake analyses of the power requirements of manual, step-by-step, and panel circuits. In 1928 he transferred to the panel switching laboratory, and in 1930 to the Switching Development Department. Here he designed toll switchboard circuits and test circuits for maintaining them. During World War II he continued the same type of work, but almost exclusively in connection with special and emergency systems made necessary by the war needs.

Connectors for the No. 5 crossbar system

G. S. BISHOP
Switching Development

Connectors are used for associating markers with other common control circuits and with the switching frames for brief intervals during the handling of a call. In the No. 5 crossbar system, the seven major types, indicated in Figure 1, are employed. Besides showing the circuits with which each type of connector is used, this diagram shows the number of paths closed by each connector, and also the direction of the connection, that is, whether the marker seizes the frame, or the frame seizes the marker. This difference in the direction of connection is also indicated in the name of the connector. Where the marker seizes a frame, the connector is given only the name of the frame the marker seizes. Thus there is a line link connector, a trunk link connector, an outgoing sender connector, and a number group connector. When it is the marker that is seized by the frame, on the other hand, both the word marker and the name of the frame are included in the name of the connector. Thus there is an originating register marker connector, an incoming register marker connector, and a line link marker connector. For the line link frames, both types of connectors are required, and thus there are both line link connectors and line link marker connectors; the former is used while the marker is setting up connections between line link and trunk link frames, and the latter only when a subscriber lifts his handset to place a call.

Paths through the connector are established by operating multicontact relays,* each such relay closing 60 contacts. Since each connector closes more than 60 paths in establishing a connection, there will be more than one multicontact relay per marker in each connector. These relays have two operating magnets, and by separating the operating circuits of each relay, the equivalent of two 30-contact relays is available. Advantage is taken of this for the line link marker connector and the number group connector—the former requiring one and a half relays per marker, and the latter two and a half.

Two different circuit patterns are used for associating the multicontact relays to

*Record, *May*, 1939, *page* 301.

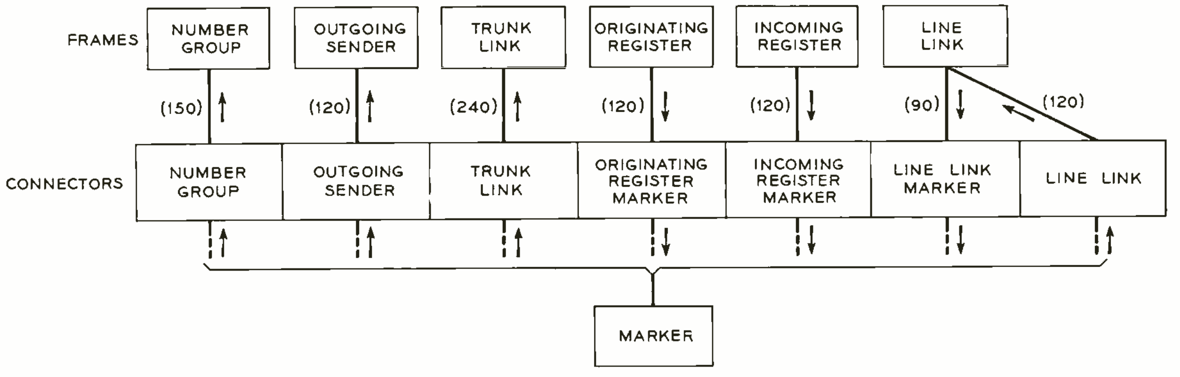


Fig. 1—The seven principal types of connectors used in the No. 5 crossbar system with the circuits with which they are associated and the number of paths they close.

form a connector, as shown in Figure 2. The arrangement shown at (a) is called a single-ended connector, while that at (b) is a double-ended connector. The latter is used only for registers and senders. Only one multicontact relay is shown connected to each marker, but as pointed out above, there will always be more than one of them depending on the number of paths that must be closed. With the single-ended connectors, used for line link, trunk link, and number group frames, the connector multiple is connected to the armature contacts of all the multicontact relays and extended to the switch frame the connector serves. There is thus one connector for each frame. With the double-ended connectors, on the other hand, used only for senders and registers, the connector multiple is connected to the armature contacts of both a group of multicontact relays for the markers and another group for the circuits to be connected to them. With this type of connector, therefore, a single connector will serve a group of similar circuits.

The reason for the provision of two types of connectors is that as soon as a line link, trunk link, or number group frame has been released by one marker, it is free for seizure by another. After a register or sender has been disconnected from a marker, however, it will not, in general, be free for connection to another, since it will be busy recording the digits dialed by a subscriber or transmitting pulses over an outgoing trunk. Double-ended connectors are thus used for registers and senders to permit the connector, after it has been released by one register or sender and a marker, to be at once reused for another connection. If single-ended connectors were used for these equipments, there would be relatively long intervals while the sender or register was performing its other functions when the connector was not in use. The two sets of multicontact relays used with double-ended connectors are mounted in different locations. Those that connect the marker to the connector multiple are on the connector frames, as are those of the single-ended connectors, while those that connect the registers or senders to the connector multiple are on the register or sender frames, as already described.*

Because of the similarity of the connector circuits and the large number of them re-

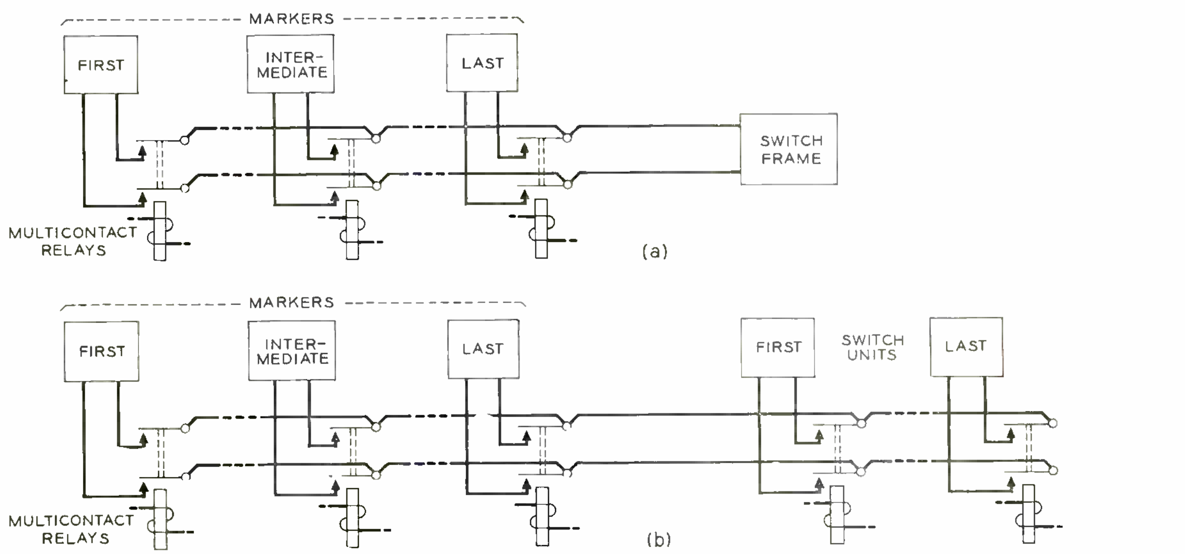


Fig. 2—Two types of connectors are employed: single-ended connectors arranged as indicated at (a), and double-ended connectors as arranged at (b).

*Record, *December*, 1949, *page* 426.

quired, the connector frames were designed to be built up of functional units in accordance with one of the basic features of the No. 5 crossbar system. The principal unit includes six multicontact relays spaced on 2¾ inch centers to provide ample space for soldering the leads from the markers. Two of these units are shown in Figure 3. Terminal strips are mounted at each end of the unit, and the bare copper wires that connect the armature contacts of all the relays are connected to the terminal strips at each end as shown in Figure 4. The small cans to the right of the right-hand terminal strip in Figure 3 enclose contact protection networks.*

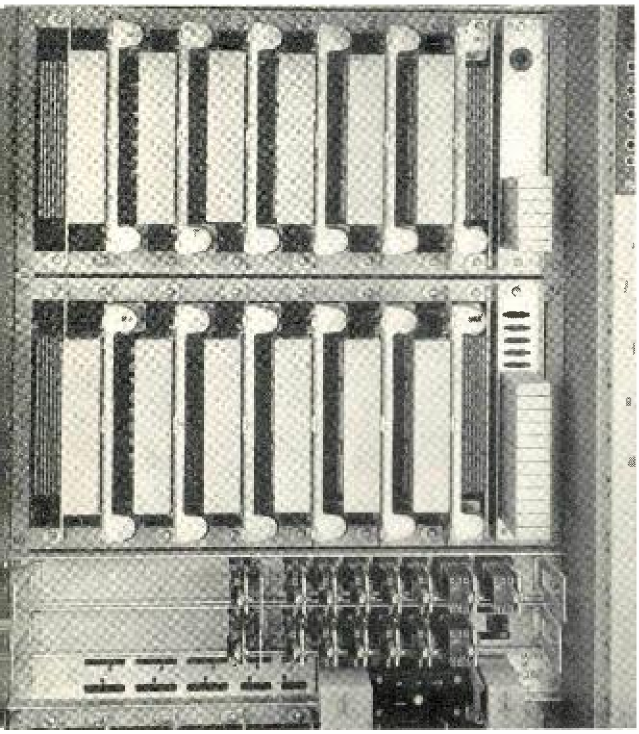


Fig. 3—Front view of a line link connector which employs two multicontact relay units.

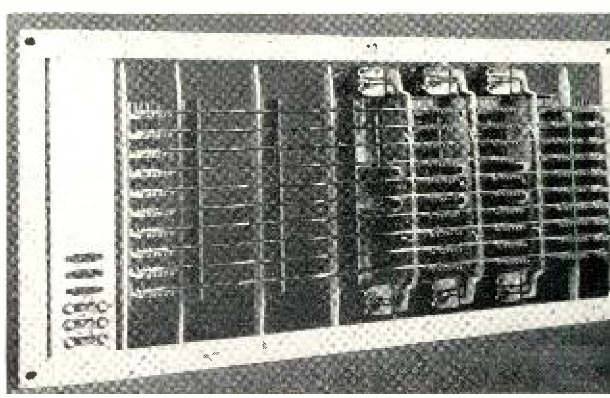
From one and a half to four such units—depending on the number of paths to be closed—will serve six markers, which is all that many of the No. 5 offices will require. For offices that require less than six markers, some of the positions for the multicontact relays will be left vacant, as shown in Figure 4. For offices requiring more than six markers, supplementary connector frames are provided, which may be furnished to serve either three or six additional markers. When such frames are used, the terminal strip at one end of the unit on the basic connector frame is wired to the terminal strip at one end of the unit on the supplementary frame to form a single connector.

Besides the multicontact relays, each connector requires a set of preference relays and a set of control relays. A preference relay unit requires one, two, or three mounting plates depending on the type of connector. Connectors through which markers seize the frames have two sets of preference relays, a regular set and an emergency set. The latter is brought into service automatically in the event of failure in the former. Control units consist of one or two mounting plates, and one unit is provided for each connector.

Six sets of terminal strips are located at the top of each connector frame. The marker leads are cabled to the front of these strips, as may be seen in Figures 5 and 6. On the rear of the frame, vertical local cables extend the marker leads to the multicontact relays for all connectors on the frame, as evident at the left of Figure 7. One set of terminal strips and a vertical local cable are furnished as a unit as each marker is equipped.

Each of the connector frames is a standard 23-inch single bay sheet metal frame, but because of the different number of paths

Fig. 4 – Rear view of a multicontact relay unit partially equipped.



*Record, *February*, 1949, *page* 50.

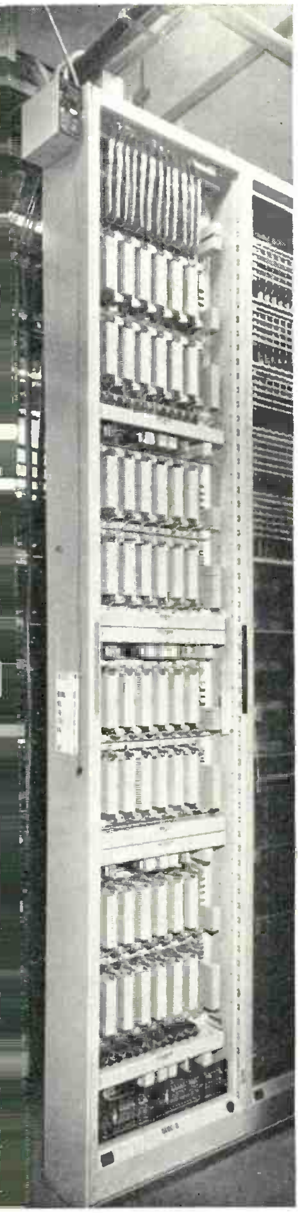


Fig. 5.—An originating register marker connector frame.

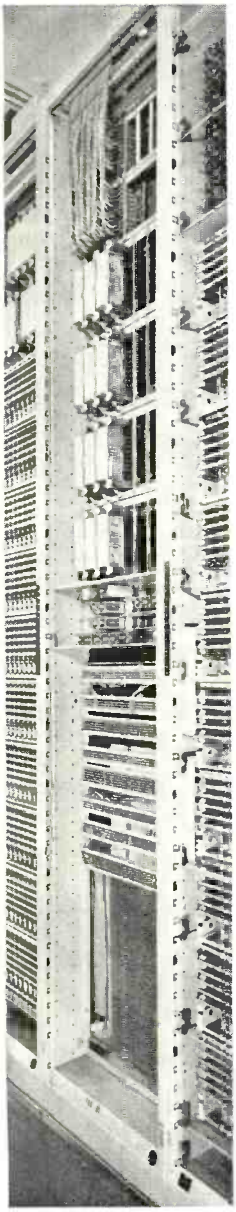


Fig. 6—A trunk link connector frame at the Media office.

Fig. 7—Front and rear views of a line link marker connector in the Towson office near Baltimore.

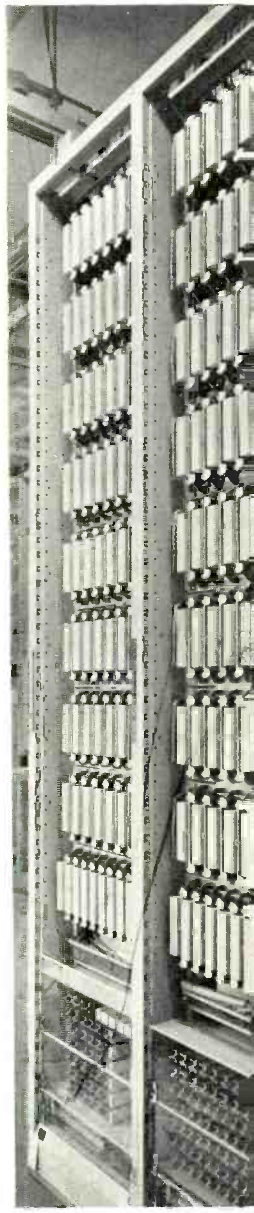


Fig. 8—A master test connector frame at the Towson office.

closed by the various connectors, and of differences in the amount of auxiliary equipment required for certain frames, the number of connectors per frame is not the same for all types. The originating register marker connector, the incoming register marker connector, and the line link connector all have four connectors per frame, each consisting of two multicontact relay units. The arrangement of these frames is indicated diagrammatically at (a) of Figure 9. Figure 5 shows an originating register marker connector frame, which in its general arrangement is similar to the other two of this group. A closeup of part of a line link connector frame is shown in Figure 3. The preference and control relays are on the three mounting plates immediately be-

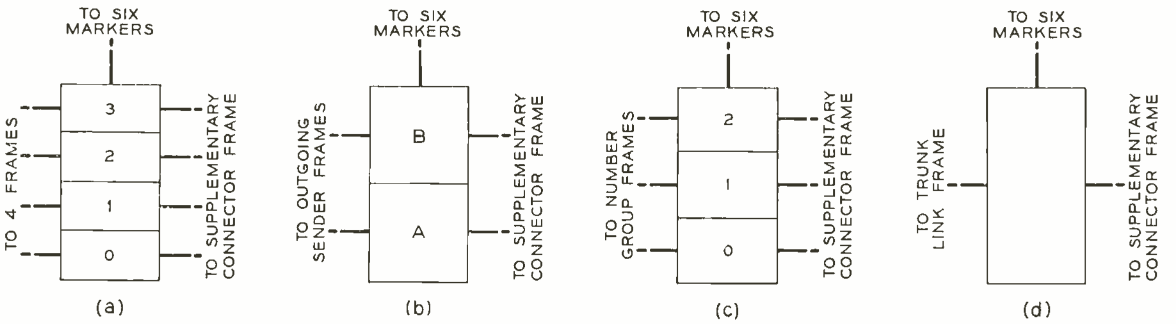


Fig. 9–Either one, two, three, or four connectors may be mounted on a single frame as indicated above.

low each pair of multicontact relay units.

Four connectors per frame are also used for the line link marker connectors, but since these connectors require only one and a half multicontact relays per marker, there are only six multicontact relay units per frame as shown in Figure 7.

The outgoing sender connector also closes 120 paths, and thus requires two multicontact relay units to serve six markers. Since a group of cross-connecting fields and a number of auxiliary relays are required in association with the outgoing sender connector, only two connectors are mounted on a frame as indicated in (b) of Figure 9.

Number group connectors close 150 paths and thus require two and a half multicontact relay units per connector. Four connectors would thus require ten multicontact relay units, but since with terminal strip and control equipment a bay will not accommodate more than eight, only three connectors are mounted on each number group connector frame, as indicated at (c) in Figure 9.

The trunk line connectors close 240 paths and thus require four multicontact relay units for each connector. Since several sets of cross-connecting terminals are associated with these connectors, only one connector is mounted per frame as indicated at (d) of Figure 9. A trunk link connector bay in the Media office is shown in Figure 6. Since this office has only three markers, the multicontact relay units are each equipped with only three relays.

Besides the seven connectors used in setting up service calls, a master test connector is required in each marker group of the No. 5 system. This connector circuit is arranged to connect markers, pretranslators, and the automatic monitor circuit to the trouble recorder. Test calls may be made from the master test control circuit through the master test connectors to markers and pretranslators.

The master test connector frame consists of two bays to accommodate the connector equipment for the first six markers, and is shown in Figure 8. For marker

THE AUTHOR: G. S. Bishop was graduated from Iowa State College in 1942 with a B.S. degree in electrical engineering. He then joined the Technical Staff of the Laboratories and worked one year with the trial installation group of the Systems Development Department. He enlisted in the Marine Corps in 1943 and returned to the Systems Development Department in 1946. Since then he has been active in the design of equipment for No. 4 toll crossbar and No. 5 crossbar systems.

groups exceeding this, one or two supplementary master test connector frames are required; the first serves markers 7 to 9, and the second serves markers 10 to 12. The supplementary frames are single bays of equipment.

For offices arranged for AMA, an auxiliary master test connector frame is required in addition to the master test connector frame. This is a single-bay frame that accommodates the multicontact and U relay equipment used for connecting transverters, AMA recorders, and the master timing frame to the trouble recorder.

Memorial service in Tokyo for Dr. Jewett

Since the last issue of the RECORD, we have received the text of the addresses at the memorial service for Dr. Jewett, held in Tokyo on December 11. Dr. Harry C. Kelly, acting chief, Scientific and Technical Division of S.C.A.P. said, in part:

"Dr. Frank Baldwin Jewett made his first visit to Japan to attend an Electric Power Congress almost a quarter of a century ago. During this visit he met many of Japan's leading men of science and industry. As director of one of the leading laboratories in the United States, he helped introduce many modern technical developments into Japan. He also introduced technical innovations, such as those in the field of magnetic metals, from Japan to the industries of the United States. He early recognized the scientific competence of the Japanese people, and early appreciated that Japan had scientific contributions to make as well as to receive. He also was aware of the receptivity of Japanese to modern technology and their need for it in the alleviation of human needs. Not only did he assist in the exchange of technical developments, but also helped arrange for the exchange of technical students and leading engineers of both countries through such means as the Iwadare Scholarship Foundation. These endeavors received the encouragement and help of far-sighted men both in Japan and the United States.

"Of much greater moment, however, was Dr. Jewett's conviction that common humanistic values could be attained through the constant intercourse of technical developments. When people cooperate in the advancement of a joint enterprise, a much broader understanding and friendship is attained than is ever possible through impersonal channels of diplomatic or social contacts.

"While on a visit to the United States early in the Occupation, I had an opportunity of seeking Dr. Jewett's help in getting scientific and technical advisors for our work here. Rather than being discouraged, he wanted increased efforts made to revive the interchange of technology for peaceful purposes and to breathe life into the embers of humanitarianism throughout the world. As President of the United States National Academy of Sciences, he arranged for two groups of the leaders of American science and engineering to visit Japan. Only the grave condition of his health prevented him from making the visits himself.

Mr. Naoto Kameyama, President of the Science Council of Japan, said in part:

"Just after the surrender, we Japanese were all in distress, and were at a loss what to do, confusedly viewing the devastation of war. The scientists were not an exception. But later we scientists began to reorganize our system of learned societies. In those days the United States National Academy of Sciences, of which Dr. Jewett was President, twice sent scientific missions to this country, the land of the former enemy.

"Such was only possible by a man of no less stature than Dr. Jewett, with deep human understanding and with the recognition of competence of Japanese scientists, which had been the outcome of his long intercourse with Japan."

An apostrophe to Dr. Jewett, written by Mr. Kokichi Mikimoto, Japanese industrialist, was read by his son. Its concluding paragraph read:

"Through your good help and advice, you sent many prominent scientists to my country to help in reconstructing Japan. You were always looking for ways of aiding my country. We, Japanese, hoped so much for your help and advice in the future. But now you have passed away. Of course your death was a big loss to your country, but it was a still greater loss to my country and to me personally. I pray, you in heaven will lead us always by an unseen hand hereafter to bring good relationships between your country and my country forever."

Optical measurements of residual stresses in glass bulbs

W. T. READ
Physical Research

In routine use electron tubes sometimes fail mechanically due to residual stresses introduced into the glass of the bulb at the time the bulb was sealed. A simple optical method to determine the maximum tensile stress in the wall of the glass bulb has been developed at the Laboratories and successfully used to identify over-stressed tubes before shipment as well as to aid improvement in sealing techniques. The method constitutes one of the first practical applications of standard optical apparatus to three-dimensional stress analysis.

Residual stresses may be introduced into the bulb in many ways. During sealing, for instance, direct exposure to the flame causes the outside of the bulb to reach a higher temperature than the inside. Consequently, in the subsequent cooling, the outside flows viscously while the cooler inside contracts elastically. When the outside cools down to the elastic phase it tries to contract but is held in tension by the inside which has already set. In some tubes tested, the maximum stress was as high as three or four kilograms per square millimeter, or about 5,000 pounds per square inch. Since glass is weak in tension a high tensile stress on the exposed outer surface of the bulb may ultimately break it. Although not apparent by ordinary observation, these stresses may be located and measured by polarized light. By using this procedure at the factory it is possible to adjust the fires and alter the assembly methods to keep stresses within allowable limits.

The optical method of stress analysis is based on the phenomenon known as double refraction. In materials which are doubly refractive light travels at two different velocities. Under ordinary conditions glass is singly refractive like most materials, but in a stressed condition it becomes doubly refractive. A wave of plane-polarized light on entering stressed glass is resolved into two components which travel at different ve-

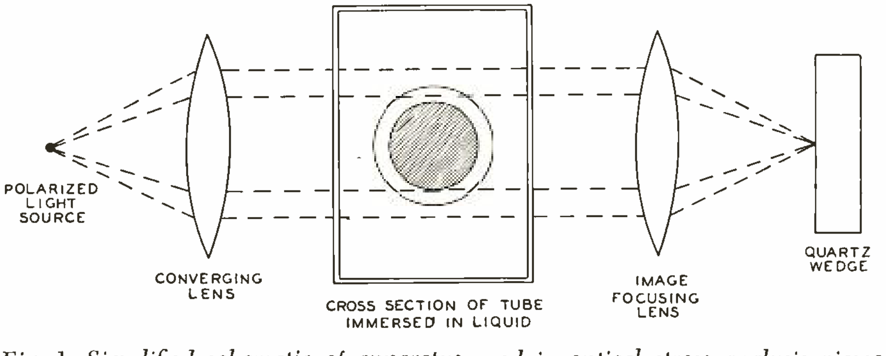


Fig. 1—Simplified schematic of apparatus used in optical stress analysis viewed from above, looking down axis of tube. Light from the source, left, is converged into parallel rays passing through the glass of the tube and thence to another lens which focuses an image of the tube on the quartz wedge. The image is viewed through the eyepiece and analyzer shown in Figure 2.

locities and therefore emerge with a difference in phase which can be measured.

Figure 1 is a simplified schematic and Figure 2 is a photograph of a complete laboratory unit to measure stresses in glass bulbs. The light source, at extreme left, is a mercury vapor lamp which, with a following filter, produces light of a single wave length. Next is a converging lens to align the rays in parallel and then a polarizer which passes waves vibrating in only a single plane. There is next a rectangular glass cell containing liquid in which the tube under test is immersed. The immersion liquid has the same index of refraction as the glass of the tube wall, to prevent rays from being bent on entering and leaving the bulb. Since not all of the tube wall is visible at one time the tube is rotated about its axis by a motor mounted on the immersion cell and operated by a suitable control. observer's eyepiece. Figure 3 outlines a tube with interference fringes as seen through the eyepiece. Figure 4 is an actual photograph of a fringe pattern in part of the tube wall. Vertical displacements of the horizontal fringes in the tube wall are proportional to phase differences since the thickness of the wedge varies uniformally in the vertical direction. The distance between horizontal fringes corresponds to a phase difference of 360 degrees.

Although the phase difference can be measured by standard techniques, the interpretation of the measurement in terms of stresses involves considerable theoretical difficulties due to the three-dimensional state of stress in the bulb. As shown by Figure 1 each ray has passed through a different thickness of glass. Also, velocities and directions of polarization of the component waves are variable along the path

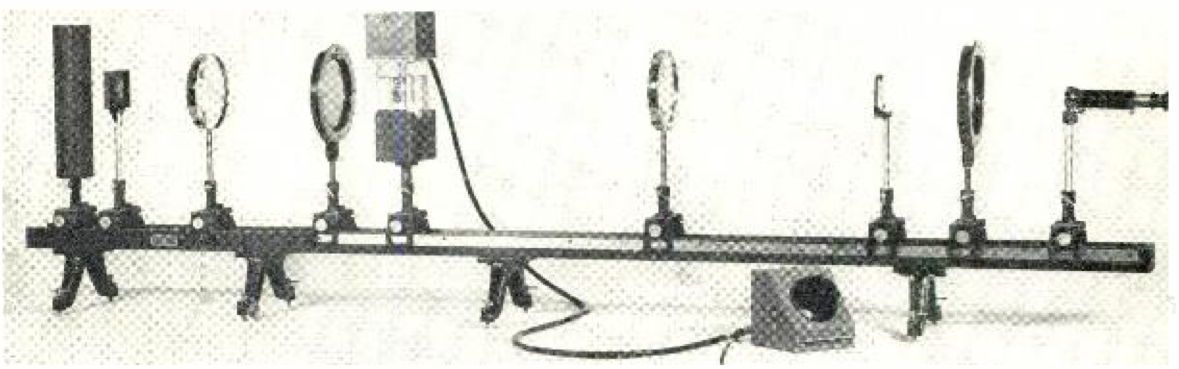


Fig. 2—Complete laboratory apparatus for analysis of stresses in glass bulbs

A second converging lens now focuses an image of the tube on a quartz wedge which introduces a phase difference proportional to its own thickness. Where the thickness of the wedge is such that the phase difference introduced by the wedge is equal and opposite to that caused by the tube the light is repolarized. The analyzer which follows the wedge is set to extinguish the repolarized light. Thus interference fringes, or regions where the light is extinguished, are observed wherever the phase difference caused by the bulb is equal and opposite to the phase difference introduced by the quartz wedge. At the extreme right is the

of each ray in the glass. However, on the basis of a series of experiments, several approximations were established which simplified the theoretical analysis to the extent that a formula was derived for the maximum stress in the bulb in terms of the maximum phase difference: Maximum Stress = Characteristic Stress x Shape Factor x Maximum Phase Difference. The characteristic stress is determined from the stress optical coefficient of the glass and the dimensions of the bulb. It is equal to the constant stress required to produce a phase difference of one degree in a distance equal to the length of the path of the inner-

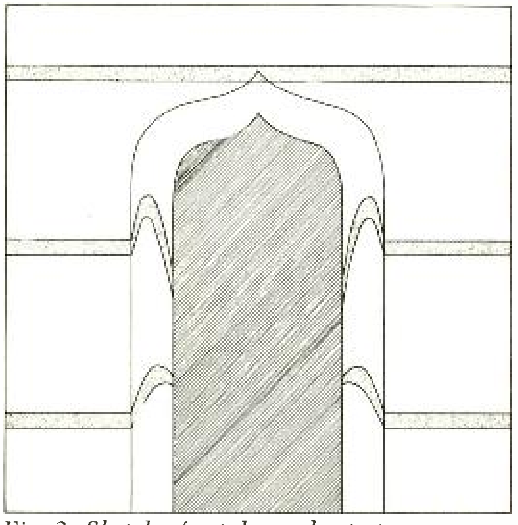


Fig. 3—Sketch of a tube under test.

most ray in the tube wall. The shape factor varies between 1 and 3 depending on the shape of the fringe pattern. For practical purposes it was taken to be 2 when the maximum phase difference was observed in the center or inside of the center of the bulb wall, and 3 when the maximum phase difference was observed to the outside of the center. The formula does not apply when the maximum phase difference is in the outer one-fifth of the tube wall but such a condition rarely occurred in the many tubes observed.

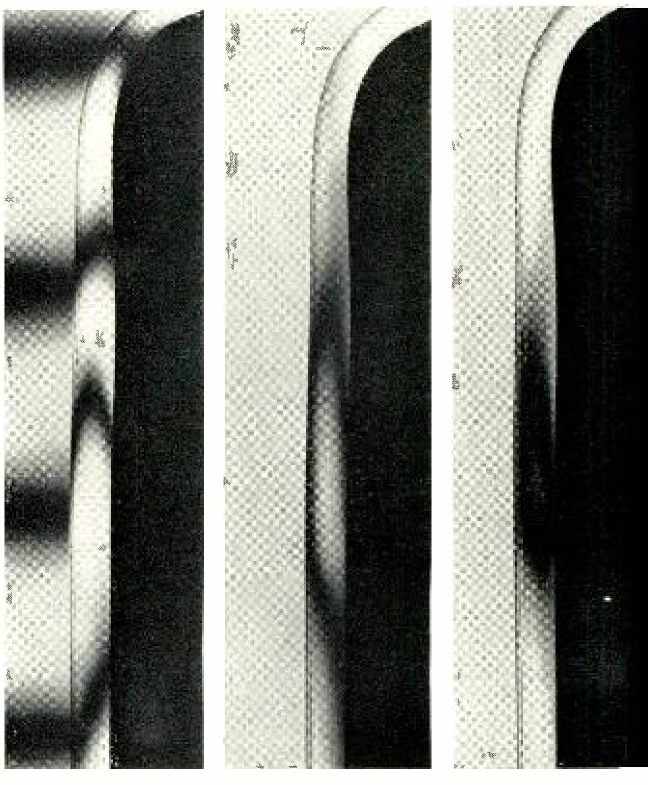
An example is shown in Figure 4 where the maximum phase difference is 180 degrees as indicated by maximum displacement of the fringe next to the lowest. Since the maximum occurs in the center the shape factor is 2. According to the formula this gives a maximum stress of 4.0 kilograms per square millimeter. This was considered too large and the tube was rejected.

Previous to the theoretical analysis a limit on the phase differences observed in some electron tubes had been established empirically on the basis of breakage tests under severe conditions. This was not entirely satisfactory because the corresponding stress was not known. Since electron tubes are now important elements in many industrial and military applications and an unexpected failure may have serious consequences it is desirable that the stresses be known and kept within a limit of about one kilogram per square millimeter for ordinary glass. The theory made it possible to calculate the stress corresponding to the empirical limit. This turned out to be 1.3 kilograms per square millimeter which is considered sufficiently close to the desired limit for practical purposes.

For rapid testing of tubes in quantity a simplified optical method was also developed whereby stresses of any magnitude could be located immediately and measured with ease and accuracy. In this procedure the image focusing lens in Figure 2 is eliminated and the quartz wedge is replaced by a quarter-wave plate which repolarizes the light after its passage through the bulb. However, the direction of polarization of the light leaving the quarter-wave

Left to right: Fig. 4—Photograph showing details of fringe pattern in part of tube wall. Fig. 5—Fringe pattern in the form of a large closed curve as viewed through eyepiece when a quarter-wave quartz plate is used instead of a wedge. The closed curve indicates stresses above the allowable limit. Fig. 6—Fringe pattern in the form of a small closed curve, or ring enclosing a light spot, where a tube likewise is overstressed.

Fig. 4 *Fig. 5* *Fig. 6*



THE AUTHOR: W. T. READ attended Rutgers University from 1941 to 1943 and received a B.S. in physics and mathematics, and also taught physics there, in 1943. During the following three years he was at the Princeton station of N.D.R.C. doing laboratory and field research on shock waves and explosive phenomena as well as development work on pressure recording apparatus. He was present at the Bikini atomic bomb tests as a field supervisor in the air blast instrumentation group. During 1946 and 1947 he attended Brown University and obtained his M.S. in applied mathematics. He joined the Laboratories' mathematical research group in July, 1947, and currently his attention is directed to problems in photoelasticity, applied mechanics and theoretical physics.

plate is different from the original direction of polarization. The angle between the two directions is equal to half the phase difference caused by the bulb. In this case the light is extinguished whenever the phase difference is equal to twice the rotation of the analyzer from the position of crossed polaroids. On the basis of this principle the following technique was established for identifying over-stressed bulbs: when a limit on the allowable stress has been set, the corresponding limit on phase difference is calculated. With the analyzer set to extinguish light having this phase difference, the bulb is rotated once around its axis while the fringe pattern is observed. If at any point the phase difference is greater than the allowable value then this point will be surrounded by a closed curve, or ring, along which the phase difference is equal to the allowable value; and along this curve the light will be extinguished. Therefore, if a fringe in the form of a closed curve, or ring enclosing a light spot, appears in a tube wall like those illustrated in Figures 5 and 6, the ring must enclose a maximum phase difference corresponding to a tensile stress above the allowable limit and the tube is rejected. If no dark rings are observed then the stresses are within the allowable limit and the tube is accepted. This streamlined procedure has been found practical for routine testing of tubes in quantity and is now in use at the Allentown Laboratory.

The experimental work was carried out jointly by the author and J. E. Clark of Electronic Apparatus Development.

Continued from page 52

the sector are carried around its periphery and attached to fittings on arm Q as indicated. As the tracing point is swung back and forth, the arm Q is moved back and forth a distance RΘ. What this attachment does, in effect, therefore is to straighten out the curved ordinates of Figure 1 and to move Q transversely—with no horizontal component—a distance equal to the value of the ordinates measured along the arcs. If a pen were attached to arm Q, it would draw a rectangular coordinate curve as the tracing pen on arm J followed the original curve. The integraph then in effect integrates the replotted curve.

The actual integraph (see page 50) includes a number of adjustments and mechanisms not referred to above. Arrangements are incorporated to assist in securing accurate alignments of the chart, and a number of adjustments by which the constant ratio of area to integral may be changed are also included. Still another constant may be added if desired by changing the radius of the segment over which the wires travel to control the motion of Q.

This modified Coradi integraph has proved very satisfactory: accuracies of better than 0.2 per cent are obtained where the deflections of the original recording pen are not over 30 degrees.

A variable-frequency oscillator stabilized to high precision

L. F. KOERNER
Transmission Apparatus Development

In developing crystal oscillator circuits for use as laboratory standards some time ago, it became necessary to determine the characteristics of crystal networks with a high precision of frequency. This required as a source of power a variable-frequency oscillator having an accuracy and stability comparable to that of the Laboratories frequency standard, and capable of covering continuously a wide frequency range. Heretofore, this has been accomplished by modulating harmonics of a standard frequency and filtering out the undesired modulation products. As an improvement on this method, a new oscillator has been developed that meets the requirements without recourse to low frequency modulation and subsequent filtering, and may simply be an auxiliary equipment for one of the more or less common systems of frequency measurement.

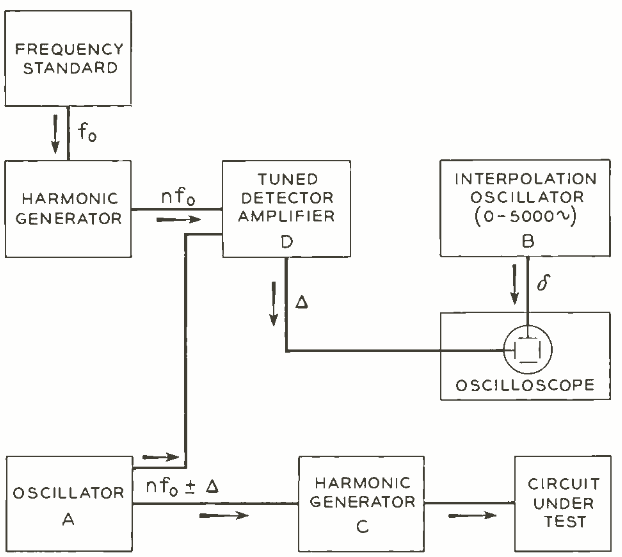


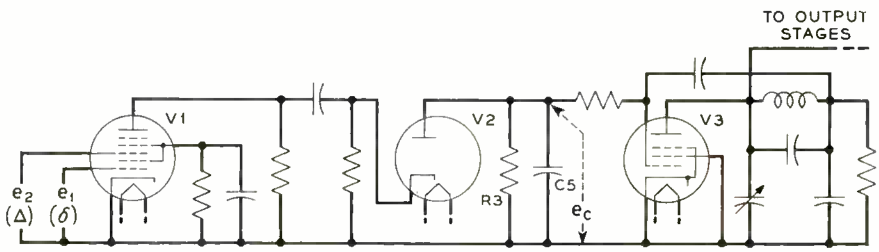
Fig. 1—Block schematic of a commonly used method of deriving an adjustable frequency of high precision.

A circuit that has been frequently used for securing adjustable frequencies of high precision is shown in block form in Figure 1. The *n*th harmonic of the Laboratories' frequency standard and a frequency from a separate adjustable oscillator—A in Figure 1—whose frequency has been set to approximately that of the harmonic, are both applied to the input of a tuned detector amplifier. These two frequencies may be called nf_0 and $(nf_0 \pm \Delta)$, where f_0 is the frequency of the laboratory standard and Δ is the frequency by which the output of the oscillator differs from nf_0. The output of the detector is the difference between these two frequencies, and is thus Δ. Its value is measured by applying it to one set of plates of an oscilloscope and applying to the other set of plates the output of an interpolation oscillator that may be adjusted to any frequency, δ, up to 5 kc to within $\pm$ 1 cycle. When these two frequencies are identical, the pattern on the oscilloscope will be a circle, while when they are different, it will assume a variety of shapes. Oscillator A is adjusted until the pattern is a circle, and at this time $\Delta = \delta$, and the output frequency of the oscillator is thus $(nf_0 \pm \delta)$, where the sign of δ may readily be determined by successive adjustments of the two oscillators. So long as this pattern is a circle, therefore, the output of oscillator A is always exactly $(nf_0 \pm \delta)$. It may be used directly to provide the test frequency f_t, or it may be passed through a harmonic generator so that f_t will be equal to $m\ (nf_0 \pm \delta)$.

Suppose, for example, it was desired to secure a test frequency of 983,240 cycles using a laboratory standard of 10 kc. The values of n and m could be made 20 and 5, respectively, and with m = 5, the desired output frequency of oscillator A is 983,240 divided by 5, or 196,648, which is 200,000 less 3352. Oscillator B would be set to give this latter frequency, and oscillator A would be adjusted until the pattern on the oscilloscope was a circle. When this occurred, the output of oscillator A would be exactly 196,648 or 200,000 — 3352, and the test frequency at the output of the harmonic generator would be five times this or 983,240, which is the desired frequency. This principle is used where a low frequency A is desired and where it is desired to measure its frequency with an accuracy which necessitates the measurement being made at a harmonic of A.

The difficulty in using this method is that the frequency of oscillator A drifts with changes in temperature and other factors. It must thus be continuously readjusted, which handicaps the testing procedure. What was desired was an automatic method of holding the frequency of oscillator A at the desired value once it had been obtained. To accomplish this, use was made of the fact that variations in the grid bias of an oscillator produce second-order frequency variations which, though small, are large enough to take up normal temperature and other short-time instabilities. The output of the tuned detector and of oscillator B are supplied to separate grids of a low frequency modulator, shown at the left of Figure 2, where these two voltages are marked e_1 and e_2. The output of this modulator is rectified and filtered to obtain a direct current varying at the difference frequency. Across R3 and C5, this current results in a voltage, marked e_c, which is applied to the grid of oscillator A of Figure 1, which is also indicated at the right of Figure 2.

Fig. 2—Lock-in circuit used to hold the test frequency at the desired value.



When the frequencies of e_1 and e_2 are considerably different, the rectified voltage e_c is constant and independent of the difference between the frequencies of e_1 and e_2. As the difference in frequencies approaches 0, however, the voltage e_c varies with the phase difference, and is constant when the two frequencies are identical. At this point the oscillator locks in, and thereafter its output frequency remains $nf_0 \pm \delta$. Tube V1 in Figure 2 is employed principally as an amplifier and to permit independent adjustment of the voltages e_1 and e_2. So far as securing lock-in is concerned, the two voltages could be applied together to the input of the rectifier. The essential features of a lock-in circuit are thus as shown in Figure 3, where R is the rectifier V2 of Figure 2, O is the oscillator V3 of Figure 2 or A of Figure 1, and M is the tuned detector of Figure 1. This, it will be noticed, is a feedback circuit, and when Δ and δ are equal in frequency, the oscillator O is locked at the frequency that makes them equal. If δ is varied, the oscillator frequency will vary similarly so as always to keep Δ equal to δ.

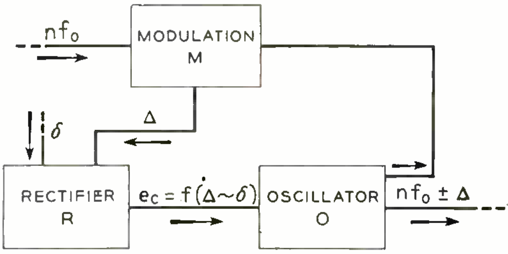


Fig. 3—Block diagram of the lock-in circuit.

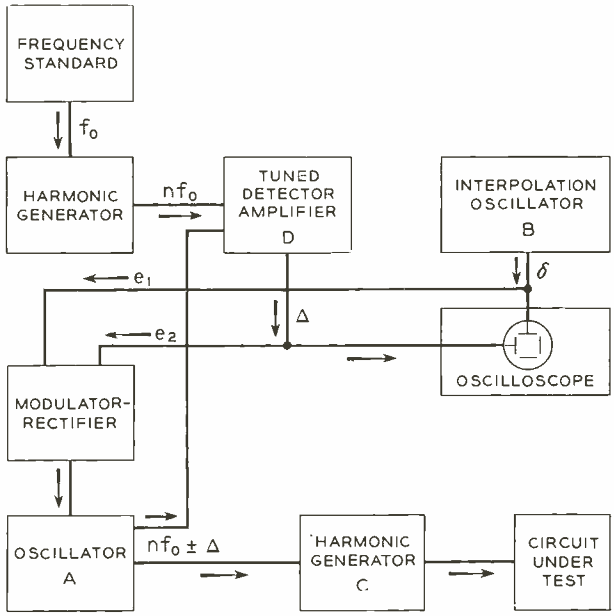


Fig. 4—Block diagram of precision oscillator.

With this lock-in feature added, the circuit of Figure 1 becomes as shown in Figure 4. The oscilloscope is retained to assist in the original adjustment of oscillator A, and to act as an indicator of lock-in, which will be a stationary ellipse. When a test circuit is taken directly from oscillator A, its value is thus:

$$f_t = nf_0 \pm \delta \qquad (1)$$

since the frequency of oscillator A is locked in at a frequency that differs from nf_0 by exactly the frequency of oscillator B. When the harmonic generator is connected to the output of oscillator A, the test frequency becomes:

$$f_t = mnf_0 \pm m\delta \qquad (2)$$

where m is the multiplying factor of the output harmonic generator.

When the conditions are those expressed by equation (1), the precision of the test frequency is within ± 1 cycle (assuming the precision of δ is 1 cycle), and the relative precision is thus $1/f_t$ or approximately $1/nf_0$. If $nf_0 = 10^7$, this same relative precision holds for the conditions of equation (2), since with this expression the relative frequency is m/f_t or about $m/mnf_0 = 1/nf_0$. When nf_0 is $> 10^7$, the precision remains above one part in ten million, which may be the precision of the standard frequency.

When nf_0 is $< 10^7$, the precision would be less than one part in ten million with this arrangement. To obtain the same pre-

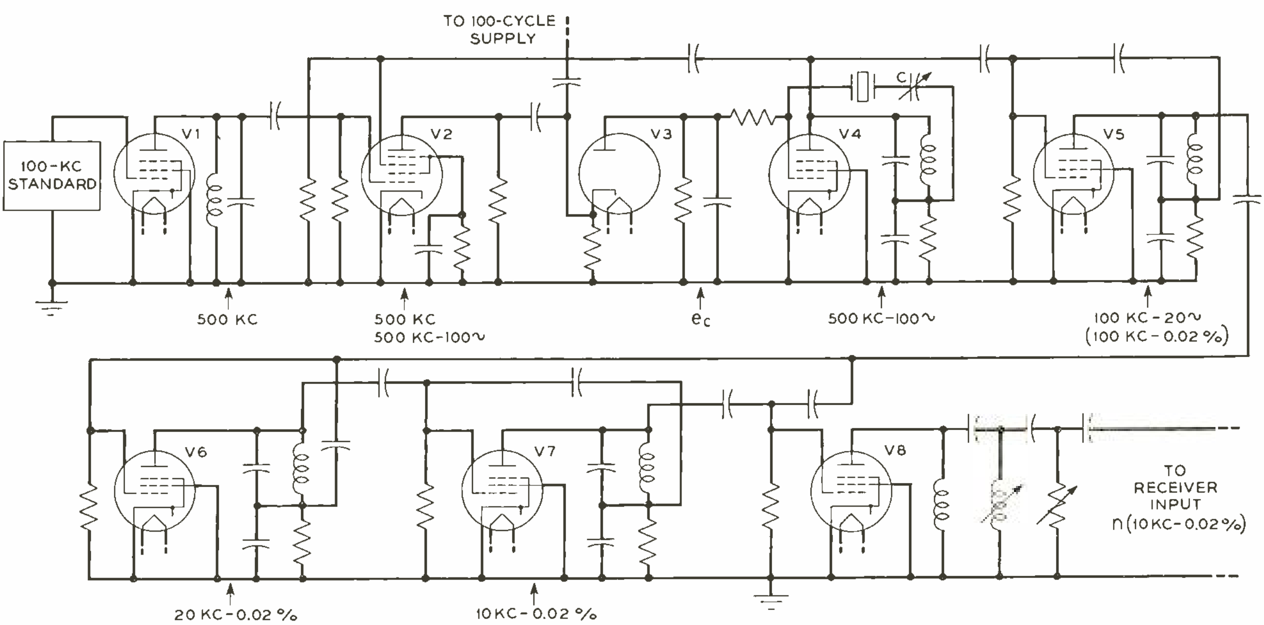


Fig. 5—Offset frequency circuit.

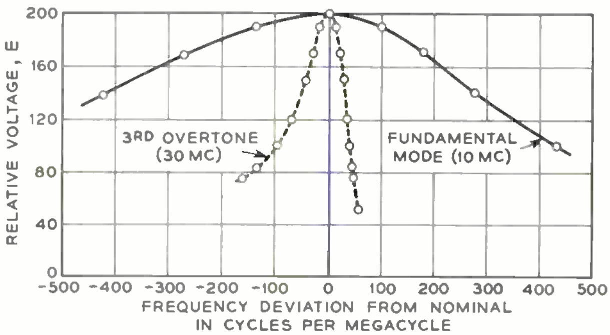


Fig. 6—Typical curves obtained with the precision adjustable oscillator.

cision for test frequencies below 10 megacycles, the lower input to the tuned detector D of Figure 4 may be taken from the output of the harmonic generator C, and the circuit under test may be fed directly from the oscillator A. Under these conditions, the expression for the test frequency becomes:

$$f_t = nf_0/m \pm \delta/m \qquad (3)$$

and the relative precision would be

$$\frac{1}{m} \Big/ \frac{nf_0}{m} = \frac{1}{nf_0}$$

Thus the precision of one part in ten million can be maintained even when the test frequency is below 10^7.

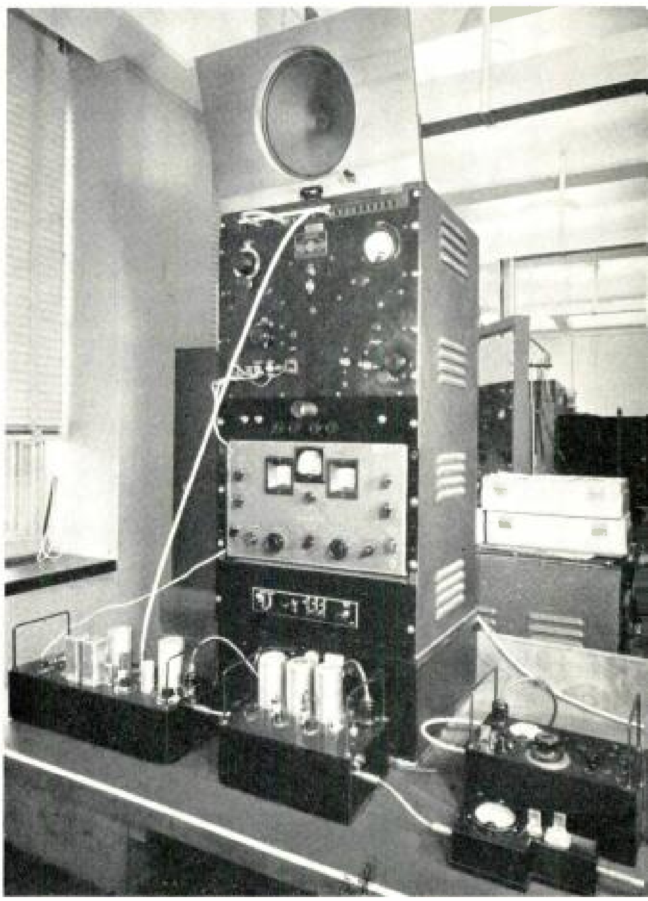
One or another of these arrangements gives the required results except when the frequency of oscillator B is required to be below 50 cycles. At these low frequencies, the output of the oscillator and the detector may tend to decrease and as a result the voltages e_1 and e_2 may be too low to maintain satisfactory lock-in. This difficulty has been overcome by the use of an offset frequency derived from the standard.

The offset circuit, which is connected between the frequency standard and the harmonic generator at the upper left of Figure 4, derives a frequency $f_{0'}$ from the harmonic generator that is equal to $f_0 - pf_0$, where p is a small decimal fraction—0.0002 has been found satisfactory for most applications. The effect of this is to raise the frequency of oscillator B by the amount npf_0—its output frequency being $npf_0 + \delta$ instead of δ as in equations (1), (2), and (3). The output of oscillator A is as before $nf_0 \pm \Delta$. The two inputs to the tuned detector are $nf_0 - npf_0$ and $nf_0 \pm \Delta$, and their difference frequency thus becomes $npf_0 + \delta$, which is the same as that of the output of oscillator B. The action of the lock-in circuit is the same as before; holding the output of the A oscillator to the frequency $nf_0 \pm \delta$.

With the offset circuit included, therefore, equations (1), (2), and (3) still apply, and the same precision is maintained, but the interpolation oscillator is at frequency $npf_0 \pm \delta$, and thus δ can be made to approach 0 while the oscillator itself is at some other frequency such as 1 or 2 kc.

The offset circuit employed when the value of p is 0.0002 is shown in Figure 5. The standard frequency of 100 kc is first increased to 500 kc by the frequency multi-

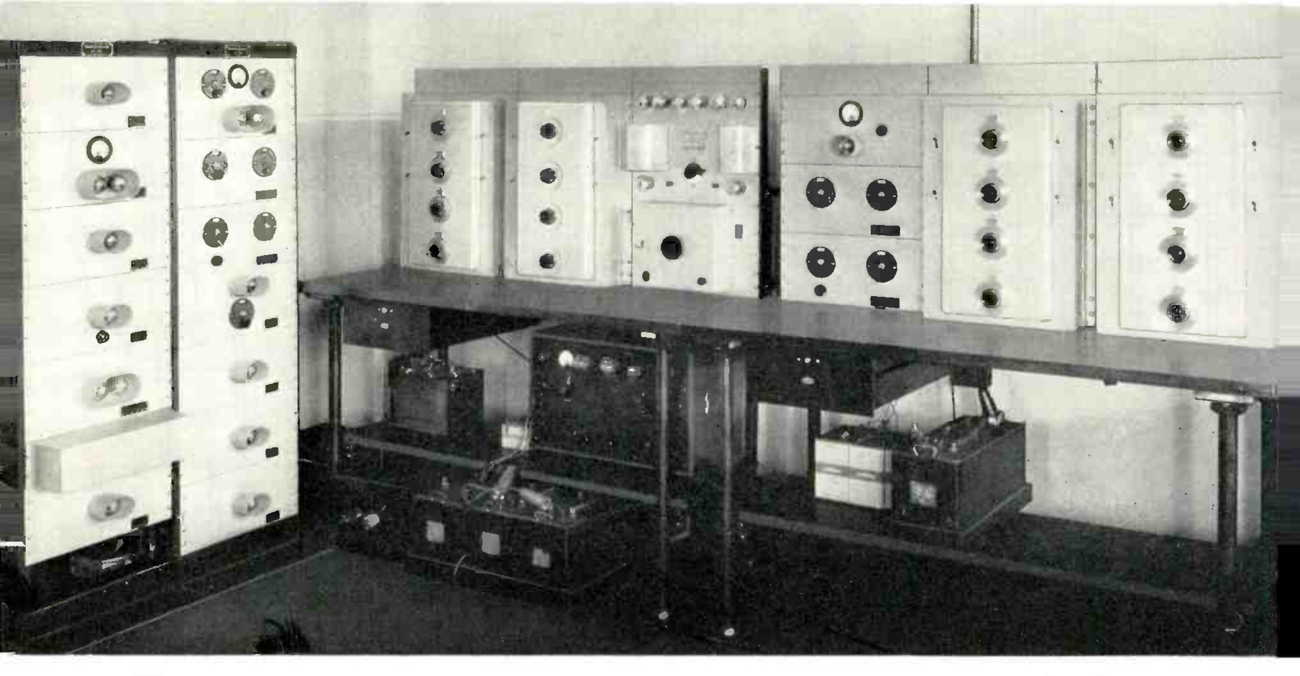
Fig. 7—Laboratory setup of the precision oscillator.



THE AUTHOR: Lawrence F. Koerner received his B.S. degree from Colorado College in 1923, and his M.S. degree from Harvard University in 1924. He joined the Laboratories in the latter year, where his work was concerned primarily with electrical testing equipment involving electric and piezoelectric oscillators. During the war he was chiefly occupied in the production of quartz crystal units at the Hawthorne plant of the Western Electric Company. He is now engaged in the development of crystal oscillator circuits and associated crystal equipment.

plier V1. The next three tubes utilize the same lock-in principle as the three tubes of Figures 2 and 3. Tube V4 is the oscillator which is adjusted for an output frequency of 500 kc — 100 cycles, and this frequency and the 500 kc generated from the laboratory standard are connected to the input of the modulator, which corresponds to the tuned detector of Figure 4 and M of Figure 3. The output difference frequency $\triangle$ and a 100-cycle voltage from the laboratory standard, corresponding to δ of Figure 3, are connected to the input of the rectifier. The rectified and filtered output is applied to the grid of the oscillator to lock its frequency in at 500 kc — 100 cycles in the same manner as described in Figure 2. Tubes V5, V6, and V7 are submultiple generators to provide frequencies of either 100 kc — 0.02 per cent, 20 kc — 0.02 per cent or 10 kc — 0.02 per cent. One or the other of these frequencies is then used in place of the standard frequency at the left of Figure 4.

Fig. 8—Previous equipment used to obtain adjustable frequencies to high precision.



The sort of measurements this circuit makes possible is indicated in Figure 6, where the curves show the output of a quartz crystal network supplied by an input of constant voltage but of variable frequency. For the points on the upper curve, the offset frequency circuit is not needed, but it is required for those on the lower curve, which shows frequencies differing by less than 50 cycles from 30 megacycles. The laboratory setup used for this testing is shown in Figure 7. Here the oscillator A of Figure 4 is on the bench at the left; the harmonic generator C is next to the right; and to the right of it is the circuit under test. The interpolation oscillator, B of Figure 4, is the top panel of the center group. The tuned detector (a commercial communication radio receiver) is the middle light-colored panel, and the offset frequency circuit is the narrow panel just beneath it.

Figure 8 shows equipment built several years ago to accomplish essentially the same results obtained from the present equipment. A large portion of the older equipment consisted of filters and modulators not required by the new system.

Telephones in the World

There were nearly 66,000,000 telephones in the world—an all-time high—at the beginning of 1949, according to the new issue of *Telephone Statistics of the World*, released recently by the A T & T. Of the more than 5,000,000 telephones added in 1948, 69 per cent were gained in North America.

The United States, with over 38,200,000 telephones, or nearly three-fifths of the world's total, on January 1, 1949, had 26.1 telephones per 100 population. (The U. S. today has about 40,500,000 telephones.) Sweden was second in telephone development, with 22.1 telephones per 100 people, and Canada third with 18.8 instruments for each 100 persons. The world as a whole had 2.8 telephones per 100 population.

New York continued to lead the world's cities in telephones, with 2,768,567 instruments at the beginning of 1949. This was more than in any country in the world except the United Kingdom.

San Francisco had more telephones per capita than any other city—about one for every two persons, or twice the national average. Outside the United States, Stockholm led the world's cities in per capita telephone development, with 45.5 telephones per 100 population, while Toronto led Canadian cities with 38.2 telephones for every 100 people.

America continued to be the "talkingest" nation, with more than 50 billion telephone conversations in 1948, or an average of 346.3 per person. This was an increase of 29 conversations per person over 1947.

Telephones in Continental Areas – January 1, 1949

Continental Area	Total Telephones: Number	Total Telephones: Per cent of total world	Total Telephones: Per 100 population	Privately Owned: Number	Privately Owned: Per cent of total tels.	Automatic (Dial): Number	Automatic (Dial): Per cent of total tels.	Connecting with Bell Syste[m]: Number	Connecting with Bell Syste[m]: Per cent of total tels.
North America (less United States)	2,959,000	4.5	4.6	2,613,000	88.3	1,701,000	57.5	2,950,000	99.7
United States	38,205,000	58.1	26.1	38,205,000	100.0	23,830,000	62.4	38,193,000	100.0
South America	1,574,000	2.4	1.5	810,000	51.5	1,133,000	72.0	1,457,000	92.6
Europe	18,940,000	28.8	3.2	2,670,000	14.1	11,960,000	63.1	17,580,000	92.8
Asia	1,923,000	2.9	0.2	150,000	7.8	820,000	42.6	700,000	36.4
Africa	735,000	1.1	0.4	9,000	1.2	475,000	64.6	595,000	81.0
Oceania	1,464,000	2.2	1.4	106,000	7.2	885,000	60.5	1,425,000	97.3
World	65,800,000	100.0	2.8	44,563,000	67.7	40,804,000	62.0	62,900,000	95.6

*Partly estimated; data reported as of other dates have been adjusted to January 1, 1949.

Vibrating reed signaling for mobile radio

D. F. HOTH
Transmission Engineering

A new type of selective signaling system for mobile radio service has been developed and is now on trial. It employs the new vibrating reed selectors described by A. C. Keller in the January issue of the RECORD. The selectors use sharply tuned magnetic reeds which vibrate and close contacts when driven by tones of the proper frequencies. In applying the selectors to the mobile radio signaling system, it was decided to transmit a group of tones simultaneously from the land station to signal a particular mobile station. Each mobile station would contain a set of reed selectors tuned to a distinctive set of frequencies which would respond when the proper set of tones was received.

The transmission of a group of simultaneous tones as the ringing code rather than a sequence of pulses results in a greater freedom from mutilated signals. Brief fades must always be expected in radio transmission, and when the signaling code consists of a sequence of pulses, there is always the possibility of one or more of them being obliterated by a fade. When the code consists of a group of frequencies transmitted simultaneously, a fade might obliterate the entire signal for a brief period but the signal that does get through will be correct.

Having decided upon multiple-frequency signaling, it was necessary to determine the number of frequencies in each ringing code and the total number of frequencies which must be available at the land station to provide the desired 10,000 code combinations. Table I shows the total number of frequencies, n, which, when transmitted r at a time, will give the required 10,000 combinations. It will be noticed that at first n decreases very rapidly as r increases, but beyond r=4, the decrease becomes relatively small. When the value of n is large, a large number of frequencies must be provided at the land station. When r is large, a large number of selectors must be provided in each mobile station. A value of 4 for r seemed a satisfactory compromise, and was adopted.

At the land station, the desired number is dialed by an operator at a switchboard. The resulting pulses are counted and registered by circuits that are standard in dial telephone practice, but a translation is required to change from the decimal number recorded to the proper four frequencies for the ringing code. A study of possible translating circuits showed that a much simpler arrangement could be used

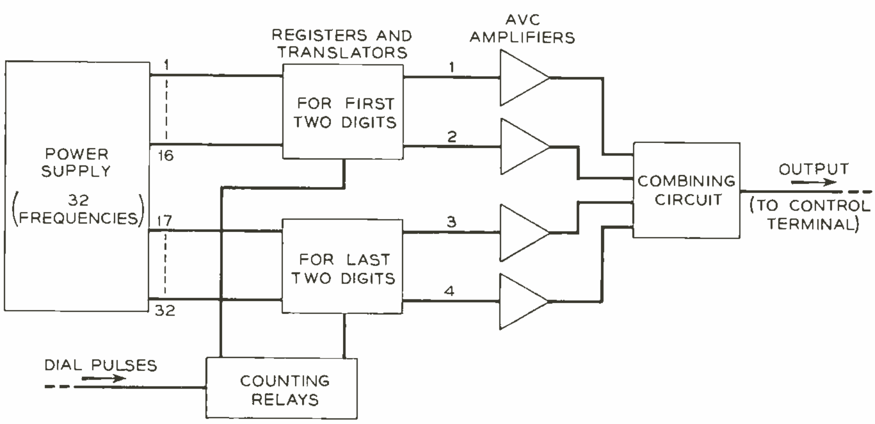


Fig. 1 — Block diagram of signaling circuit used at land stations.

if the translating were divided into two stages: if, in other words, the first two digits were used to select two frequencies, and the other two digits, the other two frequencies. This slightly changes the number of different frequencies required, since one-half the total number of frequencies must give at least 100 combinations when taken two at a time. Although 24 frequencies give 10,626 combinations when taken four at a time, 12 frequencies—one-half of 24—will give only 66 combinations taken two at a time. It was necessary, therefore, to use 30 frequencies in all, since 15 frequencies will give 105 combinations taken two at a time. Thirty frequencies were actually employed for the trial at Richmond, but tests showed that reliability could be gained by eliminating certain combinations of frequencies, and thus the system as now designed employs 32 frequencies in all. These frequencies are the odd multiples of 7½ cycles from 352.5 to 832.5 cycles, inclusive.

The arrangement of the signaling circuit at the land station is indicated in block form in Figure 1. Two register-translator circuits are provided, one for the first two digits, and the other for the last two. Sixteen of the tone outputs from the 32-frequency power supply are connected to each of these circuits. Two tones of the first 16 are selected by the first register-translator circuit to represent the first two digits and a similar choice is made from the remaining 16 tones by the second register-translator circuit to represent the last two digits. From the output of the register-translator, the tones are individually amplified and regulated in level in automatic volume control amplifiers. They are then combined and transmitted through the control terminal to the audio input of the land radio transmitter.

A simple schematic of the signal receiving unit at the mobile station is shown in Figure 2. The four vibrating reed selectors (S1-S4) are surrounded by a common driving coil connected to the audio output of the radio receiver. When four tones, corresponding to the resonant frequencies of the selectors are received, all four selectors vibrate. Each selector is equipped with a small contact which closes during a part of each cycle. The four contacts are connected in series, through a resistance-condenser network, to a d-c amplifier tube. When all the selectors vibrate, a battery voltage connected to the contact on the first selector is transmitted through the network to the tube, causing it to draw plate current and operate a relay in its plate circuit, thus ringing the call bell.

The resistance-condenser network associated with the selector contacts serves two functions. First, the series resistors, R1, R3, R5, and R7, limit the current through the contacts to insure maximum contact life. Second, the shunt condensers, C1, C2, C3, and C4, serve a filtering function, stabilizing the voltage applied to the tube. A direct path from the battery to the tube is present only when all four selector contacts are closed. Although contact closure of each selector occurs over only a small part of its cycle of vibration, simultaneous closure is comparatively frequent under normal operating conditions. To avoid erratic performance of the system under threshold signaling conditions, however, a small condenser is added at each selector. With the arrangement used, condenser C1 charges on contact closure of selector S1 and stores the charge. When the contact of selector S2 closes, a part of this charge is transferred to condenser C2, and so forth. The voltage applied to the tube is fairly steady. Resistors R2, R4, R6, and R8 discharge the condensers in a short period after the selectors stop vibrating.

The d-c amplifier uses a pentode with the control voltage from the selector contact network applied to its suppressor grid. The first grid (usually the control grid) is held to nearly cathode potential. A fairly heavy current flows to the second (screen) grid, and the cathode is raised above ground potential by the voltage drop across resistor

Table I—The number of frequencies, n, that taken r at a time will give 10,000 combinations is tabulated above for values of r from 1 to 6, inclusive.

r	n	r	n
1	10,000	4	24
2	142	5	19
3	41	6	17

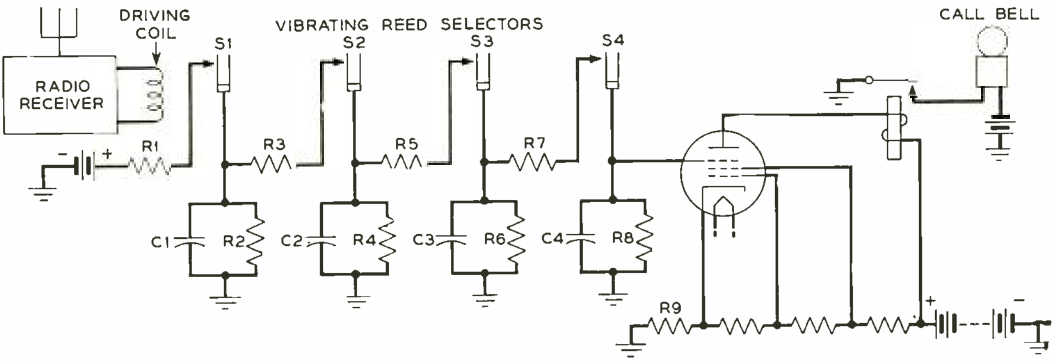


Fig. 2—Simplified schematic of signaling receiving circuit at mobile station.

R9. When the selector contacts are open, the third (suppressor) grid is at ground potential and the plate current is very nearly zero. When a call is received, the selectors vibrate and their contacts close, applying a positive voltage to the third grid. Plate current flows, operating the signaling relay which, in turn, rings the call bell. When the selectors stop vibrating, the circuit returns to normal.

This type of d-c amplifier has the advantage of being very stable and insuring positive operation of the signaling relay regardless of wide variations in power supply voltages. This is an essential feature for equipment to be used in automobiles where battery voltage variations of more than ± 15 per cent are not unusual.

The audio power applied to the selector driving coil is about 18 milliwatts. In the old selective signaling system, about 150 milliwatts is used. Because only about 10 milliwatts of power is required for talking purposes, the new signaling system permits the use of a receiver with smaller audio power capabilities, requiring less standby current from the car battery.

Another important feature of the new signal receiving equipment is its much smaller size. The volume of the present Western Electric type 38A radio receiver attributable to the built-in selective signaling receiver is about 200 cubic inches. The corresponding volume for the new circuit is only about 40 cubic inches.

The Richmond trial has shown that the new signaling system is very reliable. Signaling will normally fail only on circuits over which conversation is impossible. Tests have also shown that the new system is virtually free of false signaling due to operation of the selectors by noise, speech, intermodulation products, and other causes. The selectors have a band-width of only 1.2 cps, and the probability of speech or noise operating all four of them is extremely small.

THE AUTHOR: D. F. Hoth graduated from Stevens Institute of Technology in 1935, and joined the Laboratories in 1936. He first engaged in studies of local plant transmission, and later participated in an extensive study of room noise at subscribers' telephones. In 1942 he was commissioned in the U. S. Army Signal Corps and assigned to Arlington Hall Station, Arlington, Virginia. He returned to the Laboratories in 1946, and for the next two years was concerned with various aspects of the mobile radio program, including the development of the vibrating reed signaling system.

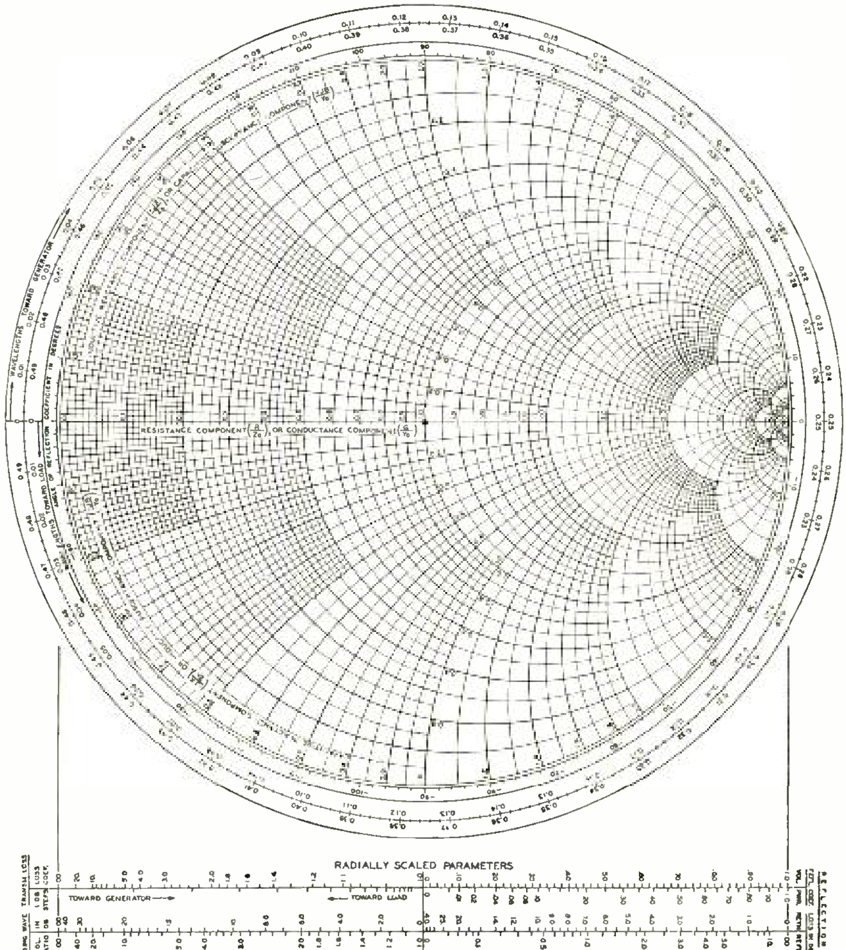
Transmission line chart

Graphical methods for determining impedances of transmission circuits frequently have advantages over purely mathematical means. For the past decade, one particular chart employing circular co-ordinates, devised by P. H. Smith* of the Whippany Laboratory, has found wide use in the solution of high frequency and microwave transmission line problems. The "Smith Chart" graphically relates the complex input impedance at all points along a uniform transmission line to the reflection coefficient, and provides a "slide-rule" solution to a great many single-frequency, steady-state transmission line problems.

The utility of the original chart has been enhanced by adding new radial scales and by relabeling the co-ordinate axes to include admittance components. One of the modified charts is shown below, reduced to half size. The scales selected are believed to represent the transmission line parameters most frequently used in communication engineering, and each bears a simple mathematical relationship to the magnitude of the fundamental voltage reflection coefficient ρ, a uniform radially scaled parameter having a value of zero at the center and unity at the rim of the chart.

Copies of the chart may be purchased from Kay Electric Company, Pine Brook, N. J.

* ELECTRONICS, *January,* 1939, *and January,* 1944; RECORD, *June,* 1948, page 258.



Telephone Service Continued to Improve in 1949

With about eleven and one-half million more telephones in service than at the end of the war, the Bell System is now handling a record volume of 180 million calls a day and these calls are going through faster than at any time since pre-war days, the American Telephone and Telegraph Company reported in its year-end business review.

The Bell Companies added nearly 2,000,000 telephones during 1949, bringing the total number in service to more than 33,300,000. The continued rapid growth, along with the System's program of enlarging local service areas, now enables subscribers to reach a great many more telephones at local rates. For example, a recent study in cities of 50,000 or more population shows that the average telephone user can reach 75 per cent more telephones without toll charges than he could in 1940.

Some 350,000 telephones were added in rural areas by the Bell System and the independent telephone companies during 1949. About 50 per cent of the farms of America now have telephones—a higher proportion than in any other country in the world. The Bell System has boosted its post-war rural telephone gain to 1,300,000 and to accomplish this has added 615,000 miles of wire and 100,000 miles of new pole lines in these areas. Steady and substantial progress has likewise been made in reducing the number of parties on heavily-loaded lines, in making it possible for customers to hear fewer rings beside their own, and in eliminating crank-type telephones. In all, the Bell companies have spent $350,000,000 since the war to extend and improve rural service and they are going right ahead with the program.

Over-all expenditures for new construction during 1949 exceeded a billion dollars, bringing the cost of the System's postwar expansion and improvement program to $4,400,000,000. The System raised about $600,000,000 in new capital in 1949.

New demand for service continues at a high rate. To meet the needs of all customers and improve telephone service further, the Bell companies must keep on adding much new plant.

"Most of the new capital required," said A T & T President Leroy A. Wilson, "should come from the issue of stock, either through conversions or otherwise, and earnings must be sufficient to attract and protect the savings of equity investors. This emphasizes again the need for telephone rates that will maintain earnings at adequate levels today and in the future."

There are now over 825,000 A T & T stockholders, an increase of about 60,000 during 1949. A substantial further increase is expected in 1950.

Post-war rate increases made effective in the Bell System, together with increases sought in pending applications, average about 20 per cent of total System revenues. "The rate increases granted up to now," said Mr. Wilson, "amount to only about half the current cost of wage increases placed in effect during the war and post-war years, to say nothing of the sharply

At Warner Robins Air Force Base, Macon, Georgia, J. F. Morrison, F. E. DeMotte and H. H. Bailey of the Laboratories and Robert Browning and Frederick Lyle of Western Electric's Field Engineering Force investigated the performance of Bell Laboratories' developed electronic equipment.
—*Air Force Photo*

Fred R. Kappel, *A T & T Vice President in Charge of Operations and Engineering, has been elected a Director of the Laboratories, succeeding Cleo F. Craig.*

increased costs of materials, buildings and equipment. Not only have telephone rates increased far less than the rise in wages, they have gone up far less than the prices of most other things that people buy. The increase in cost to the user averages only a penny or so a call and is a small amount to pay to assure the continuing extension and improvement of service to meet the public's needs."

Bell companies have come a long way in their post-war drive toward the goal of giving everyone the type of service he wants, when he wants it. Seventy per cent of the new applications are now being handled in the same month they are received. Since the war's end, while adding eleven and one-half million telephones, the System has also reduced the waiting list from about 2,200,000 to about 800,000.

Significant strides also have been made in the improvement of the service. Average time required to complete long distance calls has been reduced to one and a half minutes, and 95 per cent of the calls are now put through while the customer holds the line—a new high record. Extension of the operator dialing method of handling long distance calls has contributed to the service improvement. With new toll dialing centers opened during the year at Cleveland, Oakland and Boston, nearly 30 per cent of the nation's long distance calls are now put through in this manner.

The System's inter-city television facilities, with networks on the East Coast and in the Midwest that were joined together early in 1949, now link 25 cities and total 8,400 channel miles. Cities added this year include Providence, Schenectady, Utica, Syracuse, Rochester, Wilmington, Dela., Pittsburgh, Lancaster and Erie, Pa., Columbus, Dayton and Cincinnati. By the end of 1950, the System expects to have 15,000 channel miles of TV networks in service, connecting a total of 43 cities. A New York-Chicago radio relay system for inter-city television transmission is due to be completed next summer.

Mobile telephone service likewise experienced substantial growth this year. The System is now serving 7,500 cars, trucks and other mobile units, with a traffic volume of more than 230,000 calls per month.

Telephone research continues to yield new techniques and devices. One such 1949 development is an improved telephone instrument now scheduled for field tests early in 1950.

Calling rate to points overseas has increased to 600,000 annually. Service to Tangier, Malta, Iran and the Behrein Islands was introduced in 1949, and new direct radiotelephone circuits were opened to Hong Kong and the Union of South Africa.

Changes in Organization

The following changes in organization were made effective January 1, 1950:

M. H. Cook was appointed Director of Apparatus and Systems Engineering, succeeding H. H. Lowry, retired. Mr. Cook reports to Vice President W. H. Martin.

The organization reporting to Mr. Cook is as follows: H. J. Delchamps, Director of Apparatus Engineering; A. D. Knowlton, Director of Systems Engineering; M. H. Cook, Director of Systems Standards and Drafting; and W. L. Casper, Apparatus Consultant.

In addition to his assignment as Director of Apparatus Engineering, Mr. Delchamps has been appointed Assistant to Vice President W. H. Martin for administrative duties.

H. A. Affel, Director of Transmission Systems Development, has assumed direct supervision of the work of the group previously reporting to Mr. Knowlton.

Change in Passenger Service

Beginning January 16, transportation of Laboratories people between New York City locations is by a car which will start its first trip from West Street at 9:00 A.M., reach Graybar Varick at 9:10, Fourteenth Street at 9:20 and return to West Street. Trips will be made half-hourly with the last trip leaving West Street at 5:00 P.M.

A T & T Gives Views on Telephone Taxes

The heavy load that excise taxes place on the average telephone bill was brought out in a statement given by A T & T recently to Representative Robert L. Doughton, Chairman of the House Committee on Ways and Means, and Senator Walter F. George, Chairman of the Senate Committee on Finance. Each chairman had said that such a statement would be helpful to his committee when tax matters came up for consideration.

During 1948, the statement said, these excise taxes on Bell System business "were about $13.50 per telephone—or about $1.12 a month. The taxes averaged 18.6 per cent of the taxable revenues—in other words, in 1948 Bell System customers really paid 18.6 per cent more for their telephone service than would otherwise have been necessary, because of these taxes. . . .

"In addition to these excise taxes which users pay, there are the Federal income and other operating taxes of the Bell System companies, which, of course, must be passed on to the users through charges for service. Including these corporate operating taxes with the excise taxes, the total 1948 taxes per Bell System telephone were about $23.30, or almost $2.00 per month."

An operating control position in the television network center in the Long Lines headquarters building where technicians test, maintain, and switch network channels interconnecting New York television studios with the Bell System's inter-city networks.

The statement, entitled "War-Time Taxes on Communication Services in 1949," was presented "on behalf of the users of the nation's 33,000,000 Bell telephones, the 800,000 stockholders, and the other hundreds of thousands whose savings have been loaned to provide the facilities needed to furnish the services."

It expresses the Bell System's view that Federal excise taxes on communication services are unreasonably high, that they are a burdensome and discriminatory load on a business and social necessity, and that they are a carry-over of war-time restrictions into peace time.

It points out that regulatory authorities are keenly aware of these taxes and have taken a strong stand against them.

"Local telephone service and telephone toll messages of less than 25 cents are taxed at 15 per cent, while telephone toll messages over 24 cents and domestic telegrams are taxed at 25 per cent," the report states. "Thus, for instance, on a monthly charge of $5.00 for local service, the customer pays a tax of 75 cents and on a $1.00 toll call, he pays a tax of 25 cents."

Some idea of the over-all tax load on the business of the Bell System, the statement says, "can be obtained by comparing it with the net returns, after income taxes, to all Bell System security holders, for 1948. If we combine Federal and other corporate taxes, excise taxes, and income taxes at the conservatively assumed rate of 20 per cent on the security holders' interest and dividends from the Bell System, the total dollar tax load is more than three times the net returns to the security holders."

"The present high excise tax rates were imposed by the Revenue Act of 1943, which became effective April 1, 1944," the statement continues. "They are largely the result of three war-time tax increases and they are a carry-over of war-time restrictions which have no place in the peace-time economy. . . .

"From 1924 to 1932, there were no excise taxes on communication services. The Revenue Act of 1932 introduced a tax ranging from 10 cents to 20 cents on each toll message over 49 cents, with no tax on local service. This was a "depression" tax to help provide Government revenues at a time when certain of the other tax sources were drying up. . . .

"The Revenue Acts of 1941, 1942 and 1943 were enacted while we were either preparing for war or at war. Their combined effect was to tax those communication services which were not taxed under the 1932 Act and to raise the rates on all the services to the present high levels. The real war-time excises, therefore, are those imposed by the Revenue Acts of 1941, 1942 and 1943, and not just those of 1943.

"There can be no doubt that in taxing all communication services and in fixing the high war-time rates, as done in these three Acts, Congress gave consideration to the necessity for conserving the existing facilities for war needs. Under war-time conditions it was impossible to meet the entire public demand for service, and the effect of the high excises in helping to prevent further overcrowding of the lines was certainly desirable. Now there is no need or desire to discourage the usage.

"The 1943 Act contains a provision that six months after the termination of hostilities, excise taxes are to revert to the level of the 1942 Act. However, the Excise Tax Act of 1947 continued the rates of the 1943 Act without a definite termination date.

"It is clear that simply going back to the 1942 Act would still leave communication services taxed at very high war-time rates, as taxes on local telephone service and toll messages less than 25 cents would be lowered only from 15 per cent to 10 per cent, and on toll messages over 24 cents only from 25 to 20 per cent.

The Bell System feels that "good communication service is a necessity to many people. It is essential in business and in the home; it should not bear what amounts to a restrictive luxury tax load. . . . Excise taxes on communication services discriminate against the users of these services as they saddle on them too great a portion of the total tax load. These users pay their shares of other taxes, as well as the high communications excises."

The report recommends that "In view of the burdens they impose on so many millions of people, excise taxes on communication services should be abolished as soon as possible. If they cannot be abolished completely, they should be eliminated on local telephone service and toll messages less than 50 cents, and reduced greatly on other toll messages."

Dr. Thimann at Murray Hill

Dr. Kenneth V. Thimann, associate professor of plant physiology at Harvard University, was at Murray Hill in December and after a period of laboratory inspections, conferred with a selected group on *Growth Hormones in Plants.* He reviewed the story of the hormone effect from the time of Darwin when pertinent observations were made concerning the general growth of plants and exhibited a series of still and motion pictures showing plant stems bending toward the light in response to the diffusion of hormones from the tips of stems.

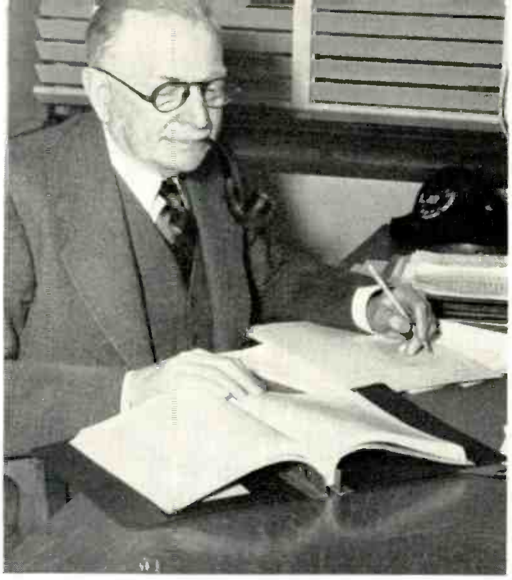
"Bells" At Work

Two churches in the Murray Hill area have 25-bell carillons, thanks to the community spirit of four Laboratories' engineers who gave a great deal of their spare time in applying their electronic and acoustic experience to the project. D. M. Chapin, P. K. Prothero, L. G. Schimpf and R. R. Galbreath pondered and experimented for about a year over the problems involved in properly striking various brass rods through a keyboard operation, picking up the sound with condenser microphone technique, amplifying it and projecting it sweetly via belfry loudspeakers.

Laboratories engineers build carillons for two churches in New Jersey.

The installations, in New Providence and Basking Ridge, were completed just before the holiday season and the parishioners and others in the valley near the Murray Hill Laboratories now enjoy the chimes.

R. L. Hanson took the accompanying photograph of the four carillon builders assessing the tone of one of their two homemade installations. Seated at the console P. K. Prothero energizes the electronic circuit and, with D. M. Chapin, L. G. Schimpf and R. R. Galbreath, left to right, critical attention is given to the result. The keyboard is mounted below the last row of organ keys. The keys themselves are push buttons arranged spacially like a piano keyboard except that there are only 25 notes, from G to G. The reeds are tuned to the even-tempered scale with A at 428 cps to agree with the organ.



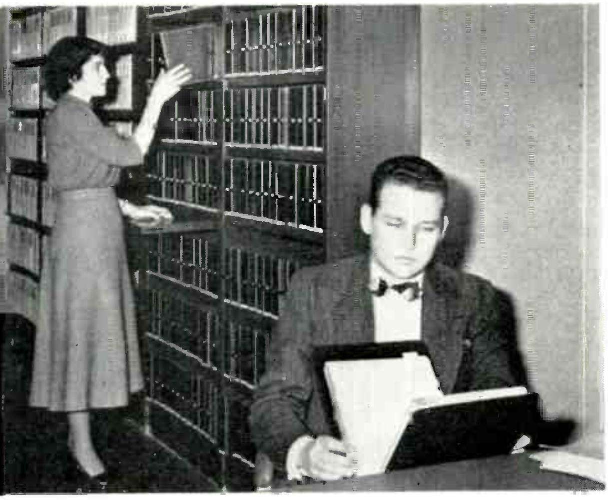
The Patent Department at Murray Hill

To facilitate the handling of patent work at Murray Hill, a section of the Patent Department is now located there. The Patent Staff is composed of twenty-four attorneys under three division attorneys. Most of them are graduates of technical colleges and universities as well as of law schools, and have been admitted to practice before state, federal, and patent bars. Also, there is a patent service staff of twenty, who maintain special library, files, drafting, and transcription services for the attorneys.

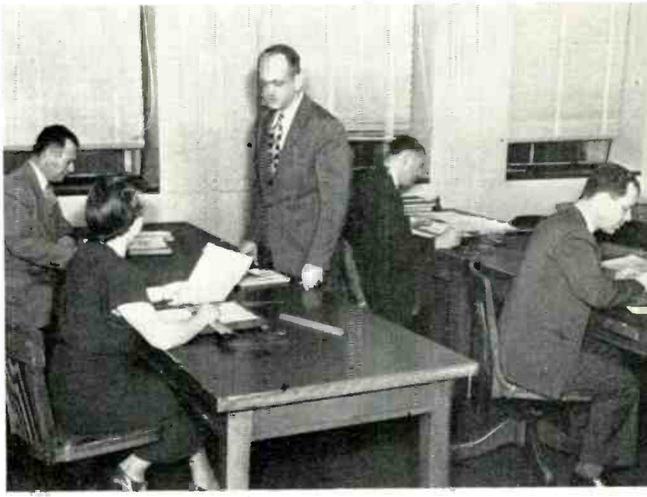
Above are attorney D. MacKenzie and division attorney R. J. Guenther who specialize in patents relating to the general telephone apparatus field. To the left is Elizabeth Scott in the patent library which contains a part of the Laboratories' 300,000 United States and foreign patents classified and filed by subject matter. The girls in the lower left photograph are members of the reports and control group; those in the lower right, of the mail and general files group.

Attorney Martha Pugh confers with attorney H. C. Hart whose field is pulse systems and transmission circuits. Mrs. Pugh is primarily concerned with carrier transmission systems.

When the photographer was taking this series C. A. Sprague, retired, was visiting H. A. Burgess, division attorney responsible for patents applied for in radio transmission and image transmission fields.



Lois Jack selects a patent from the files for R. M. Porter, an attorney, studying in the reading room.



In Patent Drafting, office tables are used in preference to the usual drafting boards.

Rear of the Patent Transcription Department showing supervisor Ellen Spanner, left foreground.

Front of Transcription. Mary McEnaney, extreme right, is secretary to attorneys Guenther, Burgess and Ewing.

F. A. Cowan, A T & T, Named Engineering Head

Frank A. Cowan, recently serving in the capacity of Assistant to General Manager Charles E. Wampler of the Long Lines Department of A T & T, has been named as head of engineering for the Long Lines Department. He succeeded Horace H. Nance, who has retired after more than thirty-nine years of service with the Bell System. Mr. Cowan has had broad experience in the engineering of coaxial cable and radio relay systems.

A British Tribute to Dr. Jewett

Writing in NATURE (London) for December 17, Sir Frank Gill, Chairman of Standard Telecommunications Laboratories, said of Dr. Frank B. Jewett:

"Jewett had been well prepared educationally for the great work he was to do. He showed a keen intellect, honesty in thought, integrity, sincerity, a pleasant manner, a respect for the personality of others and a voice which charmed. All these gave him an amazing talent for friendship, to which I can testify from some forty years association with him. Those working under his direction did so, not only because his direction was good, but also because it was a labour of love for the leader. He gave an extraordinary example of how to manage men and how to weld together teams of persons (even difficult personalities) into efficient units. For many years he suffered from defective eyesight; but he never allowed this to reduce his wonderful output of work."

Retouch artist at Whippany is Frank Holland, air brush poised, as he pauses to study a photograph on which he was working when the photographer took this shot.

Laboratories People Buy A T & T Stock

Some time this month, 2,855 members of the Laboratories will receive 27,818 shares of A T & T stock, in fulfillment of the commitment which they made some two years ago. They will also receive a cash refund of about $1.00 per share since their payroll deductions, with interest, amounted to more per share than the purchase price of the stock. It will be remembered that the price was stipulated as $20.00 less than the average market price "either for the month in which payment is completed or for the next succeeding month, whichever is lower." December average was $146.93, and this price will be used unless January's average price turns out to be lower.

Totaling the stock to be delivered in February and stock which had already been delivered to employees who discontinued their subscription and purchased the number of shares then paid for, a total of 34,626 shares under the first offering have been issued to employees of the Laboratories.

Out-of-Hour Courses

Several new courses have been added to the Out-of-Hour training program. The new courses, which started on January 23, are:

Fundamentals of Television by P. Mertz and members of Transmission Development and Television Research with classes at Murray Hill. In this course the perception of light and color and related subjects are reviewed as needed for an understanding of the graphical reproduction of scenes. This problem is approached by way of its many similarities in the photographic art. Discussions then follow of scanning, television signal transmission, television standards and apparatus, distortion and quality impairment, television signal propagation by radio and over wires, and the organization, particularly from the standpoint of the apparatus and communication facilities that it uses, of present-day television broadcasting.

Modulation Theory by J. B. Maggio, at Murray Hill. This course deals with the processes

Heating a molybdenum part to make a glass seal for a vacuum tube is R. E. Azud of Electronics Apparatus. This is the second appearance of the megatherm in the RECORD, *the first being the April, 1949, issue when it was featured in a typical move to Murray Hill.*

by which intelligence to be conveyed is converted to information in a form suitable for transmission and thereafter is recovered, suitably transformed, and presented to the designated recipient; amplitude modulation and frequency modulation; pulse modulation; principles of sampling and quantizing; and statistical properties of message material. Emphasis is placed on theoretical consideration of processes rather than on details of instrumentation.

Probability and Statistics Fundamentals–Applications to Traffic and Design Problems by C. Clos, in New York. This course provides an introduction to the mathematical basis of probability theory. Following a discussion of the definition of probability, the laws of combination of elemental probabilities are derived and illustrated. Frequency distributions in one variable are considered, and the types most frequently encountered in engineering work are discussed. The elements of combining variates to yield solutions to more complex problems are given. Some of the many applications of probability theory to telephone traffic problems are described.

First Aid–Standard Course by volunteer registered instructors. One course will be given in New York and another at Murray Hill.

Courses continued from last fall are:

Electronic Circuits–III by C. A. Warren, at Whippany, and E. K. Van Tassel, in New York.

Oscillations and Waves–III by S. P. Morgan, Jr., at Murray Hill.

Review of Engineering Mathematics–II by G. G. Muller, at Murray Hill.

Manufacturing Methods–II by K. L. Warthman, in New York, and E. H. Jones with the assistance of various members of the Military Electronics Department, at Whippany.

Freehand Sketching–II by D. H. King, at Murray Hill.

Third Stock Offering

Prospectuses for the third offering of the Employees' Stock Purchase Plan were mailed out to eligible members of the Laboratories on January 17. For those who elect to purchase shares of A T & T stock under this offering, payments will be made by allotments from pay starting in April. Under the plan up to 2,800,000 shares may be sold to employees. About 2,200,000 shares are currently being purchased by employees or have been issued under two previous offerings, made in September, 1947, and December, 1948.

Employees with three months' or more service on December 31 will be eligible to participate. Officers of the A T & T will not be eligible. The purchase price will be $20 per share less than the market price when payment is completed, but not more than $150 nor less than $100 per share. Payment will be made by payroll allotments at the rate of $5 per share per month with interest credited at two per cent per year.

Under the new offering eligible employees may elect to purchase up to one share of stock for each full $500 of their annual basic rate of pay on December 31, 1949. These shares may be in addition to the shares which employees have bought or are buying under the two previous offerings, except that no employee may purchase a total of more than 50 shares under all offerings.

The A T & T will reserve the right to allot a reduced number of shares if employees elect to purchase more shares than are currently available. However, allotments may be increased later if sufficient shares become available through cancellations under this and the earlier offerings under the plan.




MARY DOUGLAS JOSEPH IRISH H. C. SPRYER H. W. WIGHTMAN

RETIREMENTS

Among those retiring from the Laboratories are Mary Douglas with 50 years of service; Joseph Irish, 46 years; H. C. Spryer, 40 years; and H. W. Wightman, 28 years.

MARY A. DOUGLAS

Mary Douglas retired on her sixty-fifth birthday after fifty years of Bell System service, all of it in the West Street building. She had spent half a century hand-winding coils – so perfectly that older engineers have never been quite so well satisfied with those wound by machine. Miss Douglas' story was in the September, 1949, issue of the RECORD on the occasion of her golden jubilee. The event was celebrated by a luncheon at which Dr. Buckley presented Miss Douglas with a diamond brooch on behalf of the Laboratories. She received personal letters from the late Dr. F. B. Jewett and from Leroy A. Wilson, president of A T & T. The Pioneers of the Frank B. Jewett Chapter honored her with a gift during the Murray Hill Open House in September. Such papers as the *Herald Tribune* and her local paper *The Villager* carried her portrait and story. Overnight "Mamie," who had always shunned publicity and was comparatively unknown even at West Street, became famous. She accepted the acclaim so graciously and so sincerely that she endeared herself to all who had contact with her.

On January 10, the last day she worked, she was tendered a farewell dinner in the Village. Among her souvenirs were an autograph book with a cover woven of wires of the type she handled all her life, and a desk-set in miniature of the machine at which she had worked.

JOSEPH IRISH

A continuing problem in our business is the presentation of information in such ways that it can be found quickly and readily understood. "Joe" Irish's job at Hawthorne—which began in 1911—was to translate engineering specifications and drawings into instructions for the Shop. So he began to make suggestions to New York looking to better presentation, and in 1924 he was transferred to the circuit development group here. Gradually he simplified the drawings and particularly the text that explained them; he worked out the presentation in tables of a lot of information which had been in the form of notes in the margins of the drawings. He had been a maintenance man and an engineer for Southern Bell from 1903 to 1911, and it was a satisfaction to feel that his innovations were a real help to his former associates when the Laboratories' drawings became Bell System Standards and were universally used by the Operating Companies. The keysheet—an index to all the current drawings of a system—was another innovation with which he had much to do. "Joe was a great arguer," say his friends, "but he was so nice about it that we didn't mind his persistence. He was an expert on wiring diagrams—what the Shop works from—and he trained a lot of us engineers to break down our schematics into parts for easy job-engineering and manufacture. He was so well grounded in circuit design that he often contributed valuable ideas in that field."

Mr. and Mrs. Irish will live near Cape May, where Joe expects to enjoy his two hobbies—radio and good eating.

HUGH C. SPRYER

Hugh Spryer's life work has been on all kinds of special equipment for orders which could not be filled by existing designs. So he has been in on the birth of many things which are now standardized and well known, such as teletypewriter switchboards, voice frequency telegraph, telephotograph, and program systems.

Entering the famous "Class of 1909" at Hawthorne with an electrical engineering degree from Penn State, Mr. Spryer soon began to specialize on telephone train dispatching. It was then a new art, and Northern Electric was actively promoting it. Mr. Spryer spent seven years selling and installing it on Canadian railroads; then in 1918 came to the Laboratories. Here he has endeavored to fill customers' requests for circuits to meet special conditions by some simple means, or has reported the probable cost and time required when development must be undertaken. Over the years he has accumulated wide lore of what has been done in serving these special needs.

Mr. and Mrs. Spryer—the latter a Montrealer—will continue to live in East Orange, and to watch the progress of "their" Bell System.

Harry W. Wightman

Harry Wightman has come up through all the jobs associated with stockrooms. Successively as porter, service clerk, general clerk, stockroom keeper, and supervisor of order service, he has risen from a Basement B assignment at West Street, where his shortness was an advantage at each "low bridge," to a storeroom keeper at Whippany. Many will remember him from his fifteen-year stockroom work at the Graybar-Varick building.

Harry is now spending two months on Florida's west coast, where a number of the Laboratories' men are living after retirement. Then he and Mrs. Wightman will reside in their newly conditioned house in Morristown, New Jersey.

"The Telephone Hour"

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

February 6	*Jascha Heifetz*
February 13	*Oscar Levant*
February 20	*John Charles Thomas*
February 27	*Barbara Gibson*
March 6	*Fritz Kreisler*
March 13	*Marian Anderson*
March 20	*Robert Casadesus*
March 27	*Bidu Sayao*

Overseas Telephone Service

Coincident with the arrival of the Shah of Iran on a visit to the United States, regular telephone service was opened late in 1949 for the first time between this country and Iran. The new service uses a regular overseas radiotelephone circuit between New York and Berne, Switzerland. Swiss radiotelephone facilties complete the link with Teheran, the Iranian capital.

To help handle the rising volume of radiotelephone calls with Venezuela and Guatemala, Long Lines established an exclusive circuit to each of those two countries on November 7. Formerly, Venezuela shared a "forked" circuit with two points in the West Indies, while service with Guatemala was shared with two countries in Central America. The two new circuits were made possible by re-arranging and adding to the transmitting and receiving facilities at Ojus and Fort Lauderdale, Fla. Telephone traffic with Venezuela, where one of the principal in-

February Service Anniversaries of Members of the Laboratories

40 years

C. W. McWilliams

35 years

J. G. Harlin

30 years

William Bennett
William Bischoff
A. I. Crawford
T. V. Curley
H. L. Downing
E. F. Elbert
S. J. Fetyko
Frederick Frampton
A. W. Frey
H. F. Gartner
H. W. Gillette
C. T. Grant
J. P. Hoffmann
G. H. Huber
W. Y. Lang
Eugene Ress
George Risk, Jr.
George Sandalls, Jr.
Jessie Strachan
C. F. Swasey
Blanche Timm
Loretta Vogel

25 years

F. R. Bies
Stephen Ecker
Joseph Gramels
R. T. Holcomb
F. W. Kammerer
L. W. Kelsay, Jr.
Elizabeth Mains
L. E. Milarta
H. W. Nylund
E. D. Prescott
W. E. Regan
H. H. Schroeder
E. T. Stammer
W. E. Whidden

20 years

Michael Aruck
Willard Babington
J. E. Bates
A. P. Besier
H. D. Bone
Ernest Buehler
A. J. Chase
W. J. Clarke
C. P. Clausen
C. F. Curran, 3rd
C. A. Dahlbom
George Deeg, Jr.
W. G. Dolbear
H. L. Driver
G. P. Durrschmidt
H. L. Edlind
Caesar Garcia
M. J. Goodwin
E. C. Graunas
W. G. Guldner
R. H. Gumley
W. F. Janssen
J. W. Johnson
S. O. Jorgensen
P. J. Keenan
A. R. Kolding
R. R. Kreisel
Donald MacNair
R. W. McKenzie
J. J. McMahon
G. J. Miller
B. H. Nordstrom
George Rodwin
D. I. Schenck
C. J. Scheuerman
W. T. Sermeus
R. P. Smith
G. T. Springer
O. S. Sterner
R. E. Sward
E. A. Thurber
G. N. Vacca
J. M. West
J. W. West
Henry Widmann

15 years

W. R. Baldinger
Ernest Briechle
C. N. Doe
R. W. Edmonds
Karl Haller
F. W. Kausch
J. J. O'Shea
A. E. Ruppel
Martha Schmitt
R. D. Snyder

10 years

William Hippchen
Helen McKeon
J. A. Zweig, Jr.

dustries is oil, rose 91 per cent during the first ten months of this year. During the same period, calling with Guatemala, land of the coffee bean, climbed 23 per cent.

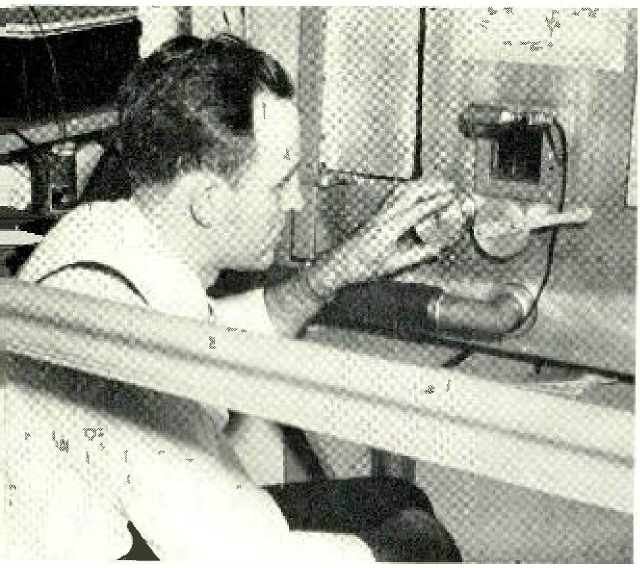
Unconventional Visitor to Murray Hill →

In the late afternoon of January 17, a privately owned Beechcraft Bonanza made a forced landing on the front lawn at Murray Hill. The newly planted sugar maples along the main entrance prevented an otherwise safe landing which might have been made in the relatively large area between Mountain Avenue and the gate house. One sapling hooked a wing and flung the craft violently to earth with a crumpled propeller, right wing tip and landing gear. R. K. Pierson, pilot from Wilmington was en route from Hartford to Camden with Mr. and Mrs. J. E. Bentley of Collingswood, N. J. The three occupants opened the cabin door and stepped onto the ground about the time the first wave of workers from the nearest building reached the spot. There were no other than superficial cuts on the men's hands. The airplane was dismantled the following day and returned to its home base in Wilmington.

Photo by D. W. Bodle

Chimney Lab

There are a few spots at West Street that visitors to the Laboratories seldom see. One is a vibration-proof laboratory in the base of the chimney, Section G, where Anthony Uminowicz is shown testing equipment now under development in the Transmission System Development Department. This chimney, now unused for its original purpose, has a deep, pile-driven foundation independent of the rest of the Laboratories' building. It provides a laboratory space about 10 feet square with a 30 foot ceiling. The entrance to this area and the problem of taking Mr. Uminowicz's picture in this laboratory can be seen on page 91.



"Exhume It, Please"

A farmer near Miamisburg, O., Ohio Bell reports, recently called out a couple of deputy sheriffs to investigate what looked suspiciously like a freshly filled grave. The deputies were led to some newly turned diggings which measured a neat six feet by two feet. They went to work and finally the "corpse" was uncovered. A little chagrined, but much relieved, they identified the body as a length of telephone cable.

Next day, the cable repair foreman read about the incident in the local newspaper, and drove out at once to investigate. Sure enough, the gravediggers had damaged his cable, but fortunately no trouble had occurred. The cable was repaired and the dirt replaced once again.

This may not be the end of the story. It seems the construction forces had to dig quite a few "graves" to change load coils along this cable.

Conversion Price Lowered

The conversion price of A T & T Fifteen Year 2¾ per cent convertible debentures, due December 15, 1961, has been reduced from \$150 to \$148. The reduction in price is in accordance with provisions in the Indenture which make the conversion price subject to adjustment under certain conditions. This adjustment has resulted from the issuance, since

December 15, 1946, of additional shares of A T & T stock at prices less than $150 per share, the initial conversion price of the debentures. Such additional shares have been issued through the conversion into stock of other convertible debentures of the Company, and under the Employees' Stock Plan.

Four Winds, Seven Seas and the Telephone

When Johnny goes off to sea these days he is no farther from home than his ship's telephone. That is, if he is a U. S. sailor and is serving aboard a destroyer, cruiser, battleship, aircraft carrier or any other large naval ship.

The reason for Johnny's new attachment to home is a recent arrangement between the Navy and Long Lines, which permits sailors to make shipboard calls from the high seas by means of Bell System high seas radio-telephone service. This is the same service used by passenger lines and cargo ships. However, calls are placed only one way—ship to shore.

Retired but Active

Newark Evening News, Jan. 1, 1950

Edward C. Molina, mathematician, pianist and amateur astronomer, who recently celebrated his 72d birthday, enjoys his work as a special lecturer at Newark College of Engineering. "With me, teaching math is incidental," he said. "Now I'm having my college days."

Molina explained that his father wasn't able to send him to college after he was graduated from Flushing High School in 1895.

"So I decided to study on my own," Molina said, "and I was able to master subjects ranging from trigonometry to differential equations. I had a job on the night shift at a New York powerhouse and I used to sit on a dynamo housing while I was studying so the vibrations would keep me awake."

Although he is enjoying his belated "college days" at NCE, Molina thinks some students don't get as much from their classes as they should.

"Many college students just concentrate on memorizing formulas and neglect the fundamental question of 'why?' " he said.

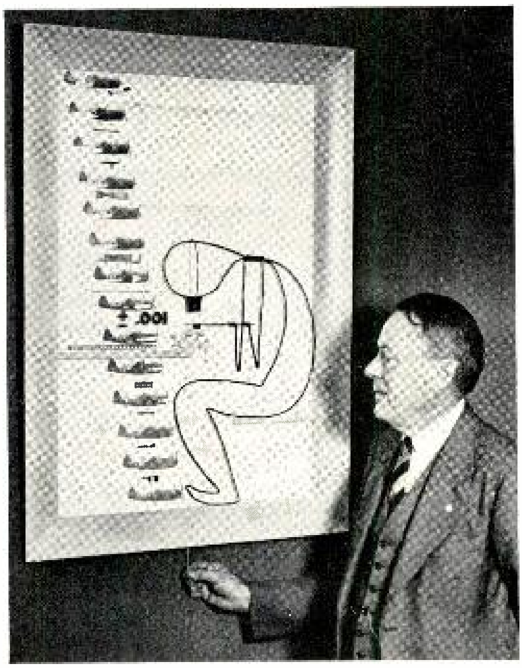
An expert on the theory of mathematical probability, Molina made a number of contributions to the telephone dial system during his 41 years with the Bell Telephone Laboratories as a researcher.

The so-called "Poisson" tables which he helped to develop for solution of telephone probability problems was of great aid at Aberdeen Proving Ground in Maryland during the war for ammunition sampling and has now been adapted in industry.

The sedentary life was not for Molina when he retired from the telephone company in December, 1942. A division of war research at Columbia University occupied him for several years and then in 1946 he was called to NCE.

Besides his teaching he has his piano playing and astronomy to occupy his time.

"When I was about 18 I had no intentions of becoming a mathematician," Molina said. "I loved the piano and I used to practice as much as 12 hours a day. I thought I might have a career as a pianist but my fingers were too short and I gave up the idea."



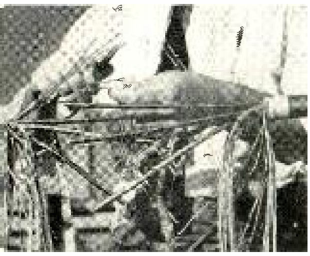
When he retired at the end of December, his associates presented to C. N. Hickman this stylized portrait of himself in a familiar attitude. On a background of a cover of the RECORD, *showing a picture taken with his ribbon-frame camera, are mounted a number of apparatus parts, each symbolizing one of Dr. Hickman's inventions. The figure, made of black insulated wire, files away vigorously when Dr. Hickman pulls the string.*

As for astronomy, any evening when he isn't at the piano Molina may be found on the roof of his home at 141 Dodd Street, East Orange, peering through his four-inch refractor telescope at the stars. Astronomy has been his hobby for many years. It is a hobby shared by his wife, Virginia.

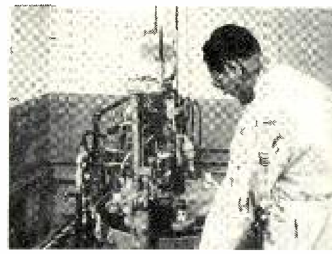
Can You Title These Pictures?

All have appeared in the RECORD *during 1949. Answers on page 95.*

Answers on page 95.



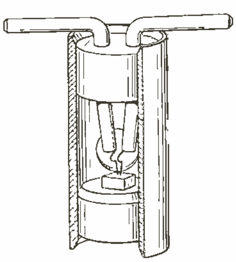
1. These hands are splicing, but what kind of cable
   - A. Local subscribers
   - B. Coaxial
   - C. Video pair
   - D. Submarine



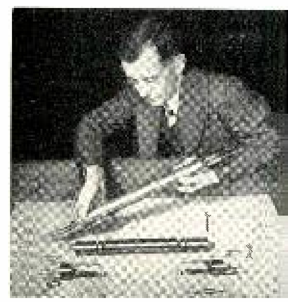
6. This man is
   - A. Polishing spectacle lenses
   - B. Assembling vacuum tubes
   - C. Punching holes in doughnuts
   - D. Grinding EDT crystals

2. The girl in the foreground is
   - A. Intercepting calls to changed numbers
   - B. Operating a toll line key set
   - C. Posing for her picture
   - D. Doodling

7. This is a
   - A. Cat's cradle
   - B. Vee-belt drive
   - C. Crystal cutter
   - D. Ice-cube machine



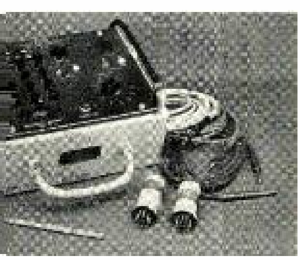
3. This cut-away view shows
   - A. A micro-manipulator
   - B. An old-time crystal detector
   - C. Detonator of a "buzz" bomb
   - D. A new kind of amplifier



8. This engineer is examining
   - A. A bazooka
   - B. A trombone
   - C. An amplifier
   - D. A coaxial

4. Here are the parts and the assembled whole of
   - A. A coaxial transistor
   - B. A vacuum tube voltmeter
   - C. Coaxial attenuator
   - D. Emergency splice for coaxial cable

9. This young lady is
   - A. Crystal gazing
   - B. Making Christmas candy
   - C. Examining an icicle
   - D. Studying a crystal weed



5. This test set tells about
   - A. Relay adjustments
   - B. Trouble locations on cable
   - C. Your heartbeats
   - D. Impedance unbalance

10. These engineers are
   - A. Finishing an igloo
   - B. Assembling a horn antenna
   - C. Putting finishes on life test
   - D. Developing a new shipping container

News Notes

Trends in the telephone business and their relation to the Laboratories were discussed by Dr. Buckley with the supervisory staff on January 5 at a conference in the West Street Auditorium. Twenty-five years earlier, he noted, the Laboratories had come into being as a corporation. In conclusion, Dr. Buckley read the letter from President Wilson of A T & T, which appears on the first page of this issue.

Dr. Buckley escorted Elihu Root, Jr., a Director of the A T & T, on a visit to the Murray Hill Laboratory on December 5. On December 7, Dr. Buckley was host to two executives of Merck & Company–George W. Merck, President, and Dr. R. T. Major, Vice President and Scientific Director, on a visit to the Murray Hill Laboratory.

G. W. Gilman, Pierre Mertz and C. E. Shannon are among those who will be made Fellows of the Institute of Radio Engineers at its annual convention in March. The rank of Fellow, an honorary grade, is the highest membership progression in the Institute.

Professor B. E. Warren of the Physics Department of M.I.T. spoke to a group of those working in associated fields in Murray Hill's Arnold Auditorium on *Effect of Cold Work on X-ray Diffraction Patterns.* The speaker has recently been making precision studies of the effect of strain on X-ray diffraction from metals.

Dr. Alex Bavelas, associate professor of psychology at M.I.T. spoke at a conference on *Communication in Task-Oriented Groups* in the Arnold Auditorium on January 11. Effect of communication patterns upon the performance of a task requiring group effort was discussed, covering such matters as fatigue and strain. error frequency, and dissatisfaction directed primarily at co-workers as factors in the overall effectiveness of the group.

Ready to serve luncheon on one side of the cafeteria line at West Street are Mildred Manuel, Supervisor Florence Lutgen, Katherine Meyer, Clytie Threadgill, Nora Killeen, Head Cook Andrew Scaglione, and Mary Cummings.

At the singing of Christmas carols in the West Street auditorium on December 22, Dr. Buckley addressed the group and extended his best wishes for a Merry Christmas.

D. A. Quarles visited Wright Field on December 29 with W. C. Tinus, J. M. West, J. F. Morrison, and J. F. Wentz of Whippany.

W. Fondiller was the speaker at the January meeting of the Deal-Holmdel Colloquium which was held at Deal. Dr. Fondiller spoke on *The Business Operations of the Laboratories.*

E. H. Perkins, Commanding Officer of the 9255th Volunteer Air Reserve Training Squadron, has been promoted to Lieutenant-Colonel. A resident of Basking Ridge, Lt.-Col. Perkins has been with the 9255th Squadron since February, 1948, and its Commanding Officer since July, 1949. The 9255th Squadron is based at the American Legion Home, and is comprised of 170 Air Force Reserve Officers and Airmen from all parts of Morris County.

A. N. HOLDEN, C. KITTEL, F. R. MERRITT and W. A. YAGER have written on *Determination of g-Values in Paramagnetic Organic Compounds by Microwave Resonance* in the Letters to the Editor section of January 1, 1950 *The Physical Review.*

VOICES OF PHYLLIS TAYLOR, H. M. CLEVELAND, H. H. HAGENS and D. R. FRANTZ were put into a series of effective disc recordings that were broadcast over radio station WMTR, Morristown, during the March of Dimes Campaign.

K. K. DARROW went to Washington on December 2 to attend a meeting of the Committee on International Scientific Unions of the National Research Council. On December 11 he gave a lecture on *Nuclear Energy* before the Washington section of the Institute of Radio Engineers. Dr. Darrow also attended occasional sessions of the meetings of the American Association for the Advancement of Science in New York.

periments and C. HERRING on *Mechanisms Involved in Sintering.*

G. J. HERBERT assisted in setting up a physical testing laboratory at Winston-Salem.

L. EGERTON presented a paper entitled *Preliminary Report on Barium Titanate-Lead Titanate Compositions* before a Ceramic-Dielectric Symposium at Rutgers University.

A. C. WALKER gave a talk on *Growing Piezoelectric Crystals* before a joint meeting of the Franklin Institute and the Philadelphia Physics Club at the Franklin Institute.

K. G. MCKAY spoke on *Electron Bombardment Conductivity in Diamond* before a conference discussing the work of the Physical Electronics group held in the Arnold Auditorium at Murray Hill in December.

R. D. HEIDENREICH presented a paper entitled *Dynamical Theory of the Forbidden (222) Electron Reflection in the Diamond Structure* before the Philadelphia meeting of the American Society for X-Ray and Electron Diffraction.

Most popular of winter sports at Whippany is volleyball. Six teams are playing this season and the spirited game, above, was between all-star teams.

HARVEY FLETCHER spoke before the International Relations Group at Murray Hill on January 11. His topic was *The L.D.S. Missionary System as a Factor for Good International Relations.* Retired as Director of Physical Research in 1949, Dr. Fletcher is teaching at Columbia University.

A CONFERENCE to discuss the work of the Physical Electronics Research Group was held in the Arnold Auditorium at Murray Hill on January 4. J. P. MOLNAR spoke on *Measurements of Very High Vacuua, and Related Adsorption Ex-*

H. A. BIRDSALL attended meetings in New York of A.S.T.M. Committee D-6 Subcommittee I on paper testing methods and the Advisory Committee of A.S.T.M. Committee D-6.

J. H. SCAFF presented a paper on *The Chemistry of Germanium* at a Symposium on Progress in Chemistry held at the A.A.A.S. meeting in New York.

F. G. FOSTER selected *Nature Through the Microscope* for his talk before the Newark Museum Nature Club.

The photograph on page 86 looks easy enough to take, now that it's in print. But to get it, photographers Jack Stark and Pat Mucci had quite a time. Jack is shown at the chimney entrance, set high above the floor, and barely wide enough for him and his camera to enter. Jack took Pat Mucci, making the actual photograph, as he was perched high on a ladder on the stairway to the testing platform, which is hung 8 feet 6 inches above floor level in the chimney base.

G. R. Price presented three papers at the Optical Society of America meeting in Buffalo.

W. O. Baker attended meetings of the O.N.R. Panel on Physical Chemistry in Washington and of the Joint A.S.T.M.-Armed Forces Plastics Committee at Princeton.

W. E. Campbell and F. Hardy participated in the Air Force-Navy Industry Conference on Aircraft Lubricating Greases at Wright Field.

A Conference between faculty and former graduate students at Princeton, held in the Graduate College there, was attended by R. M. Burns, W. O. Baker, P. S. Olmstead, and P. B. Findley.

R. L. Wallace, Jr. spoke on *The Transistor* before the New Orleans section of the American Institute of Electrical Engineers and the Tulane student branch of the Institute at Tulane University, New Orleans. Dr. Wallace addressed the Southwestern Section of the I.R.E. on the same subject during their convention in December at Dallas. He also spoke at the Western Electric plants in Charlotte and Winston-Salem.

W. E. Kock discussed electrical reproduction of music before a meeting in December of the Montclair Society of Engineers.

L. R. Walker presented an invited paper on *Electromagnetic Propagation in Ion Streams* at an American Physical Society meeting.

H. S. Black reviewed the book *Electrical Transmission of Power and Signals* by E. W. Kimbark; and E. F. Kingsbury, the book *Photoelectricity and Its Application* by V. K. Zworykin and E. G. Ramberg, in *The Proceedings of the Institute of Radio Engineers,* issue of December, 1949.

R. O. Grisdale made a visit to the Wilkor Products, Inc., Cleveland.

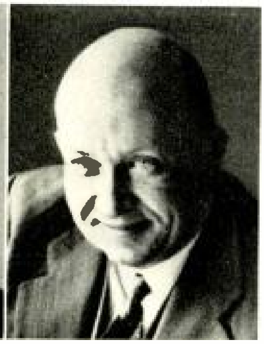
J. G. Ferguson and W. J. Means, on a visit to the General Radio Company, Cambridge, Massachusetts, discussed frequency standards.

Volume 27–Bound Copies and Index

Bound copies of Volume 27 (January, 1949 to December, 1949) will be available shortly at $2.75, foreign postage 25 cents additional. Remittances should be addressed to Bell Laboratories Record, 463 West St., New York 14, N. Y. A separate index to Volume 27 of Bell Laboratories Record *is available upon request.*

RECENT DEATHS

E. B. Hinrichsen
1882-1949



B. A. Clarke
1893-1950

Ernest B. Hinrichsen, December 29

Mr. Hinrichsen joined the Illinois Division of the Central Union Telephone Company in 1905 and from there moved on to the Chicago Telephone Company and to the Equipment Engineering Department of Western Electric at Hawthorne as an equipment engineer. In 1919 he transferred to Inspection Engineering first at Hawthorne and later at West Street where he handled questions relating to field service. From 1926 to 1937, Mr. Hinrichsen was at ERPI. Upon his return, he became a member of Electronic Apparatus where he had charge of investigations of tool-made samples and the engineering factors involved in complaints until his retirement in 1947. He also had charge of the development of the marking, packing, and shipping methods for vacuum tubes.

Bruce A. Clarke, January 10

Mr. Clarke, technical illustration editor, was a graduate of Massachusetts Institute of Technology and a veteran of World War I. He joined the Western Electric Company as a junior engineer in 1919 shortly after his return from France where he had served with the 25th Engineers Corps. In 1921 he became technical information editor and in 1923 was appointed a Member of the Technical Staff. Two years later, Mr. Clarke assumed responsibility for publication of the technical monographs published by the Bell System and continued that work until the beginning of World War II. Since then he had been responsible for the illustration of such publications as the Record, the *Bell System Technical Journal*, as well as the Laboratories' technical book series and numerous professional articles. He combined a broad knowledge of many branches of science and engineering with a long experience in illustrative techniques. His work was of special importance when, during World War II, Bell Laboratories compiled hundreds of training manuals, technical bulletins and instruction books for the Armed Forces.

Mr. Clarke is survived by his wife, whom he married in France during his military service, and a son, Robert I. Clarke, of Long Lines.

H. A. Milbury
1904-1950

Thomas Creaven
1876-1949

Herbert A. Milbury, January 1

Mr. Milbury joined the Laboratories as a member of the Power Plant in 1930. He served in the various occupational classifications of this group and in 1941 was promoted to a Plant Watch Operator. In this capacity he was charged with the inspection of continuous tests of electrical and mechanical nature throughout the Laboratories.

Mr. Milbury, who was forty-five, succumbed suddenly from sickness while on duty during the morning of January 1. A resident of Irvington-on-Hudson, he is survived by his wife, Mrs. Marion Smith Milbury; two sons, Edwin and John Thomas Milbury, and a daughter, Barbara Milbury.

Thomas Creaven, December 4

Mr. Creaven completed thirty-five years of Bell System service at the time of his retirement in 1941. He started his Bell System career in the Building Service department and served in the various occupational classifications. For the last twenty years before retirement he was a Uniformed Watchman.

News Notes

C. C. Houtz and M. Whitehead visited the General Electric Company in Pittsfield, Massachusetts, to discuss problems relating to electrolytic capacitors.

C. W. Nuttman, E. S. Willis and S. G. Hale conferred at Haverhill on details of new coil and filter designs.

Teller F. J. Boyle, foreground, and paymasters K. H. Guerard and H. J. Stewart rendering cashier services to members of the Laboratories at Murray Hill. When alterations are completed in the Treasury Department at West Street, it will feature an open counter like the one which is shown here.

C. R. Steiner went to the Sprague Electric Company, North Adams, Massachusetts, in connection with the development of a new insulating finish for electrolytic capacitors.

T. G. Blanchard visited Winston-Salem to discuss problems of transformer manufacture.

H. G. Wehe and J. R. Weeks were at Archer Avenue in connection with production problems on metallized paper condenser units for station application. Mr. Wehe attended the N.A.M. and the A.A.A.S. conventions in New York City. He was a guest at the George Westinghouse National Science Writers Award dinner at the Hotel Statler.

T. A. Marshall was in Philadelphia to observe the operation of toll slip cutting equipment on the teletypewriters used in the automatic message accounting office.

E. W. Houghton gave a lecture on *The Measurement of Power at Frequencies above 1000 Megacycles* at the Franklin Institute in Philadelphia before a joint meeting of the Institute and the Instruments and Measurements Discussion Group of the A.I.E.E.

A MESSAGE TO VETERANS

The following is a special message to veterans of World War II from the ranking Laboratories man in Bell Telephone Post 497, American Legion:

Nearly $3 billion will be distributed to 16 million World War II veterans in National Service Life Insurance dividends during the early part of this year. This money should be used wisely for the benefit of veterans and their families, and the Nation. I believe one of the wisest ways veterans can use the money is to buy United States Savings Bonds which increase in value 33⅓% in ten years, and provide funds for education, retirement, reserves and emergencies.

In partnership with Savings Bonds Committees all over the country the Legion has consistently endorsed the U. S. Savings Bonds Program. Individuals now hold $48 billion worth of these bonds which is worth about five billion dollars more than in 1945. By so doing we veterans will lead the way in demonstrating to our comrades-in-arms of World War II, all over the world, that we are dedicating this money to continue world peace, for without peace, we cannot provide security for ourselves or our children.

GEORGE J. McARDLE
First Vice-Commander

During a demonstration-lecture on portraiture, P. A. Stevens of Graybar and A. R. Thompson, Publication Production Manager, learn techniques in the medium of oils from instructor E. Stanley Turnbull of the Newark School of Fine and Applied Arts. Raymond Pippin is the model. The March RECORD *will show students' portraits of Mr. Pippin.*

L. W. MORRISON spoke before the New York section of the Institute of Radio Engineers on the challenging problems which arose in the development of the coaxial cable network now used to link east and midwest via television.

V. I. CRUSER and G. A. BOECK visited the microwave transmitting station at Tallyville, Delaware, to discuss with representatives of The Bell Telephone Company of Pennsylvania problems concerning specially designed waveguide components.

J. A. BECKER has written on *Transistors* in *Electrical Engineering* for January, 1950.

P. B. FINDLEY attended the New Jersey Conference of Industrial Editors on December 6 at Rutgers University. On December 13 he addressed the Men's Club of the Congregational Church in Flushing, using the microwave demonstration equipment described in the January issue of the RECORD.

S. P. SHACKLETON, as chairman of the student guidance committee of the New York section A.I.E.E., gave a talk on December 7 at Newark College of Engineering on *The Engineer's Job.* The meeting was sponsored by the Electrical Engineering Department of the College and was one of a series of conferences for high school students designed to cover all branches of engineering.

VISITS WERE MADE to observe the performance of the No. 4 offices during the heavy load period of the Christmas holiday by C. H. MCCANDLESS at Boston, R. C. PFARRER at New York, J. W. GORGAS at Philadelphia, M. E. MALONEY at Cleveland, O. MYERS at Chicago, and M. E. ESTERNAUX at Oakland, California.

A. J. PASCARELLA visited the Boston No. 4 toll office in connection with No. 4 crossbar and crossbar tandem intertoll trunks.

F. A. PARSONS conferred at the Albany office on the A4A system being installed there.

M. E. MALONEY made pre-cutover trips to the No. 4 office in Boston and the A4A offices in Albany and Baltimore.

E. L. GETZ visited the Pacific Company during the cutover of their Mill Valley No. 5 crossbar office.

R. P. JUTSON visited the AMA center in Philadelphia on problems relating to message accounting.

W. KEISTER gave a talk entitled *Magic of Relays* at New York Electrical Society on November 22.

K. M. FETZER went to Hawthorne in connection with No. 5 crossbar scheduling.

W. Y. LANG and B. S. SWEZEY visited the Teletype Corporation in December in connection with development of the No. 28 teletypewriter.

Engagements

Thomasina Dale—*Frank R. Criger
Rita Flanagan—*Thomas J. Landis
*Ethel Gere—Edgar G. Paradise
*Marion Leary—Conrad B. Lee
*Carol Rissmiller—*Ward C. Heaton
*Lillian Roome—A. Holler
Shirley Wather—*Walter T. Hansen

Weddings

*Anna Mae Brickner—Dick Perrotta
*Marie Callari—*Martin E. Johnson
*Inga Cassano—*Joseph P. Gaviglia
*Joan Heineman—Jesse S. Grace
Betty Harrison—*Philip E. Hogin
*Alice Heithmar—E. Robert Potter
*Elizabeth Merrell—*Robert W. Hull
Dorothy Musaus—*Richard K. Evenson
*Mabel Samper—Frank V. Perretta
*Gladys Singewald—Arthur E. Judd, Jr.
*Marguerite Van Nest—*John K. Galt
*Susan Waddell—William J. Neal

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

R. D. Williams went to Hawthorne to discuss the equipment design and method of ordering the 740E PBX; and W. Wagenseil and O. J. Morzenti, the No. 5 crossbar system.

P. W. Swenson and A. P. Goetze investigated contact problems of the step-by-step system at Stamford.

H. J. Michael, W. H. Scheer and J. G. Walsh visited Chicago in connection with the first introduction of intertoll traffic on No. 5 crossbar installation, particularly Wheaton, Calumet City, and Highland Park, Illinois.

W. I. McCullagh attended the cutover of No. 5 crossbar for Mill Valley, California.

L. T. Anderson investigated problems in connection with No. 5 crossbar at Allentown.

W. Whitney was at Somerville for the introduction of No. 5 crossbar in the new office.

C. L. Beckham, C. F. Knepper, F. A. Kuchas, and R. C. Pfarrer studied marker holding times in the Vineland No. 5 office.

A. C. Thompson visited Philadelphia in connection with the installation of coin box telephone sets in railroad trains.

F. K. Low visited the Orchard and Swarthmore No. 5 crossbar offices in connection with the performance of the new stepping relay.

J. F. Baldwin and R. A. Hecht participated in conferences at Point Breeze on design and manufacturing questions on switchboard plugs.

A. C. Millard went to Cleveland to attend a meeting of A.S.A. Committee B-18 regarding unification of bolt heads and nuts.

R. C. Miner and R. R. Stevens visited Chicago and Indianapolis for the initial production of the U1 receiver unit and the T1 transmitter unit, respectively, at the Speedway plant.

A. P. Boysen, R. Black and C. F. Benner visited New Orleans; P. S. Olmstead and E. W. Conger visited St. Paul; and E. F. Ennis, L. E. Krebs and A. W. Hayes visited Los Angeles in connection with the trial of the new telephone set.

Robert Pope inspected magnesium duct anodes which had been installed experimentally at Cleveland and Akron to mitigate corrosive conditions on underground cables. Later he stopped off at Detroit to investigate causes of sheath corrosion where considerable trouble had been experienced.

A. Herckmans, F. A. Hoyt, R. K. Thompson and B. O. Templeton visited Chicago on coin collector problems.

W. L. Tuffnell, H. A. Bredehoft, M. S. Richardson, R. E. Prescott, H. R. Clarke and L. A. Elmer visited Chicago and Indianapolis in connection with the new telephone set.

C. W. Anderson, assistant to the superintendent of buildings, grounds, apparatus and maintenance at the Whippany Laboratory in New Jersey, confers on a transportation problem with W. C. Henneberger.

H. B. Brehm and G. E. Hadley inspected several cable runs equipped with the new NC-16 cable terminals in the Springfield and Pittsfield districts of the New England Telephone and Telegraph Company.

D. W. Bodle visited Atlanta in connection with field studies of the effects of natural lightning on buried cables.

Under the Chairmanship of J. J. Harley, the Metropolitan Motion Picture Club's Christmas meeting at the Hotel Statler in New York featured a pantomime staged by the New Jersey Theatre League. M. Brotherton was among the actors.

J. K. Mills visited Hawthorne and the Lorain Products Company plant at Lorain, Ohio, in connection with 356A dial ringing equipment.

R. R. Gay conferred with engineers at Hawthorne upon the new 105D power plant for 356A dial offices.

Answers to the picture-quiz on page 88 of this issue: 1C; 2B; 3D; 4C; 5A; 6B; 7C; 8C; 9D; 10B.

J. L. LAREW with W. E. CAMPBELL discussed gasoline engine fuel problems with New Jersey Bell engineers at the Unionville central office.

D. H. SMITH, at Philadelphia, discussed mechanical rectifier designs with the I.T.E. Circuit Breaker Company.

J. GRAMELS conferred with engineers of the Westinghouse plant in Buffalo upon the design of selenium disc rectifiers for the TD-2 system.

R. B. SIMON and F. HUEBSCH attended a conference in Philadelphia to discuss with the Telephone Company a proposed traffic study of alternate route trunking at Garfield 3 No. 1 crossbar office.

H. M. SPICER conferred at the Ward Leonard Electric Company at Mount Vernon, New York, upon electrical starters for motor generator sets on the L3 carrier system.

W. H. BENDERNAGEL visited Newark, Philadelphia, Baltimore and Washington in connection with the initial surveys for the trial installation of coin boxes on the radio telephone system on trains.

THE LABORATORIES were represented in interference proceedings at the Patent Office in Washington by R. C. TERRY before the Board of Interference Examiners.

R. E. POOLE and W. A. MACNAIR were observers for the Sandia Laboratory at an Air Force conference at Omaha.

A. A. ADAMSON inspected and discussed development models of airborne equipment at Winston-Salem.

THE WEST STREET CHORUS began rehearsals on January 18 in the West Street auditorium for its series of noon-time concerts to be given this coming Spring. Rehearsals will be held every Wednesday at 5:20 P.M.

THE ANNUAL DEAL-HOLMDEL Christmas party was held at the Willowbrook Restaurant in Fair Haven, New Jersey, on Thursday evening, December 22. Members of that laboratory and their guests enjoyed a pleasant evening of entertainment with a musical program, skits and community singing. KARL JANSKY was master of ceremonies. RALPH BOWN, as guest of honor, extended Christmas greetings to the assemblage.

Laboratories' Advertising Now in Sixth Year

Appearing on the back cover is the 62nd advertisement of a series which started in January 1945. This series is designed to tell how Laboratories research and development for the Bell System help make the telephone sound better, reach farther, serve more people more dependably and faster, and at ever lower cost—high-quality telephone service at low cost. Prepared by N. W. Ayer and Son in cooperation with the Publication Department, these advertisements have been appearing monthly in technical and scientific publications with an aggregate circulation of more than 3,000,000. The following magazines are being used this year:

American Scientist
Audio Engineering
Chemical & Engineering News
Electrical Engineering
Electrical World
Electronics
FM-TV
Instruments
Journal of Applied Physics
Journal of Engineering Education
Journal of the Franklin Institute
Journal of Metals
Mechanical Engineering
Ordnance
Physics Today
Popular Mechanics
Popular Science Monthly
Proceedings of the I.R.E.
Radio Electronics
Radio and Television News
Review of Scientific Instruments
Science
Science News Letter
Science Teacher
Scientific American
Scientific Monthly
Telegraph & Telephone Age
Telephony
Tele-Tech
U. S. Naval Institute Proceedings