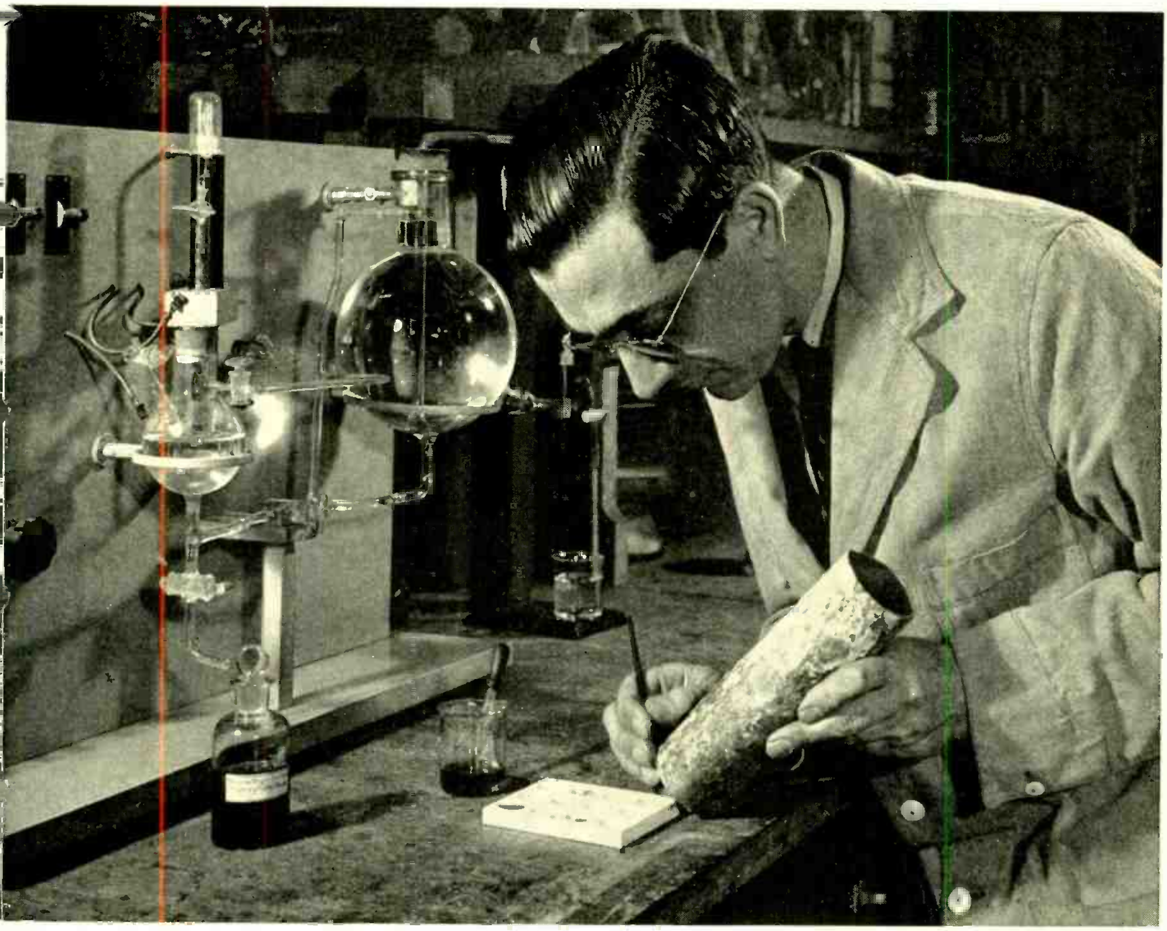
BELL LABORATORIES RECORD



Identifying corrosion product on a cable sheath.

NOVEMBER 1941 VOLUME XX NUMBER III

Azimuth Indicator for Flying Fields

By H. T. BUDENBOM
Radio Development

UNDER bad visibility conditions, an airplane pilot's determination of his position is greatly facilitated if the ground station with which he is in communication has equipment for determining the bearing of the plane. Direction-finding equipment has been used for this purpose for a number of years both in this country and abroad. The existing ground station equipment, however, requires the services of a skilled operator, and because of the time required to take a bearing, it is necessary for the plane to make special transmissions for the direction-finding determination. It was felt, therefore, that equipment which would operate instantly and automatically on the regular communication transmission from the plane would greatly contribute to the safety of air navigation. With this objective in view, the Laboratories has recently developed an azimuth-indicating radio receiver, operating in the 2 to 7-megacycle band. The equipment gives a visual indication of the direction of the source of any radio waves to which the set is tuned. The collector system may be located at a site free from electrical noise, while the indicator panel may be located at a regular operating point where personnel is available for observing the directional indications. Only an ordinary telephone circuit is required for connecting the collector system with the indicating and control equipment.

The complete equipment consists of an antenna system, a ten-frequency radio receiver, and an indicator panel shown in Figure 1. The bright circle is the end of a cathode-ray tube, and a spot of light, normally at the center, moves radially outward along the line of the bearing of the airplane as its radio signal is picked up. Any of the ten frequencies for which the receiver is equipped may be selected by the dial at the bottom of the panel, and a light in the lamp bank at the left indicates the frequency selected. Behind the six vertical bands above the dial is a loud speaker that reproduces the signal from the plane at the same time the spot of light indicates its direction. Besides dialing the frequency desired, the operator may also dial one of seven sensitivity values, and thus make sure that an adequate signal is received without unnecessary noise. The sensitivity selected is indicated by the bank of lamps located at the right of the panel.

The antenna system shown in the headpiece consists of four vertical dipoles located at the corners of a square, with a fifth dipole at the center. The four corner antennas are used for determining direction. The central antenna serves as a reference of radio-frequency phase to permit differentiation between directions 180 degrees apart; and in addition, it receives the normal communication signals. The connection of the four directional antennas is as indicated in Figure 2, which also shows the directional characteristics of the antenna array. The relative output of the two branches for various azimuths is shown in Figure 3.

This form of antenna structure responds only to the vertical component of the electric field, since the horizontal component is eliminated by a cancellation effect. The horizontal component may arise from the form of the transmitting antenna, as a result of ionospheric reflections, or both, and frequently results in an error in azimuth. By employing only the vertical component, this new azimuth indicator is free from these polarization errors, sometimes called "night effect" or "airplane effect."

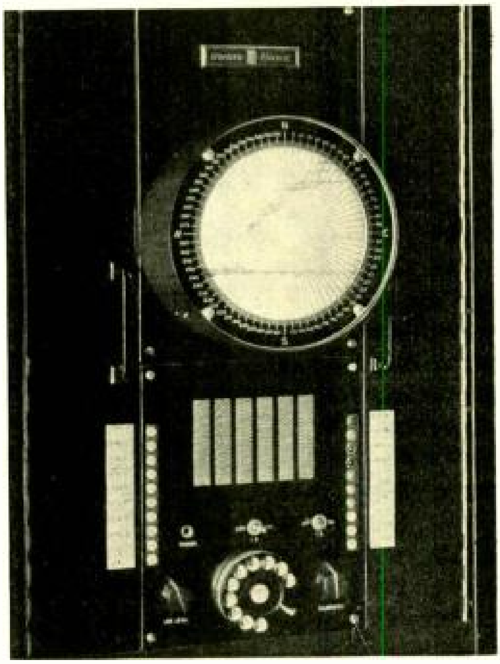


Fig. 1—Front view of the indicator panel

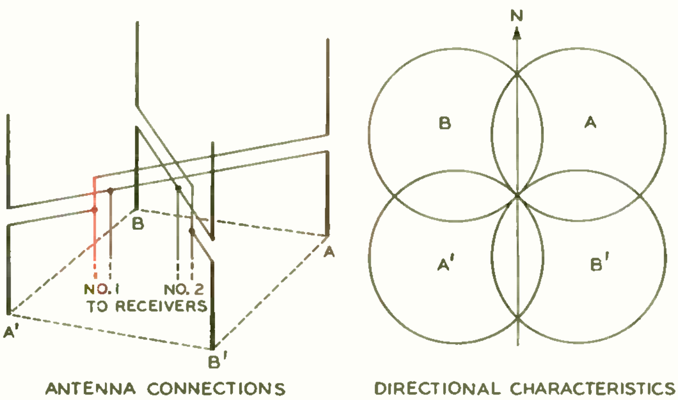


Fig. 2—Connections and directional characteristics of the four-antenna array

A simplified schematic of the circuit when the indicator is at the same location as the antennas, thus eliminating the two-wire transmission link, is shown in Figure 4. Each pair of directional dipoles is connected to the input of a pair of modulators which are also supplied with an audio-modulating frequency, A1 for one pair and A2 for the other. The carrier and the audio-modulating frequency are both suppressed, and only the sidebands of the audio modulation remain. The outputs of

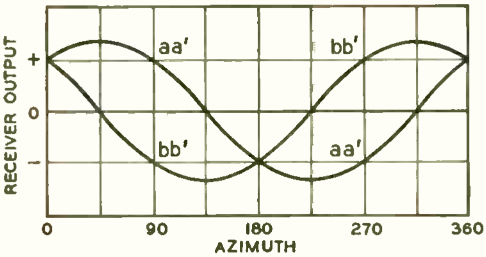


Fig. 3—Values and signs of current from the two receivers for various directions of the incoming signal

the directional modulators, together with the output of the center antenna, are then combined and passed to the radio receiver. The output of the receiver thus includes the received signal plus the two directional components of frequencies A1 and A2. Filters at the output of the receiver separate these three components; the signal is passed to the loud speaker, and the two directional components to the plates of the cathode-ray tube via conjugate input demodulators. The cathode-ray tube has two pairs of deflecting plates placed at right angles to each other, and the rectified output of one pair of dipoles tends to deflect the spot along the line of one pair of plates, and that of the other pair of dipoles along the line of the other pair of plates. With the signal coming from the north, for example, Figure 3 shows equal positive outputs from both branches, and as a result plates AA′ and BB′ of Figure 5, which represents the cathode-ray tube, will produce equal action on the spot in the direction AA′ and BB′ and the spot will move upward midway between A and B to indicate a north bearing.

With the signal coming from the direction of 45 degrees, the BB′ plates will exert no influence and the spot will move in the direction AA′. With an azimuth of 90 degrees both pairs of plates again produce equal action, but the B pair, since the output of the B branch is now negative as shown in Figure 3, will be in the direction BB′.

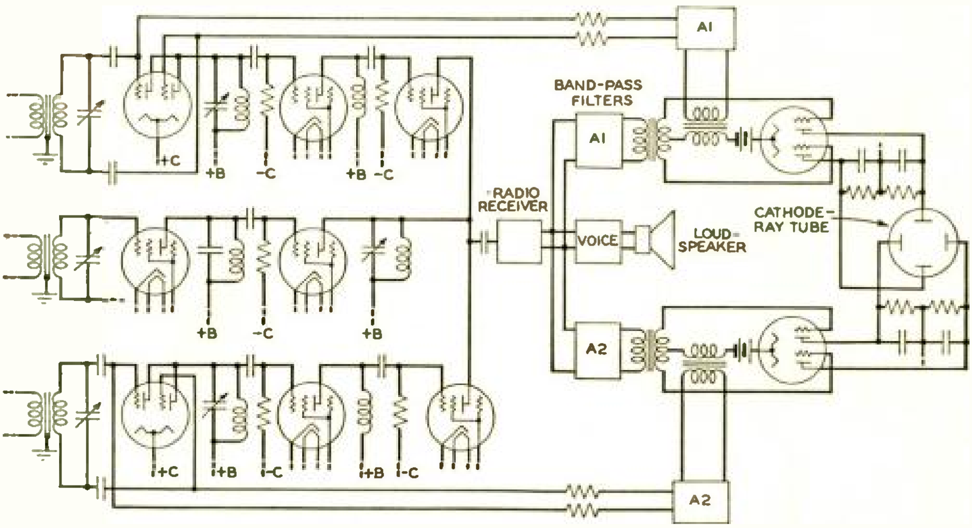


Fig. 4—Simplified schematic of the circuit when no transmission line is required

As a result the spot will move to indicate an azimuth of 90 degrees. If there were only the two directional sidebands at the detector input in the radio receiver, there would be an uncertainty between directions 180 degrees apart. The output of the central antenna, however, which is present with the two directional sidebands, provides the means of recovering the original tone frequencies and also serves as a reference of sign, with the result that the bearing is correctly indicated at all times. There is no 180-degree uncertainty as there is with a loop antenna.

To visualize the operation of this equipment, the reader may imagine himself seated before the new indicator at LaGuardia Field.* With the aid of the dial he has selected for observation 4122.5 kilocycles, the two-way plane-to-ground communication frequency for Eastern Airlines. When no carrier is being received, the oscilloscope spot stays near the center of the oscilloscope screen, save for minor excursions due to static or other noise sources. At three or ten minutes before almost any hour in the day, however, the observer is apt to note a deflection of the spot to about azimuth 6 degrees, accompanied by the announcement "flight 1 (say) testing on the ramp." This would be the Eastern Airlines ship scheduled to depart for Washington (and possibly for points south) on the even hour. A few minutes after the hour he would see a deflection of the spot between azimuth 355 and 360 degrees (or 0 degrees) coupled with the announcement from the plane that it is clear of the tower. In both these cases there will have been acknowledgment from the Newark ground station of Eastern Airlines, for which the spot would deflect to about azimuth 290 degrees. Possibly eight or ten minutes after the hour the plane may be heard reporting over Newark, at about the same azimuth as the Newark ground station. At about eighteen minutes after the hour the plane should report over the "check

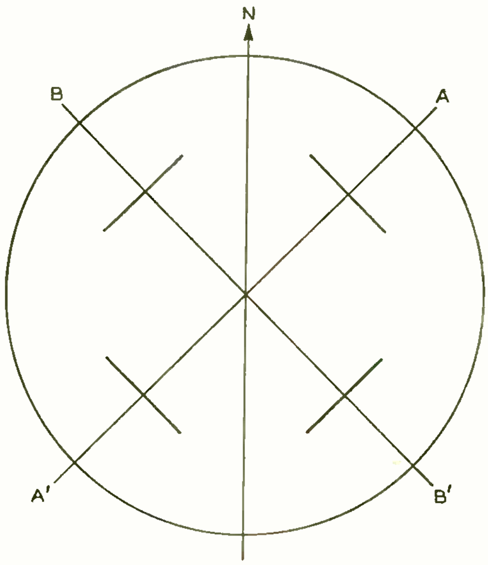
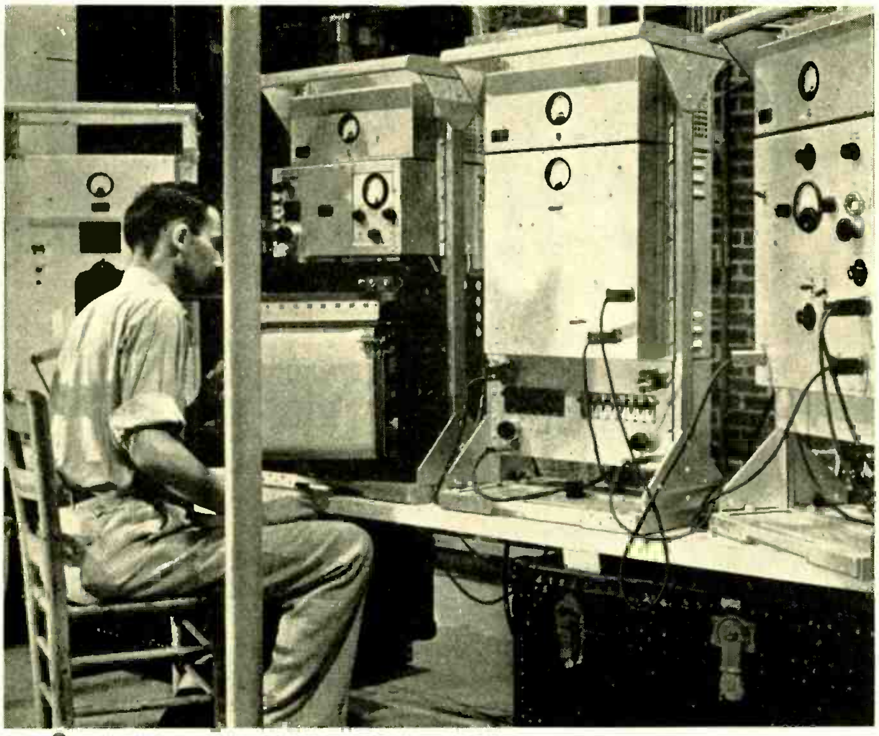


Fig. 5—The cathode-ray tube has two pairs of plates, each pair associated with one of the receivers

point" at Metuchen, New Jersey, the azimuth by this time being about 250 degrees. Sometimes no further reports from this plane will be heard until it reports "over Philadelphia" about a half hour out of LaGuardia.

Each of these observations has taken only about five seconds, the average length of time required for the pilot to report his position. With the exception of dialing the desired frequency, no manipulations or calculations need be made by the operator, since the observed location of the spot with respect to the azimuth scale gives the true bearing directly.

*The associated collector system is located just north of Floyd Bennett field.



Automatic Measurement of Crosstalk at Carrier Frequencies

By E. P. FELCH
Transmission Apparatus

CROSSTALK on open-wire lines increases with frequency, and the use of broad-band carrier systems—operating at frequencies as high as 150 kc—has been feasible only because methods of reducing it have been devised. In designing these methods and in checking on actual lines to determine that the performance will be satisfactory, a very large number of crosstalk measurements must be made. For any given type of line and transposition system, the crosstalk that would exist if the pole spacings and wire positions conformed to an assumed configuration can be calculated. Unavoidable, and in some cases unpredictable, construction irregularities in the actual line may, however, appreciably modify these results. Field measurements of crosstalk on actual lines is in many cases the most straightforward way to determine the true value in specific cases, particularly where the effects of such factors as sag, temperature, and sleet need to be studied.

Over the frequency band of the type-J carrier system, crosstalk varies widely and irregularly. A typical curve is shown in Figure 1. In many cases over 250 such crosstalk-frequency curves are required for a single repeater section, and since a satisfactory curve could not be plotted with less than forty points, over ten thousand measurements may be needed for a single section. Using the former methods of measurements, this would be a good month's work for three or four men. Early in the development of the line facilities for the J system, it was realized, therefore, that some high-speed crosstalk-measuring system would be highly advantageous, and various methods of decreasing the time and labor involved were investigated. As a result of this work an automatic crosstalk-measuring set was developed. This set will draw a complete curve, such as that of Figure 1, in a few minutes, while a curve comparable to one plotted from forty measurements, such as would have been made by the former method, can be made in 40 seconds. Moreover, only two operators are required, one at each end of the line, and their duties are restricted to setting up and equalizing the test combination, and starting the automatic set.

Both near-end and far-end crosstalk can be measured with the new set, but far-end is of more interest with the type-J carrier system because the effects of near-end crosstalk are reduced by employing different frequency bands for the two directions of transmission. A block schematic of the circuit as arranged for measuring far-end crosstalk is given in Figure 2. At the transmitting end of the section of line to be measured, a 17B oscillator* is connected to the disturbing pair, and a termination is connected to the disturbed pair to reproduce the terminal impedance the pair would have under operating conditions. The measuring equipment at the receiving end includes primarily a detector and recorder connected to the disturbed pair, and a control unit connected to the disturbing pair. The 17B oscillator provides a constant input to the line as its frequency is swept over the desired band by a

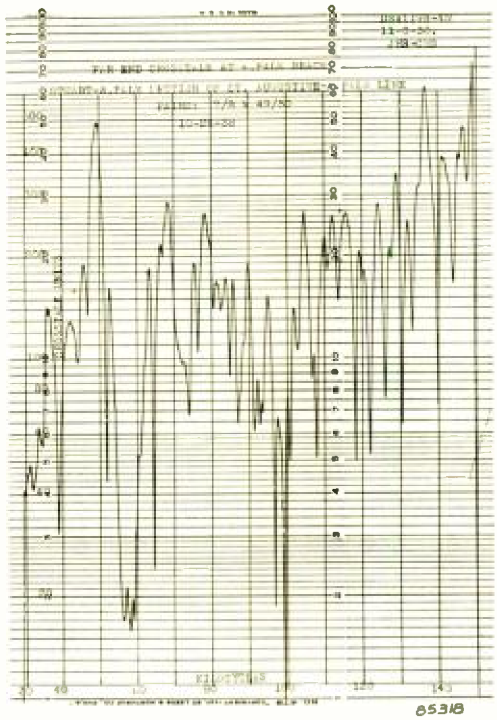


Fig. 1—Crosstalk curve for a section of J-carrier line for frequencies from 30 to 150 kc. Values on crosstalk scale are ten times those of the printed scale

motor drive. Crosstalk is measured in terms of the ratio of the energy in the disturbed pair to that in the disturbing pair, but since the set measures only the absolute value of the energy in the disturbed pair, equalizers are employed to correct for the effect of the unequal attenuation of the disturbing pair at various frequencies. Once the equalizers have been properly adjusted they may be used for all

*Record, *May*, 1939, *p.* 291.

measurements for which the same disturbing pair is used.

The calibrating network is used only at the beginning of a run. It connects the disturbing pair to the measuring equipment through an attenuating network that makes the received energy in the measuring set the equivalent of 1000 crosstalk units and the sensitivity of the detector is adjusted to make the recorder read 1000 crosstalk units under this calibrating condition. It will then indicate the correct value of crosstalk throughout the test, since the input to the disturbing pair is held constant and the equalizer corrects for unequal attenuation.

One crosstalk unit is defined as a ratio of one millionth between the current at the terminal of the disturbed circuit and that at the terminal of the disturbing circuit when the impedances involved are equal. With one crosstalk unit present, therefore, the current in the disturbed pair is 120 db below that in the disturbing pair, and with each tenfold increase in the number of crosstalk units, the current in the disturbed pair is 20 db higher. Thus with 10 crosstalk units, the current in the disturbed circuit is 100 db below that in the disturbing pair, and with 1000 crosstalk units, it is 60 db below that in the disturbing pair. By using a 60-db pad for the calibrating network, therefore, the recorder should read 1000 crosstalk units.

Before a run, the adjustable equalizers are set to equalize for the nominal characteristics of the disturbing pair. The calibrating network is then connected into the circuit and the detector set to show 1000 crosstalk units on the recorder. The oscillator at the distant end is then started, and driven over the entire band of frequencies. If the equalizers match the line characteristics, the recorder will give a constant indication during the calibrating run. If it does not, the equalizers will be readjusted until the desired results are obtained. After this the calibrating network is removed, and the regular test is run.

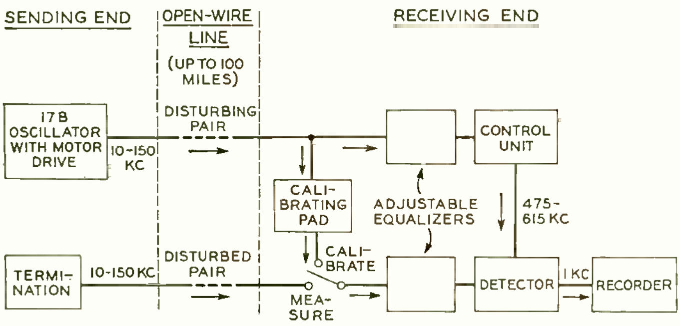


Fig. 2—Block schematic of circuit as used for measuring far-end crosstalk

The crosstalk in the disturbed pair is detected and recorded by the set as the oscillator at the distant end is driven over the entire frequency range at a constant rate and in synchronism with the motor driving the chart on the recorder. The function of the control unit is to keep the detector tuned to the frequency being measured. The method of operation is indicated in greater detail in Figure 3. The control circuit provides a frequency that is maintained at 465 kc above the test frequency. The crosstalk on the disturbed circuit is amplified and then modulated with the control frequency. The output frequency of the modulator is then at 465 kc, and this frequency is passed through a crystal filter with a pass band only 100 cycles wide to eliminate noise and unwanted frequencies. This 465-kc intermediate frequency after passing through the filter is amplified and then modulated with a 466-kc frequency from an oscillator in the detector circuit. A difference frequency of 1 kc results, and is used to operate both an indicating meter and the recorder.

Since a filter only 100 cycles wide is in the path of the 465-kc intermediate frequency, it is obvious that the controlled oscillator must be held accurately at 465 kc above the frequency of the current being sent over the line or the modulation product would not pass through the filter. Moreover the oscillator at the distant end is driven over the entire 150-kc band very rapidly, and the controlled oscillator must be varied rapidly enough to keep in step with it. The requirements were even more severe than this because it was desired to be able to use the recorder when the test frequency is warbled over a 3-kc band six times a second, since such a warble tone is sometimes desired for crosstalk measurements.

This precise and rapid control of frequency is exercised by the crystal discriminator, which controls the oscillator of the control circuit. The discriminator includes a vacuum tube with a 465-kc quartz plate connected across its grid. A constant output from the modulator of the control circuit is applied across the quartz plate through a high impedance. In the vicinity of 465 kc, the voltage across the plate, and hence across the grid of

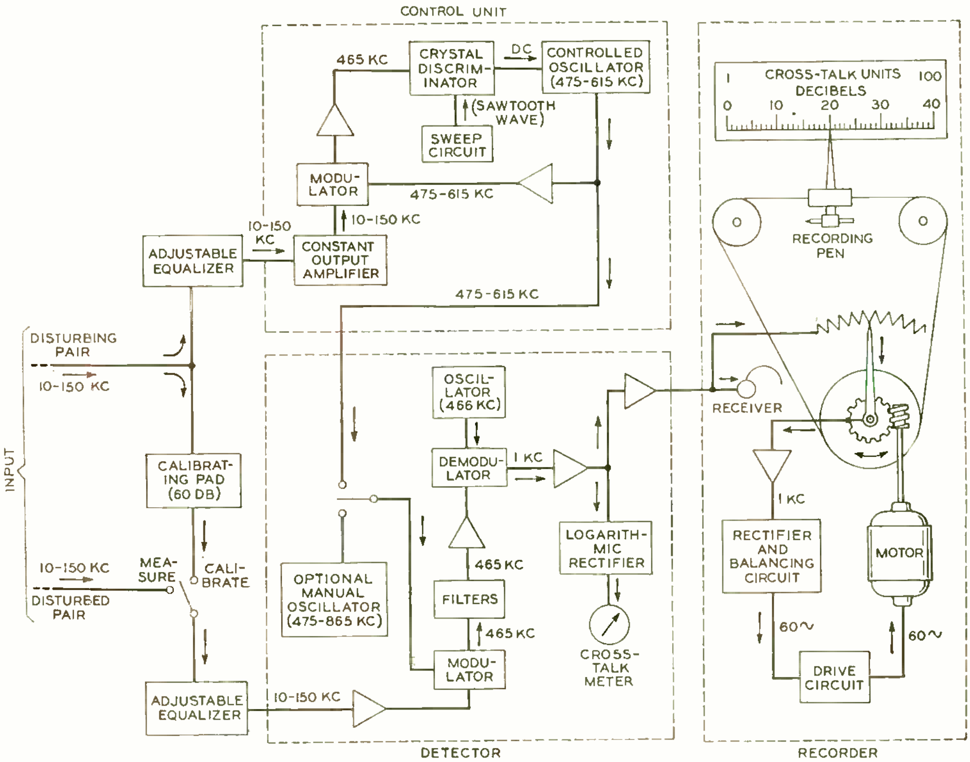


Fig. 3—Block schematic showing major components of control, detector, and recorder circuits of the automatic equipment for measuring crosstalk

the discriminator tube, varies rapidly. Any change in grid voltage results in a change in the plate current which affects the oscillator control circuit. The resulting change in the frequency of the oscillator is in a direction to restore the frequency applied to the discriminator to 465 kc.

Assume, for example, that the oscillator frequency instead of being exactly 465 kc above the test frequency on the disturbing pair is 465,002 cycles above it. As a result, the output of the modulator of the control circuit will be at 465,002 cycles instead of at exactly 465 kc. This frequency when applied to the discriminator will result in a change in voltage of its grid and a resulting change in the oscillator control circuit tending to decrease the frequency. In this way the oscillator frequency is always held 465 kc above the frequency on the disturbing pair to the extreme precision of only a few cycles.

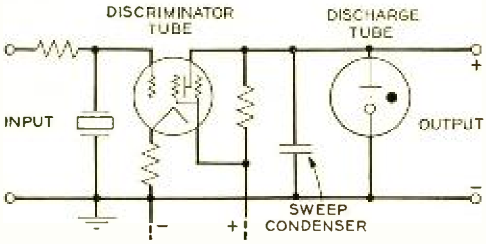


Fig. 4—Simplified schematic of sweep circuit and discriminator

While the discriminator is extremely sensitive, it is effective for only about 5 cycles either side of 465 kc. When the input frequency comes on at the beginning of a test, it might be at such a value that the output of the control modulator differed considerably from 465 kc, and if steps were not taken to avoid this condition, the discriminator would not come into action. To avoid this situation, a sweep condenser and gas discharge tube are connected between the discriminator and the oscillator control circuit in such a way that the oscillator is swept over the band from 475 to 615 kc several times a second. As long as there is no input to the disturbing pair, this sweep cycle will continuously recur, but when test frequency is applied, the frequency at the output of the control modulator will be at 465 kc at some part of the sweep cycle, and the discriminator will assume control.

The discriminator and sweep circuits are shown in Figure 4. When there is no input to the discriminator, the sweep condenser is charged by the plate potential of the discriminator tube, and as it reaches a predetermined value, the gas tube discharges it, and the voltage to the controlled oscillator drops. During the charging of the condenser, the oscillator is swept through its full range of frequencies as the voltage rises, and this cycle recurs about once a second. If test frequency is applied to the disturbing pair, the discriminator will assume control during some point on the following cycle. Once this occurs, the plate potential of the discriminator tube never rises high enough to cause the gas tube to discharge.

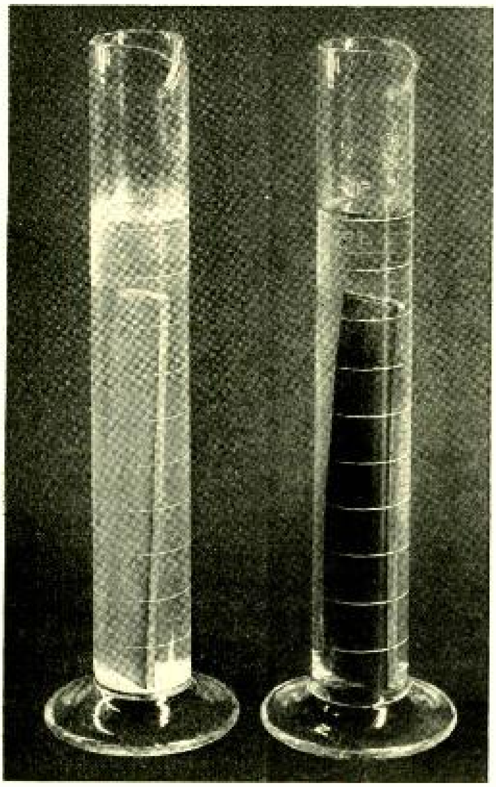
Two motors are employed to drive the recorder: one drives the chart at a constant speed, and the other operates the recording pen as the received crosstalk varies. The pen is also linked to a slide wire through which the drive circuit is supplied. There is a definite control voltage at which the motor drive circuit will not drive the motor in either direction. As the input to the motor circuit varies in either direction from this control voltage, however, the pen is driven in one direction or the other, and as it moves the contact on the slide wire is moved in a direction to restore the control voltage. The record thus indicates the change in attenuation required to maintain a constant control voltage.

Although designed particularly for measuring crosstalk, the set may be used to measure noise, transmission, or—with the addition of a portable bridge—impedance and return loss throughout the frequency range from 1 to 150 kc. It is arranged for 50- or 60-cycle a-c operation and is equipped with electronic voltage regulators to permit its operation from either commercial lines or gas-engine generators. The meter scale and multiplier keys are provided with auxiliary decibel scales for use for noise, transmission, or return-loss measurements. While the filter of the control circuit used for crosstalk measurements has a 100-cycle pass band, 3-kc and 10-kc filters are provided for noise and attenuation measurements. The detector alone may be used for making point-by-point measurements over an extended range from 1 to 400 kc by use of the optional manual oscillator.

Research and Technology

Without continuous technological improvement the Bell System would not have been able to give an adequate or nation-wide service, even if it would have been able to give any service at all. And without continuous technological advance the Bell System would not have employed much of anybody, nor would it have served the economy and speed of other businesses so that they would employ more people. And without continuous technological advance there would not have been either increased values or reduced rates to the public, and certainly no added income to devote to increased wages for the employees.

—Arthur W. Page, Vice President, A T & T, in his recent book "The Bell Telephone System."



Environmental Factor in Corrosion

By V. J. ALBANO
Chemical Laboratories

CORROSION is a normal attribute of ordinary metals because it results from their natural tendency to revert to stable states by combining with other elements which surround them. The environment may vary so much in chemical properties, however, that a metal which is resistant to corrosion in one may be quickly attacked by another. Complete prevention of corrosion could only be achieved in a totally inert medium, which does not often occur in nature for sufficient traces of moisture or dissolved chemicals are usually present to render the environment active. Under certain conditions of exposure protective films form on many metals. This is fortunate for the telephone plant where otherwise corrosion would be an even more serious problem than it is.

Formation of protective film requires in the environment a substance that reacts with the metal to form an insoluble, impervious, and adherent compound on its surface. Corrosive substances in the environment militate against the formation of such a film. As a result of these opposing reactions, the production of a protective film is determined by the nature and relative concentration of film-forming and corrosive substances. That is why distilled water, which lacks film-forming substances, corrodes lead very readily. On the other hand New York City tap water, a high-quality water which contains only about forty parts per million of dissolved substances, affords sufficient film-forming constituents to cover the lead with an invisible film which retards corrosion, as illustrated above. The film forms an inert envelope about the lead and shields it from its surroundings.

Influence of environment in corrosion was shown in a study by the Laboratories of the corrosion of thirteen different alloys of lead which were buried in five different soils. At the conclusion of the test, four years later, the order of corrodibility of these metals varied among themselves in each of the soils and this variation could not be correlated with alloy composition. The test indicated that the character of the soil was the predominant factor in determining the progress of corrosion. A graphical representation of some of these findings is shown in Figure 1.

The importance of the environment was also demonstrated in a test to determine whether wrought iron pipe was more resistant than steel pipe to attack by water. Sections about five feet long were installed in the hot water supply line in each of nine telephone exchange buildings in different parts of the United States. The locations were selected to provide widely different natural waters. After three years no significant difference between the corrodibility of steel and wrought iron could be distinguished. A study of the data from this test indicated that the rate of attack and the physical characteristics of the corroded metals were determined by the nature of the water, that is by the character and relative concentrations of dissolved substances, rather than by the combined concentrations of all substances present.

Resistance of wrought iron and steel to attack by soils was tested by placing anchor rods in soils of the white alkali, acid muck, and salt marsh types. These tests also showed no significant difference in the behavior of these metals. The nature of the soils investigated was found to be more important than the metal in determining the rates of corrosion.

The nature of the environment also governs the galvanic corrosion which occurs when two dissimilar metals are in contact in the presence of an electrolyte. The rate of corrosion of one of the metals will be accelerated when electro-chemical action occurs and may become serious in industrial and marine atmospheres, in soils and in waters. In certain cases it is possible to reverse the electro-chemical behavior of the metals of a galvanic couple by altering their chemical environment. For example, when a lead-iron couple is immersed in an acid solution the iron corrodes, but the lead is attacked in preference to iron when the solution is alkaline.

Variations in the corrosion behavior of metals in different environments is of particular concern when rating a metal on the basis of an accelerated corrosion test. By its very nature such a test distorts the variables involved in the normal corrosion process and conclusions drawn from it are frequently misleading or even erroneous. Thus in accelerated salt-spray tests cadmium coatings on steel are more protective than zinc coatings. This same behavior might be expected in marine atmospheres, but actual field tests have shown zinc to be better than cadmium in all typical environments.

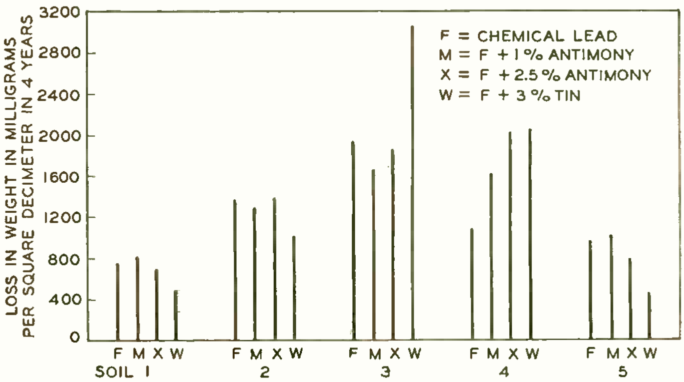


Fig. 1—Comparison of the rates of corrosion of lead alloys in different soils shows that the character of the soil rather than the composition of the alloy is the predominant factor

Corrosion can be controlled by choosing a metal to suit a given environment, or by altering the environment to suit the metal. Although the latter procedure may be more difficult, there are occasions when it may be necessary for physical or economic reasons. The most direct way of reducing the corrosiveness of an environment is to remove its corrosive constituents. This method is applicable when the environment is limited in extent as an indoor atmosphere, or small volumes of water. The removal of dust, moisture, and sulfur gases by air-conditioning methods reduces the corrosiveness of an atmosphere. The addition of film-forming ions, such as silicates, carbonates, phosphates, and chromates to water or the removal of activating materials, like chlorides, nitrates and dissolved oxygen, reduces the corrosiveness of water.

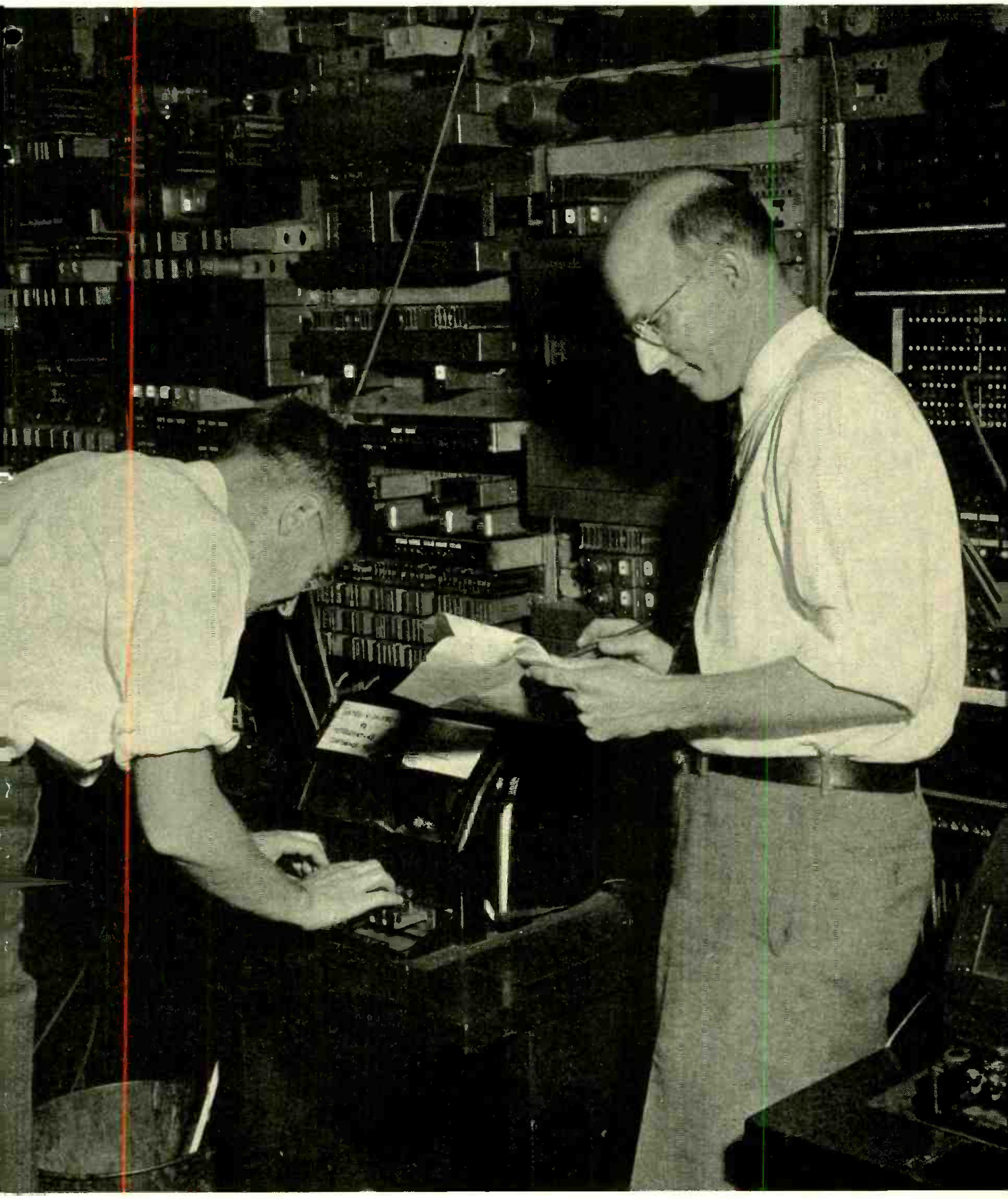
When the corrosive environment is unlimited as in soils or large natural bodies of water, it is not, as a rule, practical to alter the environment. Special measures must then be taken to guard against corrosion. The prevention of the corrosion of lead cable sheath by soils is a case in point. Cable is usually housed in conduits which, among other purposes, serve to keep it out of direct contact with soils that might be corrosive. If corrosion occurs in spite of this precaution, the rate of attack can be reduced and corrosion almost completely prevented by maintaining the cable at a potential slightly below that of the earth. This method of protection in effect alters the nature of the environment immediately adjacent to the cable, and renders it less corrosive.

The indiscriminate selection of a metal for service in a specific environment based solely on its corrosion behavior in a number of other environments may result in unsatisfactory and uneconomic choice. Since corrosion is definitely a chemical reaction which depends on the nature of the environment as well as that of the metal, it is essential that adequate consideration be given to the environment.

Vitamin Research Brings New Honor to Dr. Williams

Incident to its fiftieth anniversary, the University of Chicago has conferred on Robert R. Williams, Chemical Director of the Laboratories, the degree of Doctor of Science. The accompanying citation designates him "A leader in a great industrial laboratory who independently elucidated the structure of Vitamin B_1, devised a method for its synthesis and made other valuable contributions to chemistry and physiology"

NEWS AND PICTURES



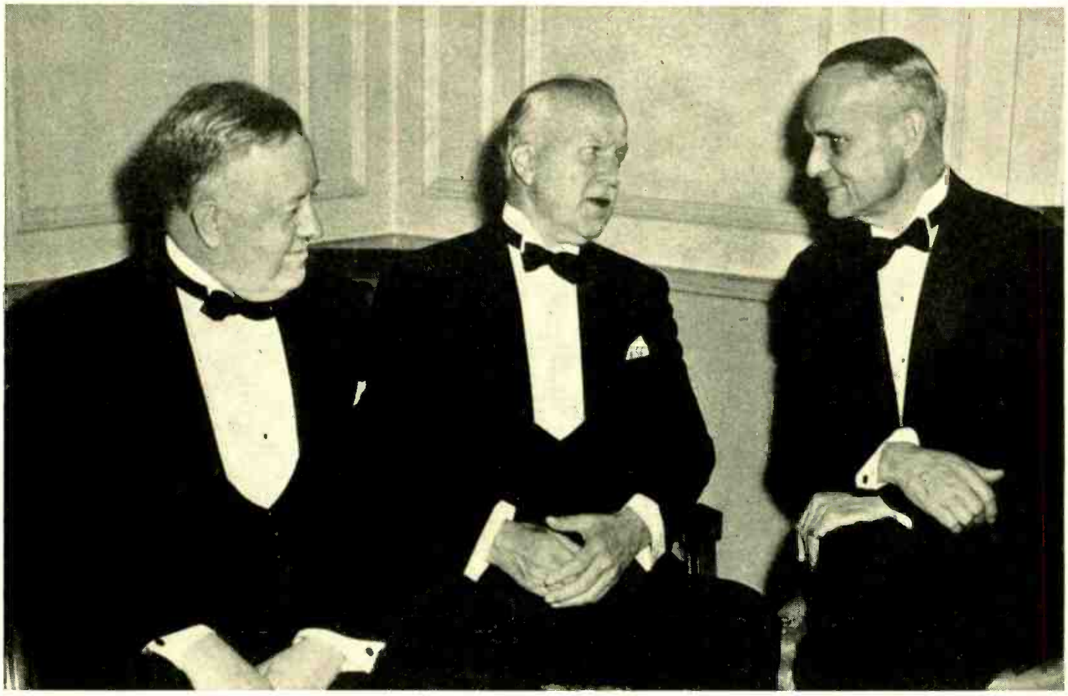
Checking a proposed Bell System Practice on maintenance of the 3A switchboard in the telegraph laboratory at the Graybar-Varick building

News of the Month

Carrier Systems Help Defense Program

Two years ago, when war broke out in Europe, the Bell System had 16,200,000 telephones and handled 72,000,000 calls a day. Now there are 18,489,000 telephones and 81,000,000 calls a day. Toll service has grown even more spectacularly; comparing the first six months of this year with the same period in 1939, there has been an increase in all toll calls of 22 per cent and in the longer haul calls of 41 per cent.

To some extent these additional loads have been cared for by putting spare facilities to use. Generous additions to plant have been made: net additions for 1941 will be about $300,000,000 as compared with an average of about $86,000,000 for the seven previous years. In the case of long distance lines, carrier telephone systems are greatly increasing the number of calls that can be handled over the same number of conductors. For example, each of the five hundred type-K carrier systems which are to be installed will furnish twelve voice channels instead of the single channel which they displace; a net gain of eleven channels on each two pairs of wires. These wires are 19-gauge and for a 500-mile circuit the two pairs weigh 42,000 lbs.; the eleven additional channels in effect release 462,000 pounds of copper, and worth-while amounts of lead cable sheath and paper insulation.



At Pioneer Assembly Meeting in Chicago

Left to right, Bell System Presidents George M. Welch, Walter S. Gifford and Ned R. Powley chat for a minute before the banquet. Mr. Welch was elected to head the Pioneers in 1942, *and Mr. Powley is president of the Association for* 1941

Or, to look at the other side of the picture, if and when copper and lead must be heavily restricted, the availability of carrier systems may make the difference between enough telephone circuits and a shortage over certain routes.

The Laboratories has contributed to the availability of *materiel* of defense in other ways. It has collaborated with the Western Electric Company to substitute plastic for metals in an important part of the combined-set housings. It has helped to engineer changes which limit the use of permalloy—a nickel-bearing alloy; also developed facilities like the inexpensive information desk for very small central offices which makes unnecessary trunks to a larger center.

After 36 years in the Bell System, Harry Prescott Charlesworth, vice president of the Laboratories 1928-1933, has retired as assistant chief engineer, A T & T. With Mr. Charlesworth as he looks over a souvenir album are W. H. Harrison, a director of the Laboratories, and J. W. Campbell, outside plant engineer, O & E

Research contributions to the nation's defense are under seal of secrecy; when the return of peace brings about their publication, members of the Laboratories will see that their organization has acquitted itself well in the service of their country.

Former Vice President Retires

At the end of September Harry P. Charlesworth, who was vice president of the Laboratories from 1928 to 1933, retired from the American Telephone and Telegraph Company at his own request after several months' absence on account of illness. Mr. Charlesworth entered the Bell System in 1905, on graduation by M.I.T. During the first World War he had charge of special problems of service to the government. In 1920 he became plant engineer of A T & T. On his return from the Laboratories he became assistant chief engineer.

H. S. Osborne, Plant Engineer of the A T & T, will assume Mr. Charlesworth's duties, and the title of assistant chief engineer will be discontinued.

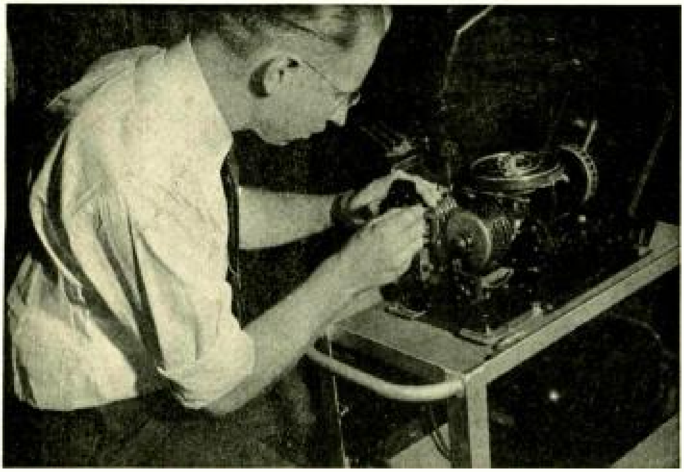
Telephone Pioneer Assembly

"I think we Pioneers have a right to have confidence in the future," President Walter S. Gifford told his audience at the annual banquet of the General Assembly of the Telephone Pioneers of America, held in Chicago on September 26. "Telephone men and women are constantly facing emergencies," he said, "and our traditions and ideals always rise to the occasion, and we meet them in a way that gets and deserves, in my opinion, the good will, respect and thanks of our fellow citizens"

"Now we are faced with an emergency that is nation-wide. It is my hope, and I

In the Frontispiece on page 57 the engineer shown is V. J. Albano whose article on the effect of environment on the corrosion of metals will be found on page 68.

In the photograph on the first page of these News Notes: A. L. Hopper (left) and G. J. Knandel (right).



H. R. Vail adjusting contact spring clearances on a laboratory-type telegraph distortion generator

exchanges and proceeding to larger units. Publication of Chapter magazines or news sheets was discussed and extension of such work recommended. Formation of subcouncils, or small local Pioneer groups in communities far from Chapter or Council headquarters, was described and enthusiastically approved.

Results of the program to intensify Pioneer work and to increase membership were reported to be exceptionally good. It is probable that new members in 1941 will almost double the number in any previous year. Chapters are holding more and better and more varied meetings. There are more working committees and more people are serving on them. There are more clubs for life members, more councils organized within the Chapters and more visits to members who are in difficulty of any kind.

know it is yours, that each one of us can do his part in this emergency in such a way that in the years to come . . . we can look back on what we did with the same pride that we look back on what the telephone men and women did in the New England hurricane, and the many other emergencies we have been through in the past. I, for one, am confident that that will be the result; that we can look back with pride . . . and I am confident that if we can and will, as I am sure we will, those who come along after us can go ahead to further still greater achievements, and can continue with the thanks and good will of the fellow citizens of this great country of ours."

Serious purpose underlay the pleasant fellowship which permeated this twentieth annual meeting of the Assembly. "We are determined," declared Association President N. R. Powley, "to give full expression to that characteristic telephone spirit of the will-to-do." Acting in that spirit, the Assembly, in one of the liveliest sessions in many years, disposed of a mountain of important business.

George M. Welch, President of the Michigan Bell Telephone Company, was elected President for 1942. The Constitution was amended so as to improve greatly the method whereby the membership is represented on the Executive Committee. The Assembly voted that Pioneer Chapters everywhere undertake the compilation of telephone histories, starting with individual

Colpitts Directs Engineering Foundation

Edwin H. Colpitts, who was vice president of Bell Telephone Laboratories from 1933 until his retirement in 1937, has been appointed Director of The Engineering Foundation. Dr. Colpitts served the Bell System for thirty-eight years and played an important part in its development and research work. After several years with the A T & T he became assistant chief engineer of the Western Electric Company, in charge of development and research. He returned to A T & T in 1924 as assistant vice president, the post he held until his appointment as vice president of the Laboratories.

The Engineering Foundation, of which O. E. Buckley is President, was established in 1914. Its purpose is "the furtherance of research in science and engineering and the advancement in any other manner of the profession of engineering and the good of mankind." It is a joint agency of the four major engineering societies and sponsors and supports investigations that are carried on in university, government and private laboratories.

100-Megacycle Cathode-Ray Oscilloscope

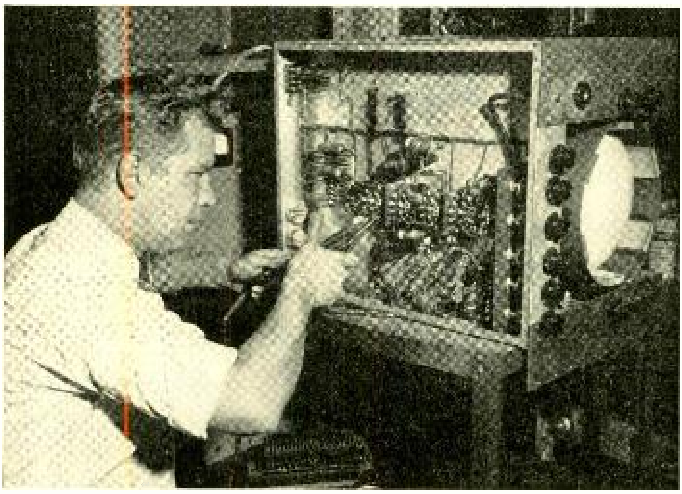
In various projects involving equipment operating in the megacycle range, the need has been experienced for oscilloscopes capable of handling frequencies far above those heretofore attained. To meet this need there has been developed an oscilloscope whereby waves can be observed over the frequency range up to 60 mc. This includes a 10-stage amplifier which is substantially flat over the range from 1 cycle to 100 mc, i.e., a frequency ratio of a hundred million to one. The sensitivity of the oscilloscope is approximately 0.1 volt per inch. A sawtooth sweep circuit which covers the range from 10 cycles to 5 mc, with provision for internal, external or 60-cycle synchronization, is included.

Five of these oscilloscopes have been built in the Graybar-Varick tenth-floor laboratory and an additional one is in process of construction. Engineers engaged on this project include J. B. Maggio, D. M. Osterholz, R. C. Hersh and E. W. Houghton. The construction and assembly was carried out under the supervision of A. Chaiclin. The accompanying photographs illustrate some features of the work.

J. B. Maggio adjusting the controls of a 100-mc oscilloscope

The Telephone Business

No more appropriate item could appear under this heading than a note on Arthur W. Page's book, "The Bell Telephone System,"* for in this book that great business institution is delineated as to its corporate make-up, its ideals, and its basic policies. There is a chapter on research and technology; one on the Laboratories; and one on Western Electric. Reclothing the statistics, many of which have been published elsewhere as mere skeleton statements, Mr. Page shows what are measures of good telephone service, and completes the picture by showing why the service has improved. How the Bell System met the depression of the thirties, stabilizing its working forces as far as possible in the face of station and traffic losses; its attitude toward the Federal Communications Commission's investigation of 1935-1937 and its willingness to co-operate with regulatory bodies, state and national; these and other System viewpoints are explained by showing that they represent, after all, sound



D. M. Osterholz adjusts a 100-mc oscilloscope

*Published by Harper and Brothers ($2.00). A number of copies are available in the Library.

business judgment in the interest alike of the telephoning public, of the investors in Bell System securities and of all its workers.

Answers to many questions can be found in the book; for that reason everyone who is interested in the telephone business should have a general familiarity with it.

* * * * *

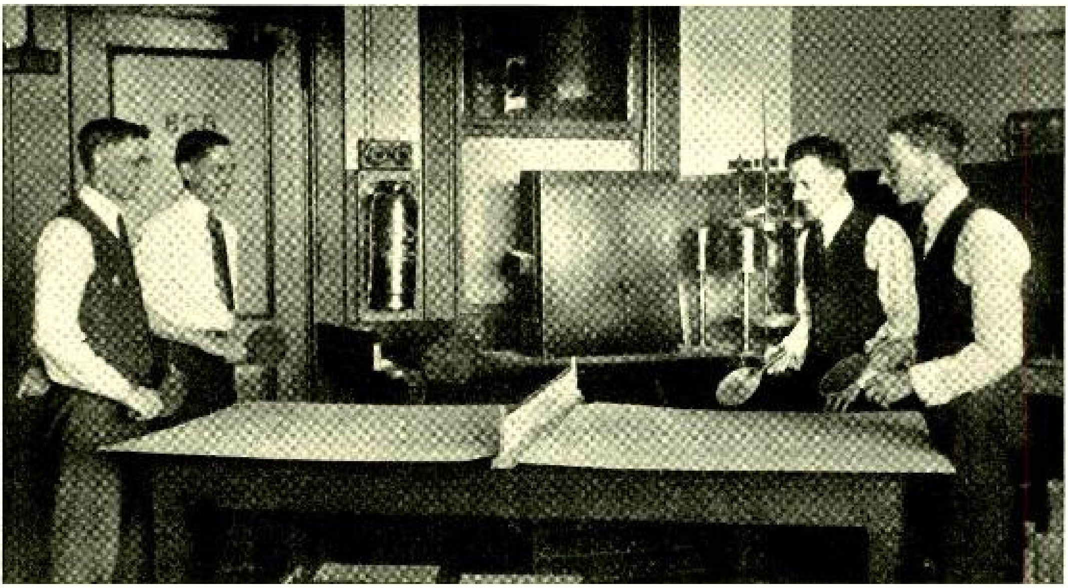
During September there was a gain of 142,400 telephones in service in the Bell System, the largest for any month in the history of the company. This gain compares with an increase of 110,400 in August and 109,200 in September last year. The net gain for nine months this year totals 1,007,900, which is greater than the entire 1940 gain of 950,000, the largest increase for any year up to now. At the end of September this year there were about 18,489,300 telephones in the Bell System.

* * * * *

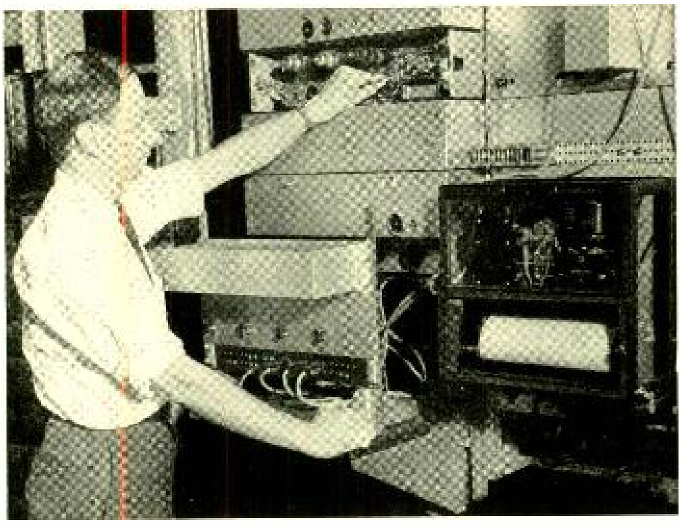
Within a few days of each other, the two large cities in the United States having the greatest telephone development in proportion to population both reached the 300,000 mark in number of telephones. The 300,000th telephone in San Francisco, which leads all large cities of the world in telephone development, was installed on August 11. The 300,000th telephone in Washington, D. C., second in rank in the U. S., was installed on August 15 in the office of the Chief Signal Officer of the Army. It is interesting to note that the first telephone ever installed in Washington, in 1877, was also in the office of the Chief Signal Officer of the Army. It was connected with another instrument at Fort Myer, Virginia, some time before Washington had a telephone exchange.

Rhombic Antenna Design

Present-day practice in the design and construction of the rhombic antenna, so important in short-wave radio communication, is the subject covered in this book by A. E. Harper of the Radio Research Department and published by D. Van Nostrand Company. To meet the requirements of the practical designer, it includes an introductory discussion of directional radio transmission, followed by a description of horizontal



The beginnings of Table Tennis in the Laboratories. This photograph, taken twenty years ago, shows (left to right) H. T. Reeve, H. W. Everitt, B. B. Webb and R. H. Wilson using a muslin net and two pieces of transite on an office table—a far cry from the equipment now available. In 1932 Mr. Wilson was seventh in National Singles ranking and, with Mr. Reeve, fifth in the Doubles ranking. The same year three of these men—Everitt, Reeve and Wilson—formed a Team-of-Four with E. L. Fisher and were Metropolitan Ping Pong Association champions



Thermistor-controlled twist repeater and temperature recorder used on laboratory trial of new type-K carrier system over the cable recently installed on the roof of Section R at Bethune Street. J. P. Kinzer is changing one of the connections on the repeater

rhombic antenna design methods and mechanical construction practices. Tabulated and graphical functions found useful in antenna development work have been included to expedite computation. The plans of typical transmitting and receiving antennas have been appended to indicate the type of overhead wire-line hardware that is ordinarily required.

The subject matter of the book has been collected from the published and unpublished reports of many Laboratories' engineers responsible for the development and construction of directional antennas.

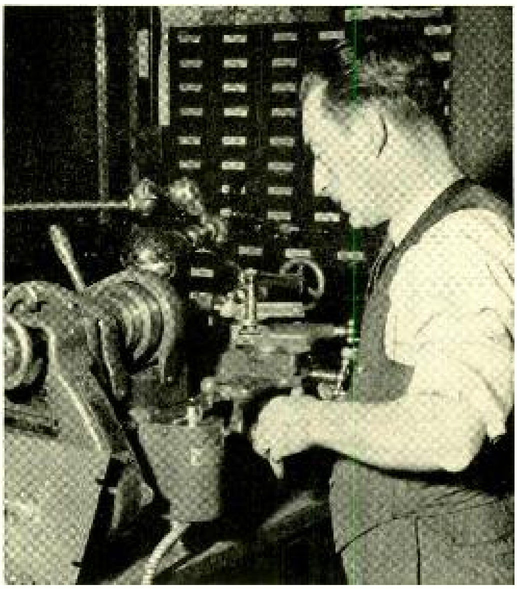
Part-Time Postgraduate Study Plan

Seven applications for participation under the Part-Time Postgraduate Study Plan have been approved for the fall term. This plan, which was announced by the Personnel Department last August, provides an opportunity for advanced study of a type not available in evening colleges or in the Out-of-Hour courses. Members of the Laboratories who have been regularly employed for approximately one year, or more, and who hold a bachelor degree in arts, science, or engineering are eligible. The plan has been in operation for twenty-one years, during which time 86 M.A. or M.S., 14 Ph.D., and 8 LL.B. degrees have been conferred on participants of the plan.

During the past year two men who participated in the plan were granted degrees: R. J. Kircher, M.Sc., Stevens, and B. T. Weber, M.A., Columbia.

Colloquium

H. B. Briggs discussed *Resonance Phenomena in the Frequency Response of Gas-Filled Photoelectric Tubes* at the first Colloquium meeting of the 1941-1942 season. Using a supersonic cell for light modulation, a new method has been developed for measuring the frequency response of photoelectric tubes. Measurements up to 200 kilocycles are readily obtained. A detailed study of the frequency characteristics of several gas-filled tubes has been made. Resonance effects depending on the transit time of the positive ions formed in the process of gas amplification



F. J. Grattan making parts for a high-frequency attenuator in the Transmission Development Laboratory Shop are shown in great detail for tubes of special design, and are almost equally well shown for some commercial type tubes. An application of the results in the determination of ionic mobilities was discussed by Mr. Briggs.

Erpi Merges with Western Electric

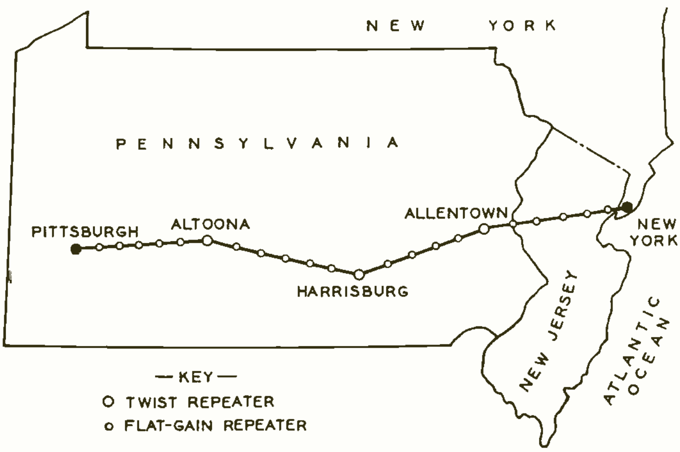
Electric Research Products, Incorporated, formed in 1926 to handle Western Electric products in the sound picture field, was merged into the Western Electric Company on November first. Its domestic activities will be carried on as a division of Western Electric in charge of T. K. Stevenson, formerly its president, and now vice-president of Western Electric. Erpi's former officers will continue their responsibilities in the new division.

Ownership of Erpi's foreign subsidiaries has been transferred to a new company, Western Electric Export Corporation, of which Mr. Stevenson will be president.

Karl J. Ogaard of the Fourth Medical Battalion at Fort Benning, Ga.

Field Trial of K2 Carrier Telephone System

A new member of the carrier family is now undergoing a field trial. This is the K2 carrier telephone system, the 1942 model of the twelve-channel carrier system for toll cables. Two systems have been set up between New York and Pittsburgh for these special tests. Between the terminals are twenty-two repeater stations at intervals averaging a little more than 16 miles as shown in the accompanying illustration.



Route of K2 carrier system between New York and Pittsburgh

The K2 system represents an advance over the present standard K1 system in many respects. Instead of mechanical arrangements, thermistors are used for the regulation of repeater gains against changes in cable loss with temperature. Filamentary type vacuum tubes heated directly from an a-c supply will reduce power costs considerably. Certain parts and materials which are in great demand for national defense purposes have been eliminated in the new design. The equipment will not only be less expensive but will also substantially reduce the manufacturing effort that is required by the Western Electric Company.

The trial will also be a proving ground for new testing apparatus units that have been designed to serve in the maintenance of the system.

Intensive effort by a number of the Laboratories' engineers is required to complete the field work by the middle of December, when the trial systems are to be placed in commercial service by the A T & T.

Improvements in 755A P.B.X.

Several modifications have recently been made in the 755A private-branch exchange to conserve materials for National Defense and to improve its reliability in service. UA-type relays have been provided instead of U-type. These relays, having a much larger pole-face area, operate on less ampere turns which enables the use of iron for the core material instead of permalloy, thus conserving nickel.

The crossbar switch of the card-operated type, coded 304N, has replaced the 300W switch. This change was made to reduce manufacturing costs and to obtain improved switch operation. Contacts have been added on certain relays in the call-allotter circuit to parallel the other contacts on these relays in the lockout chain circuit with improvement in the reliability of the circuit, particularly in dusty locations. Another change is in the sheet-steel pocket on the right side of the front cover for holding drawings. This has been improved by the addition of an extra piece of sheet steel to close the bottom of the pocket and a similar pocket has been added to the left side of the cover.

National Defense, Military and Naval Items

Members of the Laboratories who have been granted leaves of absence for military service since the last issue are:

William J. Galbraith, Signal Corps School, Fort Monmouth, N. J.

Robert L. Kaylor, Aircraft Radio Laboratory, Wright Field, Dayton, Ohio.

* * *

Since September 15, Major R. O. Ford has been Assistant Ordnance Officer of the First Army with headquarters at Governors Island. He is now on maneuvers in North Carolina. Last year he was Ordnance Instructor of the Cornell R.O.T.C. and during the past summer was in command of the R.O.T.C. camp at Aberdeen Proving Ground, Maryland. There were 150 boys from eight different colleges together with an instructor from each college at the camp.

Karl J. Ogaard of the Fourth Medical Battalion, Fort Benning, Ga., writes:

Our work consists of giving first aid treatment to the personnel of the 8th Infantry. We operate a collecting station a mile to the rear of the firing line. Casualties are evacuated by litter bearers from the "battle scene" to our station. At the station they are given further medical aid, and are then transported by ambulance to a clearing station. The 4th division is the only completely motorized division in the country, and because of this our action is fast and plentiful. As bugler of the battalion, my sleeping hours are lessened some, and hazing is never-ending.

(Mr. Ogaard returned to the Laboratories on October 20.)

Charles E. Merkel is with the Headquarters Company of the 4th Armored Division at Pine Camp, N. Y. He writes:

I had hoped to pay a visit to the Laboratories before this but things didn't turn out as expected

Major R. O. Ford is now Assistant Ordnance Officer of the First Army with headquarters at Governors Island

Lieut. Walter S. Gunnarson on the firing range at Fort Bragg, N. C.

so my alternative is to put it in writing. I do know that *Life* Magazine gave a most interesting and accurate account of the activities of Army life. It even went so far as to print a picture taken from a neighboring village.

Monday, September 15, has started me on my fifth month of service and has brought me from a "rookie" status to that of "buck private," but they have seen fit to elevate me from the state of buck private before it even started to that of "Private, First Class."

My duties and activities have been varied from that of K.P. to that of chauffeur. At the present time, my assignment is working in the company supply room, how long one never knows. Should something better and more pleasing come forth a change may be made. The final decision as to what one really does is never left up to us, as the officers have the last word.

LIEUT. WALTER S. GUNNARSON writes:

The first three months of my present tour of duty were spent in the Field Artillery School at Fort Sill, Oklahoma, undergoing a "refresher" battery officers' course. On completion of the course in February my orders took me to the Field Artillery Replacement Center at Fort Bragg, N. C., where I was assigned to the 16th Battalion, 5th Field Artillery Training Regiment. This is the only battalion training colored selectees at the center.

At present I am serving as gunnery officer with Battery E, which is equipped with 75-mm guns. My duties previously have included posts as motor officer, supply officer, executive and acting battery commander with a 155-mm howitzer battery, as well as regimental rifle instructor for new officers.

THOMAS J. SLATTERY writes:

I am now a radio operator in the communication section of the 187th Field Artillery at Fort Ethan Allen, Vt. Previously I was a lineman and switchboard operator. The portable radio equipment shown in the accompanying photograph weighs about twenty pounds and is capable of sending and receiving over a five-mile radius.

LIEUT. WILLIAM KES writes from Fort Jackson, Columbia, S. C.:

I am a First Lieutenant with the 102nd Cavalry. My duties include the responsibility of transporting the Horse Squadron of a horse-

Thomas J. Slattery operating a portable radio set at Fort Ethan Allen, Vt.

mechanized regiment. To accomplish this, I have 116 men and over 100 vehicles of which 77 are the tractor-trailer type for transporting the horses, with the balance made up of jeeps, combat trucks, scout cars and motorcycles.

WALTER W. MAAS of the 102nd Observation Squadron, U. S. Army Air Corps, at Fort McClellan, Alabama, writes:

Ever since our induction last October we have been living in tents here in Fort McClellan except for our expeditions into the field on maneuvers. In the past eleven months our airplanes have not seen the inside of a hangar and they are still in fine condition. I personally think that is a tribute to both the manufacturers and the mechanics who service the ships.

During the army war games in Tennessee we were stationed at Lovell Field in Chattanooga for about five weeks. We were camped in a camouflaged position in the woods alongside the airport. Our planes were engaged in the business of spotting for the artillery and also in mosaic mapping. At the beginning of July we returned to our home base again and then most of us went home for ten-day furloughs.

Walter W. Maas is with the 102nd Observation Squadron at Fort McClellan, Ala., where his duties consist of maintaining aircraft radios

When I got back from my leave I was sent, with ten other men and three airplanes, to Manchester, Tennessee for a coöperative mission with an artillery brigade from Camp Forrest. During the two weeks we were there we operated out of a small emergency landing field that was hardly worthy of the name. My duties during all this time consisted of maintaining the aircraft radios including one designed by the Laboratories. It is the new command set and I find it to be the simplest and best performing set we have in our planes.

Lieut. William Kes (on motorcycle in foreground) is with the 102nd Cavalry, Fort Jackson, Columbia, S. C.

Our life has been pleasant as compared to line soldiers in that we have no hard physical labor. We do put in a long day of technical work though and have no difficulty in sleeping the night through. Our squadron is particularly fortunate in having a fairly nice camp area. As I write this I am sitting at the edge of our private swimming pool which is in a pine grove on the hill overlooking our airfield. In back of Officers' Row we have a skeet range for our personal use and down near the field we have a good baseball diamond. At the head of our squadron street we

R. J. Drout is with the 13th Infantry, 8th Infantry Division, Fort Jackson, S. C.

have a canteen in which we have put up a very good ping pong table that is put to great use. A day room that is to contain a pool table, radio and some comfortable furniture is almost completed. That will help make our evenings a little more pleasant, especially if we are here for another winter.

News Notes

O. E. Buckley has been appointed chairman of the Charles LeGeyt Fortescue Fellowship Committee of the A.I.E.E. He has been a member of the committee since 1939.

John F. McKernan, until recently chief of equipment in the production division of the OPM, has returned to Western Electric in the newly created post of manager of defense program planning, with headquarters at the Kearny Works.

R. M. Burns has been appointed to represent the Laboratories on the Policy Committee of the Gibson Island Research Conferences sponsored by the A.A.A.S.

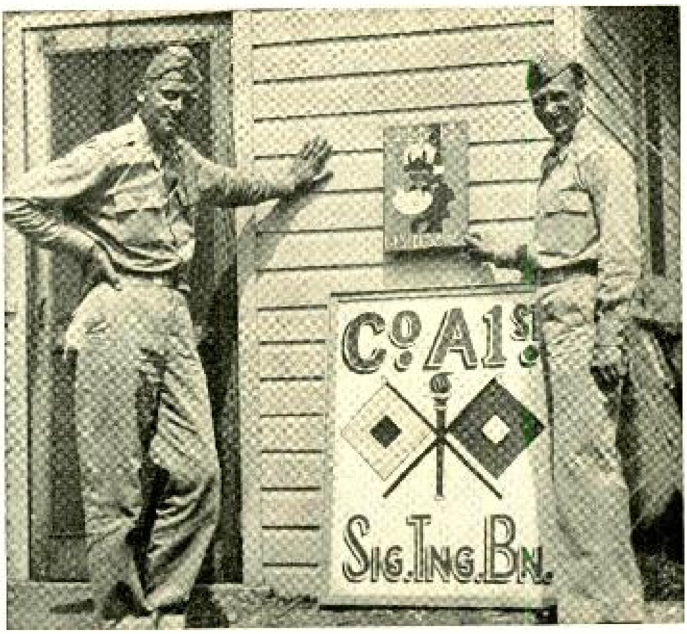
Mr. Burns attended the Electrochemical Society convention in Chicago, discussed finish matters with Hawthorne engineers and visited Pittsburgh on matters pertaining to contact studies which the Laboratories are conducting there in telephone offices.

The American Chemical Society convention at Atlantic City was attended by A. G. Arlt, W. O. Baker, B. S. Biggs, F. J. Biondi, J. R. C. Brown, R. M. Burns, B. L. Clarke, C. S. Fuller, J. H. Ingmanson, C. C. Hipkins, D. B. Herrmann, A. R. Kemp, G. T. Kohman, F. S. Malm, D. A. McLean, S. O. Morgan, H. A. Sauer, M. L. Selker, G. G. Winspear, L. A. Wooten and W. A. Yager. During the convention Dr. Clarke presented a lecture-demonstration at the general meeting on *The Electrographic Method of Analysis* and, before the division of the Analytical and Microchemical Committee, presented a paper on the *Accuracy and Precision in Analytical Methods*. He was also reëlected a member of the Advisory Board of the Analytical Editors of *Industrial and Engineering Chemistry*. Mr. McLean and Mr. Kohman participated in a symposium devoted to *Insulating Materials* and Mr. McLean presented a paper entitled *Paper Dielectrics Containing Chlorinated Impregments—Deterioration in DC Fields* of which L. Egerton, Mr. Kohman and M. Brotherton were co-authors.

Other papers presented were *Dielectric*

Joseph F. Daly recently became a Sergeant of the 2nd Aircraft Warning Company, Mitchel Field, Long Island

Properties of Polyesters and Polyamides by Mr. Yager with Mr. Baker, co-author; *Chemical Studies of the Oxide-Coated Cathode: I—Rate of Evaporation of Barium and Strontium and II—Change in Composition with Age* by Mr. Wooten with G. E. Moore, A. E. Ruehle and C. L. Luke, co-authors; *Determination of Surface Area on the Oxide-Coated Cathode* by Mr. Brown with Mr. Wooten, co-author; *Effect of Heat and Solvents on Cellulose Plastics* by Mr. Fuller with Mr. Baker and N. R. Pape, co-authors; and the paper *Brittle Point of Rubber Upon Freezing* by Mr. Selker with Mr. Winspear and Mr. Kemp, co-authors.



Lieut. Ernest C. Graunas, of the 1st Signal Training Battalion at Fort Monmouth, shows Lieut. Harry W. Holmlin, also of the Laboratories, his company insignia. Lieut. Graunas commands a company of 250 selectees being taught telephone communication. After thirteen weeks' intensive training, the selectees are sent to various tactical units, trained as Signal Corps soldiers. Lieut. Holmlin is with the Engineers at Fort Devens, Mass.

Ralph Bown left for Lisbon by Clipper on September 24 on a technical mission for the National Defense Research Committee.

J. M. Finch attended a meeting of the A.S.T.M. Committee D-9 devoted to the subject of insulating materials.

R. L. Jones has been appointed an AIEE representative on the new Engineers Defense Board, an organization of the national engineering societies, to assist various branches of the Government with engineering knowledge and experience on questions of materials conservation and other engineering matters relating to the defense program.

Walter Senitoritch of the Transmission Apparatus Department received a B.E.E. degree from New York University last June.

V. E. Legg addressed the Philadelphia section of the Institute of Radio Engineers on October 2. The subject of his address was *Magnetic Materials in Communication and Radio Apparatus.*

At the Hawthorne plant of the Western Electric Company E. B. Wheeler discussed insulated wires, switchboard lamps and other apparatus; J. Abbott, dials for linemen's hand sets; J. R. Fry, O. M. Hovgaard and F. A. Zupa, relay development and contact-metal problems; G. E. Atkins, step-by-step apparatus; B. L. Clarke and C. C. Hipkins, the effects of raw material shortage on finishes; and C. J. Frosch, molded plastic telephone sets.

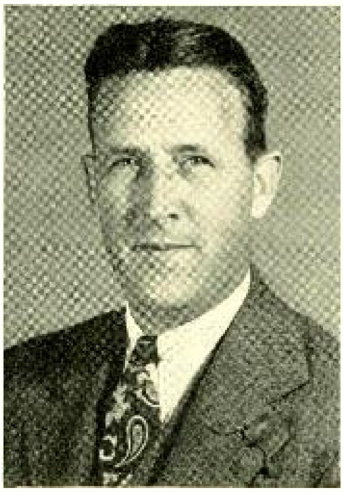
R. T. Staples, at Point Breeze, discussed cord development problems.

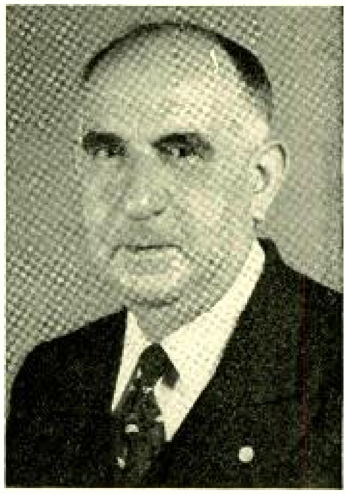
F. R. Bies visited Kansas City, St. Louis and Wyanet (Ill.) in connection with crystal filters used on the type-K carrier telephone system.

C. R. Moore visited the Gleason Works, Rochester, to consult with their engineers on the manufacture of hypoid gearing in connection with dial development.

E. St. John, with W. C. Weaver of A T & T and several engineers from the New Jersey Bell Telephone Company, went to the Mt. Holly central office of the New Jersey Company in connection with switchboard clocks.

L. N. Hampton visited the Naval Ordnance Laboratory in Washington.





Rush F. Newcomb
Treasurer of the Laboratories completed forty years of service in the Bell System on the first of October

William L. Filer
of the Switching Development Department completed thirty-five years of service in the Bell System on October 17

C. Jacob Kuhn
of the General Service Department completed thirty-five years of service in the Bell System on October 3

L. C. Roberts was in Chicago from September 25 to October 6 testing the operation of voice-frequency telegraph on type-K1 carrier equipped with deviation regulators.

J. W. Corwin, at Chicago, conferred with the Installation Department of the Western Electric Company regarding cabling in crossbar offices and, at Hawthorne, discussed the matter of various substitute materials for use in central-office equipment.

* * * * *

C. C. Barber became associated with the Bell System in 1916 after eight years of extensive experience in mechanical engineering in other companies. His first work in the Engineering Department of the Western Electric Company was with the panel apparatus drafting group and he was placed in charge of this group in 1918. At this time he inaugurated a course in drafting for technical assistants—a forerunner of the Out-of-Hour Courses.

In 1920 Mr. Barber transferred to the panel apparatus design group. Here a number of his ideas became the subject of patents, notably the method, now in current use, of attaching springs to centrifugal governors on the cork roll drive, and the oil-circulating pump used on this drive. The use of cork compression discs to take up thermal expansion in the 153-type interrupter is also one of his many contributions to the telephone art. In 1924 he received his Professional Engineer's license from the State of New York. Since 1930, he has been engaged in the supervision of a group of engineers in the Switching Apparatus Development Department whose activities are identified with the design of panel and crossbar apparatus. During this time he was closely associated with the development of the release spring on clutches and the flexible panel-multiple brush used to reduce noise in telephone circuits. More recently he has spent much of his time on development problems connected with National Defense. He has also served as an instructor of the Out-of-Hour course classes in *Manufacturing Methods* since 1938.

Mr. and Mrs. Barber, who live in Rockville Center, L. I., have a married daughter. Mr. Barber's recreations are travel, navigation and color photography. He is an honorary member of the U. S. Power Squadron in which he holds a JN rating. During the time that he was active in this organization he was an instructor in navigation. He is also a member of the Telephone Pioneers of America.

* * * * *

James Cusack, a uniformed watchman and elevator operator of the Plant Department, received a five-star emblem on October 21 signifying his completion of twenty-five years of service in the Western Electric Company and the Laboratories. Before joining the Bell System as a watchman in 1916 he had spent seven years with E. C. Rich in New York City. At the time of the First World War he was a watchman on the outside of the 463 West Street building during the period that twenty-four-hour guard service was maintained. In recent years he has been assigned to the entrance of Building R. Occasionally he is at the main entrance of the 463 West Street building and, in addition, often operates elevators.

C. C. Barber

James Cusack

The Cusacks, who live on Bank Street, have two daughters and a son. The eldest daughter, Mary, works in the Blueprint Department in the Davis building while the other daughter is married and lives in Ohio. Their son works in New York City. Mr. Cusack belongs to the Edward J. Hall chapter of the Telephone Pioneers of America.

J. W. Woodard visited Atlanta and Richmond to discuss current switchboard orders.

V. T. Callahan visited the General Motors Corporation in Detroit, and the Telephone Companies in Pittsburgh and Cleveland on matters pertaining to Diesel engines for telephone power use.

F. T. Forster, on a recent trip to Trenton, tested storage batteries.

A. E. Petrie attended a conference at the Diesel Engine Division of the General Motors Corporation in Detroit. This con-

Claude Deyo
of the Purchasing Department completed thirty-five years of service in the Bell System on October 6

Edward J. Johnson
of the Equipment Development Department completed thirty years of service in the Bell System on October 3

James W. Farrell
Secretary and General Attorney of the Laboratories completed thirty years of service in the Bell System on Oct. 11

Stanley B. Kent
of the Patent Department completed thirty years of service in the Bell System on October 3

Walter A. Boyd
of the Quality Assurance Department completed thirty years of service in the Bell System on October 30

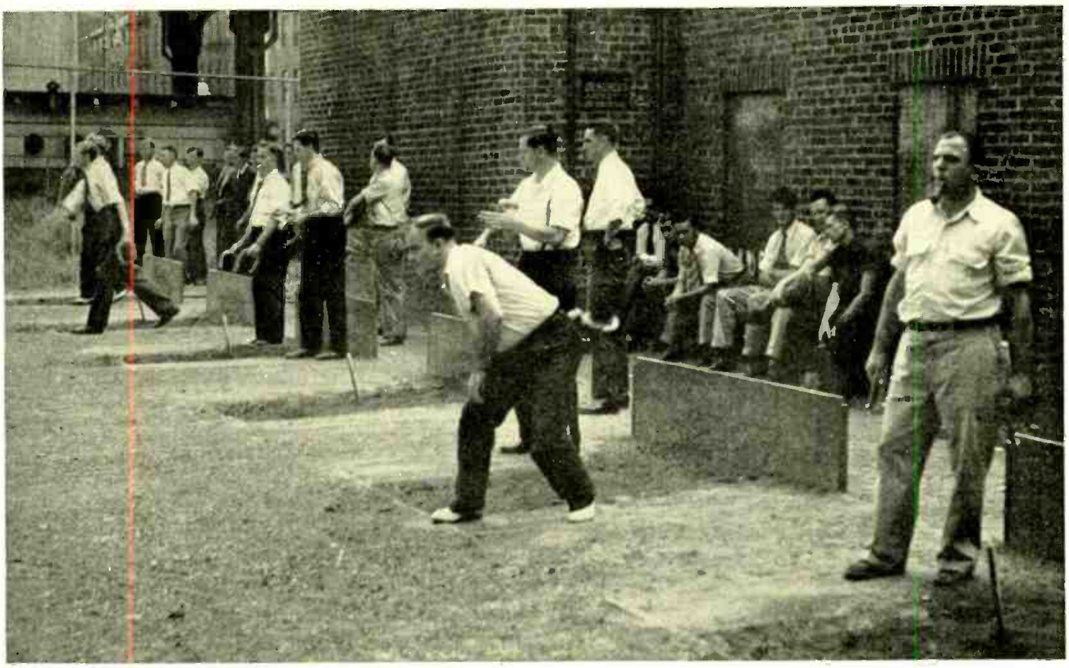
W. Chester Redding
of the Outside Plant Development Department completed thirty years of service in the Bell System on October 2

ference was devoted to a study of engines for telephone power systems.

J. H. Sole discussed power-plant machine design at Fort Wayne.

O. H. Williford and C. H. McCandless spent the month of September in St. Louis where the first crossbar office in that area has just been placed in service. W. Rupp was also in St. Louis to instruct Telephone Company maintenance forces in the methods required for this new office.

H. H. Spencer visited the new 20 x 40 buildings for type-K carrier auxiliary repeaters in Cleveland. He was accompanied by engineers of the Western Electric Company and the Long Lines Department.



C. W. Van Duyne discussed Diesel engines with engineers of the Witte Engine Works in Kansas City.

O. J. Morzenti, H. A. Lewis and A. J. Wier have made several trips to points between New York and Pittsburgh on matters pertaining to the trial installation of the new type-K carrier system.

H. Keppicus attended conferences at Princeton and Philadelphia on the New York-Philadelphia coaxial system.

G. H. Downes, R. B. Bauer, O. S. Mesch and H. T. Douglass visited New Haven to observe the operation by maintenance forces of the Southern New England Company of a contact welder for replacing contacts on step-by-step relays in service.

L. J. Stacy and P. Winsor were at Hartford to obtain data on the operating characteristics of step-by-step switches under field maintenance conditions.

G. A. Hurst spent a week in Detroit where a crossbar-tandem office is at present being installed.

H. G. W. Brown, E. Von Nostitz and G. Hecht spent two days visiting local dial offices in Riegelsville and Lansdale, Pa., to observe the operation of the recently developed No. 1 dial pulse recorder.

E. S. Wilcox, C. H. Gorman and C. O. Cross moved to Grand Island, Neb., for crosstalk tests at type-K frequencies on the

Members of the Laboratories Who Have Enrolled as Telephone Pioneers During the Third Quarter of 1941

Henry C. Baarens
James A. Carr
John F. Dalton
Emil Dickten
Francis S. Farkas
Harold J. Fisher
Herbert W. Flandreau
Rogers H. Galt
Gilbert Haege
Clarence M. Hebbert
Ralph C. Hersh
Frank L. Hollingworth
Robert A. Horsburgh
George A. Hurst
Franklin A. Korn
William A. Krueger
James M. Labaugh
Albert G. Lang
Frank Lohmeyer
David W. Mathison
Alfred E. Melhose
William A. Moore
Karl O. Olson
George H. Peterson
Robert Pope
George Puller
George A. Pullis
James A. Ratta, Jr.
William E. Reid
Allen H. Richardson
Arthur G. Scharwachter
George T. Scheeler
George F. Schmidt
Donald M. Terry
Walter J. Thayer
Alfred E. K. Theuner
John R. Townsend
Fred W. Treptow
William Trottere
Arthur H. Volz
Ladislaus Von Nagy
Milton A. Warren
Gerard P. Wennemer
George J. Wismar
Miss Estelle Womack
Ernest B. Wood
John B. Worth
Charles F. Young

George Hess, 1870-1941

James O'Farrell, 1890-1941

Omaha-Denver buried toll-cable route. H. B. NOYES and W. E. REID were in Sidney, Neb., making similar tests on other repeater sections of the same route.

* * * * *

JAMES O'FARRELL, a watch electrician in the Plant Department, died suddenly on September 26. Mr. O'Farrell joined the Engineering Department of the Western Electric Company in 1919. Previous to this he had spent three and one-half years with the New York Railways Company, one year with Remington Arms and nearly two years with the 308th Ambulance Corps of the 77th Division in France. With this Division he was in action at the Baccarat Sector, at Visle and during the Oise-Aisne and Meuse-Argonne offenses. His first work here was as a porter. In 1921 he became an elevator operator and three years later transferred to the Power Plant as a helper. Later he was assigned various other duties such as power-service operator, fireman and watch electrician. For the past five years he had been assigned to the Graybar-Varick building.

* * *

GEORGE HESS, a former building trades mechanic in the Plant Department who retired in 1932 after twenty-nine years of service in the Western Electric Company and the Laboratories, died on October 5. He joined the Western Electric Company in 1903 as a steam fitter's helper and at the time of his retirement in 1932 was a maintenance pipefitter in the Building and Maintenance Department.

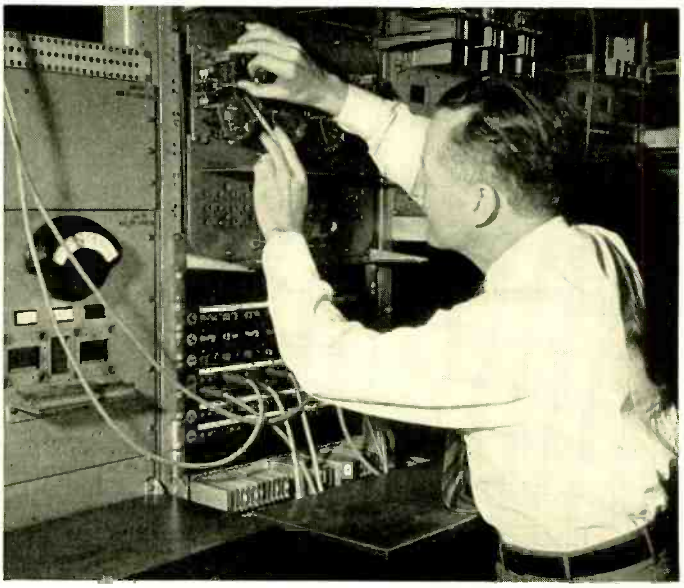
* * *

A. L. BONNER, at Chicago, made tests of ringing interference on a system equipped with K-1 deviation regulator.

J. MAURUSHAT, JR., has been in Boston on a trial installation of program equipment for type-K carrier systems.

L. R. COX has been in Minneapolis and Stevens Point supervising the installation of a new pilot supply for the L1 carrier system on the coaxial cable between Stevens Point and Minneapolis.

O. R. GARFIELD and J. O. SMETHURST have been in Norfolk and Cape Charles, Virginia, testing a twelve-channel radio system.

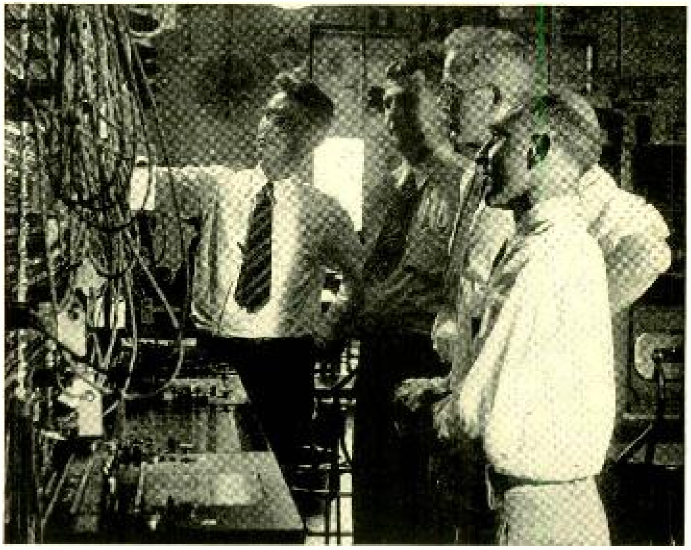


J. A. Mahoney studies the mode of operation of the selector and transmitting contacts of the 106-type regenerative repeater in the telegraph laboratory

W. A. Edson has left the Laboratories to assume an Assistant Professorship in the Electrical Engineering Department at the Illinois Institute of Technology.

Tests of a circuit designed to substitute a spare-line section for a regular section of a type-K carrier system without interrupting service were carried out by H. A. Wenk at Springfield, Ill. The tests were made on a Chicago-Joplin system which is equipped with the new deviation regulator.

A. J. Pascarella of the Laboratories, R. V. Jones of O & E and R. H. Henderson of Long Lines visited several Long Lines offices in the Southwestern Company to investigate toll-test board facilities.



Observing the patching congestion at the toll-test board in St. Louis. Left to right, R. H. Henderson, Long Lines, New York; L. J. Houck, Long Lines, St. Louis; R. V. Jones, O & E; and A. J. Pascarella of the Laboratories

J. J. Gilbert and O. B. Jacobs reviewed submarine cable tests at Manahawkin.

K. C. Black and O. D. Grismore were in Baltimore in connection with the trial of the 0.8-megacycle coaxial system between Baltimore and Washington.

G. R. Frantz, J. J. Jansen, and I. E. Wood were in Philadelphia lining up the New York-Philadelphia coaxial television circuit for coming television transmissions. H. C. Hey and A. F. Mott were in Philadelphia coöperating with The Bell Telephone Company of Pennsylvania in setting up video television circuits.

During the month of October the following members of the Laboratories completed twenty years of Bell System service:

Research Department—H. A. Hay

Apparatus Development Department

A. H. Falk	Claude Kreisher
L. E. Gaige	Norman Scribner

Systems Development Department

M. L. Almquist	W. H. T. Holden

General Service	*Plant Department*
Miss Louise R. Ellin	B. A. Nelsen

M. M. Jones went to Minneapolis to relieve B. Dysart during tests on the Minneapolis-Stevens Point coaxial system.

E. B. Cave appeared before the Board of Appeals at the Patent Office in Washington during September.

During the month of September patents were issued to the following members of the Laboratories:

T. Aamodt	E. P. Felch
L. H. Allen	J. B. Maggio
J. H. Bollman	R. F. Mallina
A. R. Bonorden (2)	R. C. Mathes
E. Bruce (2)	C. F. Mattke
A. C. Dickieson	R. L. Miller
G. J. V. Faley	I. G. Wilson

An article by S. A. Schelkunoff entitled *Theory of Antennas of Arbitrary Size and Shape* was published in the September issue of the *Proceedings of the I.R.E.*

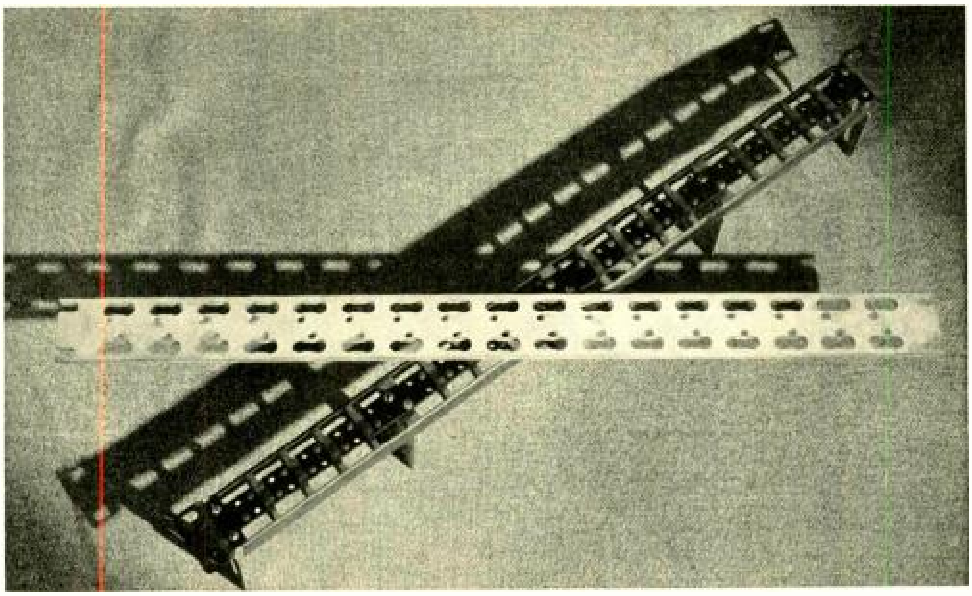
H. W. Gillette has been appointed chairman of the Program Committee of the New York Employment Managers' Association.

R. A. Deller spent September 2 in New London with T. E. Shea, Director of the Columbia University National Defense Laboratories, and R. G. Watling, discussing the selection of technically trained men.

A. R. Thompson, as president of the American Institute of Graphic Arts, has been appointed a member of the Advisory Committee, the Division of Graphic Arts, New York University.

Bell Laboratories Club Calendar

ARCHERY CLUB	Every Thursday and Friday, 5:30 P.M. New York Archers' Club, 277 Canal St.
BOWLING	*New York Section* Every Wednesday and Thursday, 6 P.M. National Recreation Alleys, 23rd St. & 8th Ave.
	New Jersey Section Every Monday, 7:30 P.M. South Orange Recreation Alleys.
BRIDGE	Every Monday, 6:00 P.M. Game Room, Section 1-G
CHESS	Every Tuesday, 6:00 P.M. Service Dining Room, Section 1-G
DANCING CLASSES	Every Monday, Tuesday and Friday, 6:30 P.M. Bassoe Studio, 66 Fifth Ave.
FIRST AID CLUB	Second and Fourth Thursday, 5:30 P.M. Club Lounge
HORSESHOE PITCHING	Courts open every day, 11:30 A.M. to 2:00 P.M. Bethune St.
HUNTING AND FISHING CLUB	Schedule to be announced
MOTION PICTURE CAMERA CLUB	First and Third Wednesday, 6:00 P.M. West Street Auditorium
ORCHESTRA	Every Tuesday, 6:00 P.M. Game Room, Section 1-G
OPERA	Every Monday, starting November 24 Metropolitan Opera House
PHOTOGRAPHIC CLASSES	Every Monday, 5:30 P.M. Room 671
PHOTOGRAPHIC CLUB	Tuesday, November 18, 6:00 P.M. West Street Auditorium
RIFLE CLUB	Every Wednesday, 6:00 P.M. Swiss Hall, Union City, N. J.
SAILING CLUB	Schedule to be announced
STAMP CLUB	Second and Fourth Thursday, 5:30 P.M. Game Room, Section 1-G
TABLE TENNIS	Daily from 11:30 A.M. to 2:00 P.M. West Street Auditorium



Effect of Mounting-Plate Vibration on Relay Operation

By A. J. ENGELBERG
Switching Development

RELAYS are used in very large quantities in all telephone switching systems, and as a rule they are assembled in groups of common mounting plates. For many years the most widely used relays have been of the flat type*—either the E or the R—and two types of mounting plates have been employed. One of them, and for some time the only one, is a flat steel plate 1¾ inches wide and a little under a quarter of an inch thick. The relays project from one side of the plate, and above and below the central strip where the mounting screws fasten, the plate is cut out to allow the terminals of the relay to extend through to the rear, where soldered connections are made. The other plate is a punched channel; such a section provides sufficient additional stiffness to permit much thinner metal to be used, and with thinner metal the slots for the terminals can all be punched in the same operation. For the most part these plates are made either 19 or 23 inches long. The two types are shown in the headpiece.

With the development of the crossbar system, a number of factors entered to affect the mounting-plate situation. In the first place many of the crossbar frames are wider than most previous frames, and mounting plates 28 inches and 30½ inches long are required. In addition the U and Y-type* relays, used almost exclusively

*Record, *Nov.*, 1925, *p.* 83.

*Record, *May*, 1938, *pp.* 300 *and* 310.

in the crossbar system, are heavier than the E and R types, and require greater operating forces because of the much larger spring "pile-ups" they carry. All of these factors—longer plates, heavier relays, and greater operating forces—result in

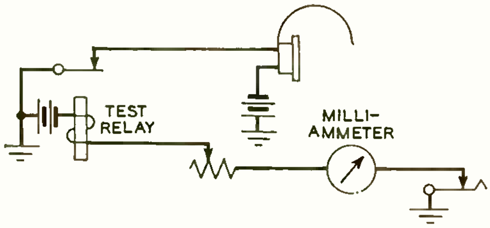


Fig. 1—Schematic of circuit used for determining the effect of mounting-plate vibration on relay operation

greater stresses on the plates when the relays operate and release. Still another factor entered that tended to make the stresses in the mounting plates larger. Because of the greater number of springs in the pile-ups of the U and Y relays, and thus the greater number of wires connecting to them, it was decided to fan the terminals farther apart so as to make more room for soldering. Because of this, the slots in the mounting plates, through which these soldering terminals pass, must not only be made longer because of the greater number of springs, but must be made wider as well. Thus the mounting plates are weakened by the cutting away of more material.

It was decided, therefore, to provide a stronger mounting plate for the U and Y-type relays when they were to be used on 28 or 30½-inch racks. To secure economy in manufacture, thin metal should be employed so that the mounting plates could be punched. A channel form was selected, and to secure the required stiffness the metal was made slightly thicker than that of the former channel and the channel was made two inches wide instead of 1¾, and with ¾-inch flanges instead of ⅝. With these changes, the plate was sufficiently strong to withstand the forces that it would be subjected to both when mounted and while in shipment.

Before finally standardizing the new plate, however, a measure of its stiffness was desired to make sure the vibration was not great enough to cause the relay contacts to open or close falsely. Long experience with the previous mounting plates had shown them to be satisfactory in this respect. It was decided, therefore, to devise some simple test to make sure that the new and longer plates were as free from false operation caused by vibration as

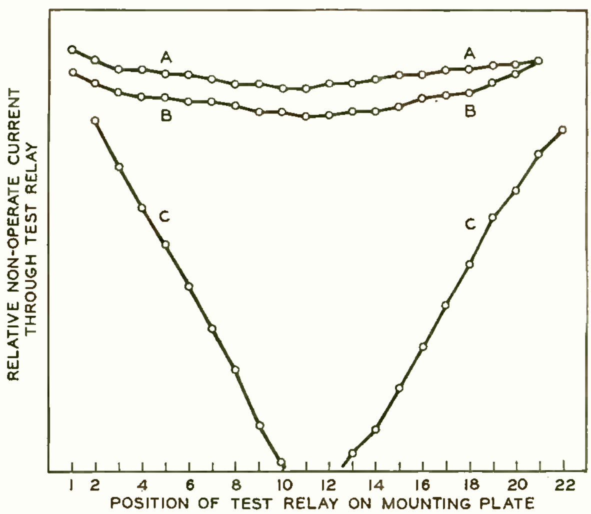


Fig. 2—Results obtained with test circuit for a 30½-inch mounting plate: A, *one* U *relay at right of test relay;* B, *all positions to right of test relay filled with* U *relays;* C, *all positions on both sides filled*

were the shorter plates. The vibration under consideration is that caused by the operation of other relays on the same mounting plate, and to secure the information wanted, it is necessary only to compare the false operations of a relay on the former plate with those of a relay similarly mounted on the new plates loaded with an equivalent set of relays.

It was decided to measure false contacts on the test relay by the simple circuit shown in Figure 1. Battery is connected to the winding of the test relay, and the circuit is completed through a milliammeter and a rheostat to permit the current through the relay to be set to any desired amount. A second circuit from battery is carried through a telephone receiver and a back contact on the test relay. The test relay may be placed in any position of the mounting plate, and other relays will then be mounted in some or all of the other positions, and operated and released periodically. A current tending to operate the test relay is passed through its winding, and the value of this current when the vibration is just sufficient to cause the back contact to open momentarily is a measure of the amount of vibration in terms of its effect on a relay mounted in the position of the test relay on the plate.

For this test circuit an R-type relay was selected because it is one of those most susceptible to vibration effects, and it was adjusted just to operate on .0101 ampere and just not to operate on .0099 ampere. The test procedure was to mount the relay in some position on the plate, pass the non-operate current through its winding, and operate and release the other relays on the plate 2½ times a second. Any opening of the back contact of the test relay would be immediately indicated by a click in the head set. If such opening occurred, the current through the test relay would be gradually decreased, and the highest value of current at which no opening of the relay contact occurred would be taken as a measure of the effect of vibration. Tests were usually begun with one relay mounted immediately to the right or left of the test relay, and were then continued as the other positions on the plate were gradually filled with relays, the relays being

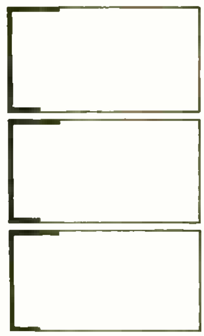


Fig. 3—By making one flange ⅝ and the other ⅞ inch, the gaps between cover and flange on adjacent plates are not opposite each other

operated and released in unison 2½ times a second. Readings would be taken with the test relay in all positions along the mounting plate. A typical plot of some of the results for a 30½-inch mounting plate is shown in Figure 2.

The test with all positions filled and all relays operating simultaneously is, of course, far more severe than is ever likely to be encountered under ordinary service conditions, because although the plate may have a full complement of relays, only a very few of them would ever operate simultaneously. The criterion for these tests, however, was not the actual value of the non-operate current through the test relay, but its value under any given condition compared with that through the same test relay when mounted on one of the former flat or channel plates loaded in an equivalent manner with R-type relays. In view of the satisfactory behavior of this mounting plate as judged by this criterion, it was approved for general use with certain minor restrictions regarding critical relays, which—it is stipulated—should be located only near the ends of the plate, or on a plate that is also equipped with coils, resistances, or condensers.

Metal covers are made to slip over relay mounting plates to protect the relays from dust and mechanical injury, and also to provide magnetic shielding from relays on adjacent plates. With the previous channel-type plates, these covers overlapped the flanges, thus forming a completely closed magnetic path. With the greater width of the new channel, however, it was not desirable to have the cover overlap the flanges of the channel because of the additional space that would be required. It was decided, therefore, to let the covers butt up against the flanges.

Where the cover butts against the flange, however, there is always the possibility of a small gap in the shielding magnetic path, and the gap on one mounting plate would be exactly opposite the ones on the plates immediately above and below it. To remedy this situation, the mounting plate was modified to make the flanges of unequal length; instead of having both of the flanges ¾ inch, one was made ⅝ and the other ⅞ inch. With this change, the gap on one plate is opposite solid metal on the plates above and below it. This is indicated in Figure 3. A check test showed that this change did not increase the vibration of the plate. One of these plates and covers is shown in Figure 4.

These mounting plates took care of the U and Y relays where the wider frames are used, as in the crossbar system, but since these new relays were coming into extensive use, it seemed worth while to investigate the possibility of modifying the existing 1¾-inch channel plates to make them satisfactory for the new relays so that the U and Y relays could be used to replace the E, R, or round-type relays in existing installations when necessary. When these plates were arranged

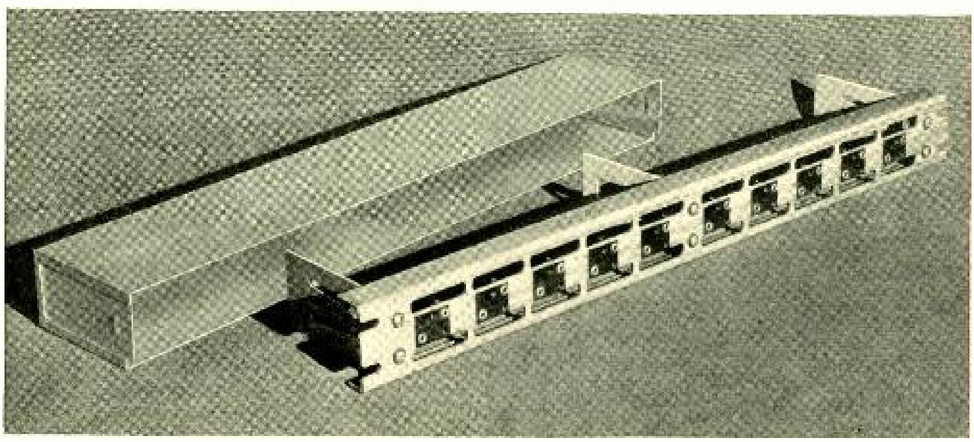


Fig. 4—The two-inch channel mounting plate designed for U *and* Y*-type relays*

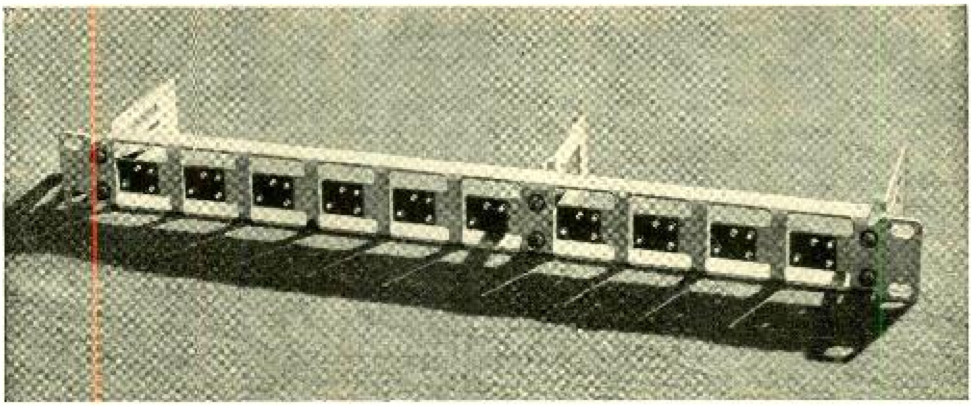
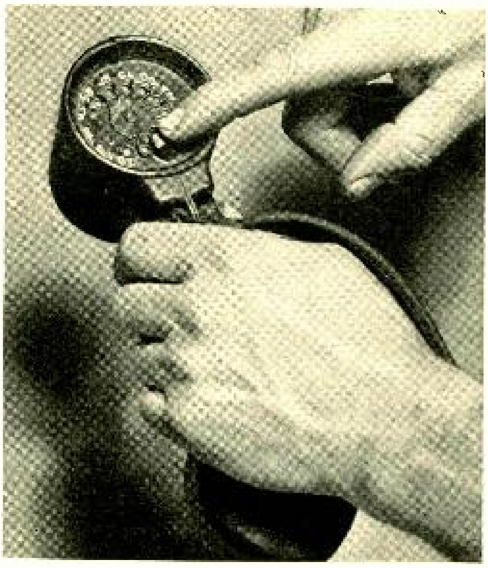


Fig. 5—By cutting a transverse slot at one side of each relay the vibration of one relay cannot be transmitted directly to the adjacent ones

for U or Y relays, they were still strong enough in so far as the static forces were concerned, but enough metal had been removed to make the vibration excessive, although the plates are only 19 or 23 inches long. As a result various methods of reënforcing the plates were tried, but none was found satisfactory. The vibration of a relay due to its own operation is not of great importance; what must be avoided is the transmission of the vibration of one relay to other relays on the plate. This fact led to the suggestion that a slot be cut transversely along one edge of each relay position—thus connecting the two longitudinal slots through which the soldering terminals pass. The plate made in accordance with this suggestion is shown in Figure 5. With this construction, each relay is mounted on a cantilever; and vibration must travel transversely to the flanges and then longitudinally along them. Since these flanges are stiff, and at right angles to the plane of the relay vibration, they are very inefficient in transmitting vibration.

Tests of plates of this type showed them to be nearly as satisfactory as the two-inch channels in respect to vibration. Vibration has been reduced to a satisfactory level for the majority of the mounting positions. Before finally approving these slotted plates, however, it was felt that their behavior during shipment should be studied because of the structural weakness resulting from cutting the transverse slots. This problem was studied in collaboration with the Western Electric Company. Under their supervision, special packing procedures were employed, after which shipping tests were made of individually packed plates fully equipped with relays, and of plates similarly loaded mounted on equipment units. The results of these tests showed that the packing methods that were finally adopted were satisfactory for shipping these plates.

As a result of this series of developments, relay mounting plates were made available for the crossbar system that were stiff enough to avoid objectionable vibration and yet economical to manufacture. In addition a plate has been made available that will permit U and Y relays to be used to replace E, R, and round-type relays on relay frames where space for the two-inch plate is not available.



Rubber Handset for Linemen

By D. T. EIGHMEY
Station Apparatus Development

IN DIAL-telephone areas installers have been using a dial-type handset with a metal handle. A new piece of equipment has now been developed which has several advantages. It is lighter, more compact and has improved transmission which arises from its utilization of the same units for transmitter and receiver as the F-type station handset. It has a rubber handle which renders it more resistant to damage from impact and handling than its predecessor.

The handle, molded in one piece of resilient rubber, retains the instruments and protective grids over the transmitter and receiver without threaded caps. Each end of the handle is split to allow the insertion of the instruments and other components; the split ends are held together by small bolts whose heads and nuts are imbedded below the surface of the handle. Conductors pass through the hollow handle, which also contains a condenser and a toggle switch.

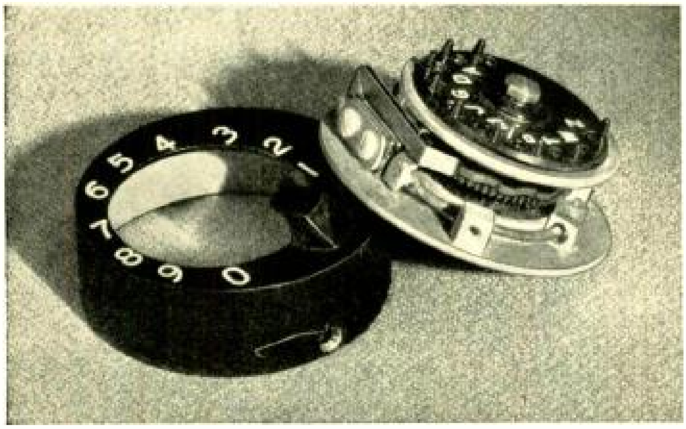
In reducing its size and weight, a small light-weight dial was developed, which is approximately two inches in diameter compared with three inches for the standard. It weighs about five ounces less than that of the previous handset. Care was taken to provide letters and numerals easily legible notwithstanding their small size. For pencil dialing there are recessions opposite the numbers and for finger dialing projecting prongs directly adjacent to each recess. In manual areas the dial is replaced by an apparatus blank of phenol plastic material.

Over the transmitter unit there is a convex disk, .040 inch thick, which serves as a protective grid. It is made of layers of phenol fabric sheets cured in a mold while held to a specified contour and thickness. Unusually high resistance to fracture is thus obtained. The receiver cap is molded of a phenolic resin with wood-flour filler and reënforced with cotton fibers.

For some tests there is a one-tenth microfarad condenser in series with the transmitter; when signaling or talking this is shorted out by a spring-actuated toggle switch.

A cadmium-plated clip of very rugged design is available for both types of the new handset. It assures positive locking to a loop in the linemen's belt and it is easily released by depressing its thumb piece.

Experience with the new handsets has shown that their light weight and protection against mechanical shock are distinct advantages and that their improved transmission characteristics make them more satisfactory.



Dial for New Repairman's Test Set

By J. ABBOTT, JR.
Switching Development

DESIGNED for small size and weight, a new dial for the new repairman's test set is completely enclosed within the die-cast cover, base and finger wheel. The numerals, one through nine to zero, are cast in the cover adjacent to the periphery of the finger wheel. Because of space limitations, only the first letter of each of the groups, usually associated with the numerals 2 to 9, is cast on the finger wheel.

The finger wheel has ten conical projections $\frac{7}{64}$ inch high and ten adjacent depressions $\frac{1}{16}$ inch deep instead of the conventional finger holes. The dial may be operated either by pulling one of these projections with the finger or by placing the tip of a pencil or small tool in one of the depressions. A lug, cast integrally with the cover, serves as a finger stop to limit the rotation of the finger wheel during windup.

The main shaft of the dial, which is staked to the die-cast base, is stationary and has shoulders to support the finger wheel, main gear-pulsing wheel, and the governor assembly. The governor is driven from the main gear through an intermediate gear and pinion, and the spiral motor spring of flat clock-spring steel is mounted in a cavity on the underside of the finger wheel.

When the finger wheel is pulled in a clockwise direction during windup, the pulsing mechanism remains stationary; on release, the mechanism is driven by a pawl on the finger wheel which engages a tooth on the pulsing wheel. The centrifugal governor has brass weights staked to springs which bear directly on the friction surface. These springs are accessible for adjustment by sliding a cover which is pivoted to the case.

The pulsing springs are actuated directly from the teeth of the pulsing wheel. Off-normal contact springs used on the standard station dial to open the receiver circuit and shunt the transmitter during pulsing are not provided and single instead of twin contacts are used on the pulsing springs. Elimination of these features simplifies the design and saves space which are prime considerations.

Switching Devices for Toll System Maintenance

By H. A. WENK
Transmission Development

BROAD-BAND carrier systems have required the development of arrangements and techniques that permit testing and other maintenance work to be carried out at any time without interrupting or interfering with the transmission of communication over the many channels provided by each system. Amplifiers for broad-band systems are located at frequent intervals along the line, and many of them are at stations visited only occasionally. All of these stations, as well as the equipment at the terminals, must have attention from time to time—for tube replacements, at least. On a long J or K system, which may have several hundred vacuum tubes in continuous use, it may be necessary to replace a vacuum tube on an average of every few days. With the large number of channels in one of these systems, furthermore, it is impracticable to obtain the release of all channels operating through a piece of equipment or on a single pair of conductors. Each J or K system provides twelve telephone channels, any one of which may be used for from twelve to eighteen telegraph channels. These features have required major changes from the procedures employed with systems employing only one or a few channels per amplifier or pair of wires.

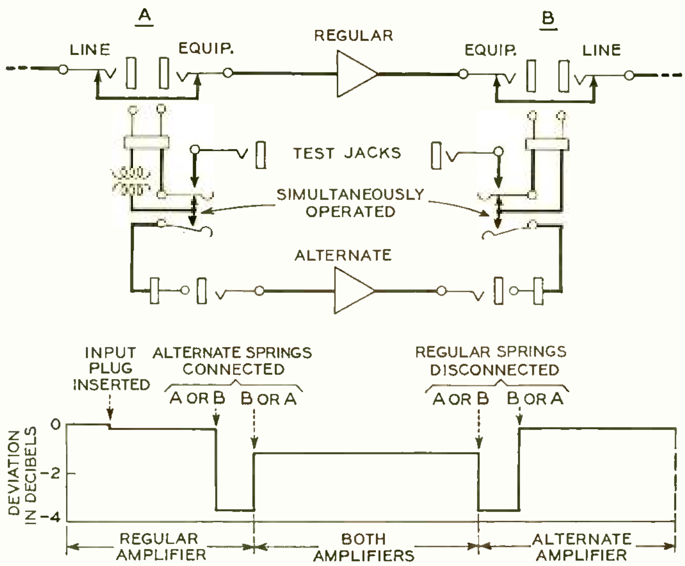


Fig. 1—Single-line schematic of arrangement for replacing amplifiers in the type-K carrier system, above, and resulting level changes, below

In these new systems the testing of vacuum tubes has been taken care of on an "in service" basis, as already described in the RECORD.* There was left the more difficult problem of permitting tube replacements and other maintenance work without removing the circuits from service. This has been solved by the develop-

*RECORD, *June*, 1939, *p.* 316.

ment of switching units that permit an amplifier, a repeater, terminal equipment, or a section of line to be temporarily replaced by spare facilities without interfering with normal communication. After the necessary work has been done on the regular facilities, they are switched back into service without interrupting transmission over the circuits.

Since carrier telegraph systems may be operated on one or more of the channels of a multi-channel telephone system, it is necessary to perform the switching without introducing a material amount of telegraph distortion. Initially it was thought that this could best be accomplished by a very rapid transfer. Accordingly, the first circuits developed used relays that would make the transfer in two or three milliseconds, so that not a single pulse in a telegraph message would be lost during the switching period. The contacts of the fast-operating relay were paralleled by other relays before and after the transfer was made to insure low-resistance contacts.

Further studies indicated that the transfer time could be greatly increased without disturbing telegraph transmission provided the changes in transmission introduced by the switching operation were limited in magnitude. It was found that when the telegraph level is changed at any instant and remains at the new level for a certain interval prior to restoration, satisfactory results could be obtained if the level changes were held within the following values: a change continuing for ten milliseconds or more, within about 3 db; a change continuing for one to three milliseconds, within about 5 db. In addition sudden changes of phase shift had to be kept small. These results meant that fast-operating relays could be dispensed with, and the switching circuit simplified in other respects.

To meet the requirements of the various systems and of the variety of apparatus and circuits to be temporarily replaced for maintenance, it has been necessary to develop a number of switching arrangements. That for use with amplifiers of the type-K carrier system is shown in single-line schematic form in the upper part of Figure 1. It consists essentially of two

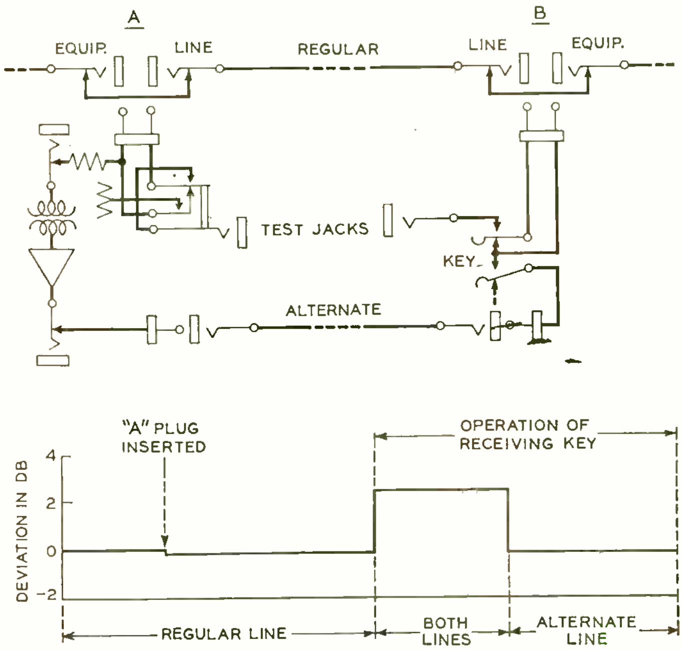


Fig. 2—Circuit used for switching a section of line with the type-K carrier system. Resulting level changes below

four-finger plugs, two two-finger plugs, two test jacks, and a two-position key. The contacts of the key are shown separated on the diagram, half of them being associated with one end of the circuit and half with the other end, but a single lever operates both sets of contacts simultaneously.

When the two four-finger plugs are inserted in jacks at each side of the regular amplifier, the connections of line to amplifier normally made through the jacks are made through the contacts of the key. Previous to this, a spare amplifier has been associated with contacts on the key by inserting the two-finger plugs in the amplifier jacks, but this amplifier remains open-circuited at the key. The key may now be operated to make the switch, which is performed in three successive operations as the switch lever is moved from one position to the other. The first connection made places the spare amplifier in parallel with the regular amplifier; the next disconnects the regular amplifier; and the final connects the regular amplifier to the test jacks.

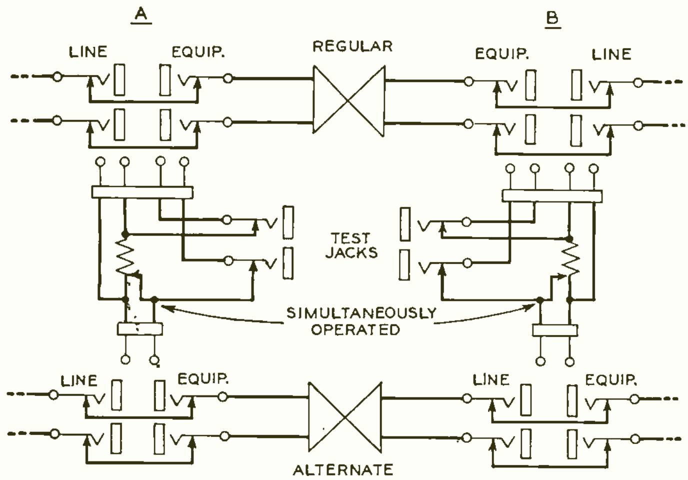


Fig. 3—Circuit used for switching repeaters in the type-J carrier system

The key is equipped with a latch which locks it in the regular and alternate positions to prevent accidental operation.

The changes in transmission accompanying such a switch are shown in the lower part of the illustration. There is a very slight change due to the insertion of the four-finger plug, and a change of about 1 db for the short period while both amplifiers are in the circuit. Only momentarily, while one or the other of the two amplifiers is connected to the line at just one side, is the change greater than this. During this momentary interval it may be about 3.5 db. This condition occurs only because the two sets of contacts do not make or break at exactly the same instant as the lever is moved from one position to the other. These amplifier switching units are installed at all repeater stations so as to be available whenever they are needed.

This type of circuit may also be used for switching other units of equipment such as group modulators, line and twist amplifiers in tandem, or any equipment so located that the input and output sides may be connected to the common key for switching. It does not apply, however, to a section of line, where the two ends are separated by a considerable distance. Since simultaneous operation of keys at two repeater stations cannot be easily accomplished, another circuit was developed for switching a section of K line at the transmitting end, shown at A in Figure 2. The B half of the amplifier switching circuit shown in Figure 1 is used at the receiving, or B, end.

A spare line, including the line amplifier at the receiving end, is connected to switching circuits at both ends by means of the two-finger plugs. The insertion of the four-finger plug at the receiving end merely completes the line circuit through the switching key rather than through the normals of the line-equipment jack. Insertion of the four-finger plug at the transmitting end leaves the regular line connected through, but also connects the spare line to it through a high-impedance bridge pad and an additional amplifier to make up for the loss in this pad. After these plugs have all been inserted, the switching key at the receiving end is operated. This carries through the three changes in connections described in referring to Figure 1. The two lines are first momentarily placed in parallel, resulting in the transmission change indicated in the diagram below the schematic of Figure 2, and then the regular line is disconnected and connected to the test jacks.

In conducting field tests of switching type-K amplifiers, it was observed that condensers in the input circuit of the line amplifiers would accumulate a charge due to the difference in ground potential between adjacent stations. The mere insertion of the plug of the switching circuit cord into the input line and equipment jack, or the operation of the switching key, would disturb this charge, and produce distortion to telegraph transmission. Also, the d-c voltage on pilot-wire pairs prevented satisfactory switching of amplifiers associated with these pairs. Accordingly, it was necessary to insert blocking condensers ahead of the input line jacks on

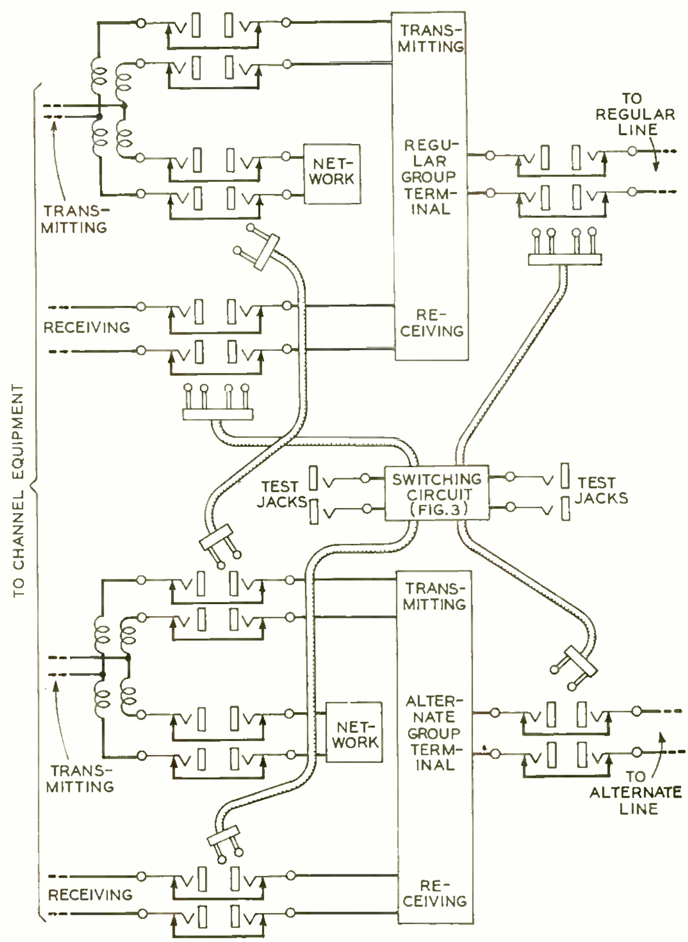


Fig. 4—Circuit used for switching terminal equipment for the type-J carrier system

cable pairs equipped for use as twist or flat-gain pilot wires, to shunt the condensers at the input of line amplifiers with 5,000-ohm resistances, and to insert a 0.4-mf condenser in the ground lead in the output circuit of twist amplifiers.

In providing switching systems for the type-J carrier system, a different arrangement had to be used. While the K carrier is a four-wire system, the J is a two, both directions of transmission being carried at different frequencies over the same pair. With a two-wire system there is a considerable difference in level on either side of a repeater between the signals in the two directions. As a result, a small change in level of the high-level signal leaving the repeater represents a considerable energy change compared to the level of the signal in the opposite direction. It was found that a sudden transmission change of 1 db in the high-level signal would introduce a distortion transient in the low-level signal of sufficient size to interfere with telegraph transmission. It was necessary, therefore, to design a switching circuit that would make the change gradually—first fading the alternate circuit into parallelism with the regular circuit, and then fading the regular circuit out.

The circuit adopted for use with repeaters is shown in Figure 3. As with the other circuits, four-finger plugs are used for connecting to the regular circuit, and two-finger plugs to the alternate circuit. Insertion of the four-finger plugs bridges a potentiometer across the line, with the potentiometer arm in such a position that the alternate circuit is short-circuited. As the potentiometer arm is turned, this condition is reversed, and at the end of the rotation, the regular circuit is short-circuited and the alternate circuit is connected across the bridge. The two potentiometers are operated by the same dial. The transmission change is thus made gradually.

With the type-J system, still another arrangement is required to switch the group terminal equipment, because the line side of the terminal is a two-wire circuit, and the office side, a four-wire circuit. Since the circuit of Figure 3 is suitable for switching only from two wires to two wires, and not from two to four, some modification is needed, and the arrangement provided is shown in Figure 4. The circuit shown in Figure 3 is used for switching the line and the receiving half of the terminal equipment. To switch the transmitting half of the office side of the terminal, a hybrid coil in the transmitting path of the regular equipment is used to apply transmission to the alternate equipment: a two-wire double-ended cord substituting the transmitting equipment of the alternate circuit for the network of the regular circuit. To transfer from the regular to the alternate equipment, the dial is rotated as before, the transfer taking place gradually as the arm moves across the potentiometer. Because of the different paths for transmitting and receiving, however, the receiving gain is slowly decreased and then increased back to normal, while the transmitting gain is slowly increased and then decreased to normal. As the switching of type-J repeaters is performed between the line filter and the repeater, the switching operation is not affected by line potentials as in type K.

A switching circuit similar to that used for the type-K carrier system has also been designed for the new voice-frequency V1 repeater. (*Sept.*, 1941, *p.* 20.)

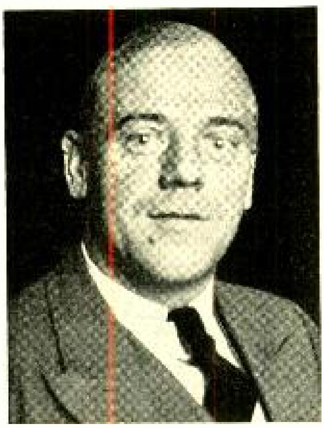
Contributors to this Issue

V. J. Albano was graduated from Cooper Union in 1930 with the degree of B.S. in Chemical Engineering. He joined the Laboratories that year. In 1937, after completing courses at Brooklyn Polytechnic Institute, he received the degree of M.S. in Chemistry. Mr. Albano has been engaged mainly in electrochemical studies dealing with the corrosion of metals in soils and waters. He has been particularly concerned with problems relating to the causes of cable-sheath corrosion and methods of its prevention.

A. J. Engelberg received a B.S. degree from Virginia Polytechnic Institute in 1917 and at once joined the coast artillery as second lieutenant, serving until 1919. While at V.P.I. he had worked with both the Western Electric Company and The Chesapeake & Potomac Telephone Company and on leaving the army in 1919 he came to West Street. Here, with the Circuit Development Department, he worked on the panel system during its early development and testing, and later on the panel-tandem system. He has also taken part in a wide variety of tests of panel circuits and apparatus. Since 1923 he has been a member of the Coast Artillery Reserve Corps, where he attained the rank of Major. In March of this year he was called to active service.

V. J. Albano

H. T. Budenbom immediately joined the Laboratories following his graduation by Purdue University in 1922 with a B.S. degree. Here, with the Transmission Engineering Department, he acted as a consultant to the local systems group on transmission practices. While here he received an E.E. degree from Purdue and also took post-graduate work in electrophysics at Columbia Uni-



A. J. Engelberg

H. T. Budenbom

J. Abbott, Jr.

D. T. Eighmey

H. A. Wenk

E. P. Felch

versity. In 1928 he transferred to the radio development group. His early work there included radio interference studies and radio receiver development. Since 1933 he has been concerned principally with radio direction and position finding and allied problems.

J. ABBOTT, JR., has been engaged in development work on step-by-step, panel and crossbar dial apparatus since he joined the Laboratories after graduating from Stevens Institute with the degree of M.E. in 1919. For the past several years, Mr. Abbott's work has been chiefly concerned with dial development problems.

D. T. EIGHMEY joined the Laboratories in 1929 and has been engaged in mechanical design and manufacturing problems on transmission instruments. Previously he was for four years Chief Engineer of the Fairchild Aerial Camera Corporation. In this capacity he was responsible for much of the pioneer development in electrical controls for automatic aerial cameras; also for the research and tests at New York University which determined the mechanical characteristics of the first "within the wing" landing lights for airplanes. Mr. Eighmey came to the Laboratories from the Fox Film Laboratories where he was engaged in designing facilities for processing colored film. He received his academic training at Kingston Academy and Cooper Union.

H. A. WENK entered these Laboratories in 1928 upon graduation from high school. In 1932, he graduated from the technical assistants' course, and in 1936 received the B.S. degree in Electrical Engineering from New York University. During this time he was associated first with the type-C carrier repeater group and later with the System Department's service group, where he worked on the design and maintenance of laboratory testing equipment. Since 1936 he has been concerned with the development of field testing equipment for J and K carrier and voice-frequency systems, most recently being engaged in the development of various switching devices for these systems.

E. P. FELCH graduated from Dartmouth College in 1929 with the A.B. degree in Physics and at once joined the Technical Staff of the Laboratories. Following a brief training period with the Western Electric Installation Department he entered the trial installation group in the Systems Development Department. Transferring in 1930 to the electrical measurements group of the Apparatus Development Department, he has since been engaged in the development of carrier and radio-frequency oscillators, detectors, and phase-measuring equipment. Since 1939 he has been in charge of a group designing vacuum-tube-operated measuring apparatus.