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Adjustable lens used in high-frequency attenuation tests.

Automatic Circuit for Determining Load Characteristics

By D. ROBERTSON
Transmission Development

THE loss or gain sustained by electrical signals in passing through various pieces of apparatus varies with a number of factors. It is important, therefore, to know the transmission characteristics of all apparatus used in a circuit to enable it to be used most effectively. Perhaps the most familiar characteristic shows the variation in transmission loss or gain as the frequency is varied over the range involved. Another very important one shows the transmission loss or gain for various loads. Apparatus for determining load characteristics has been available and used for many years. With such apparatus the load is changed in steps of some convenient size and the transmission is measured at each load. Usually a few characteristics for a given piece of equipment are sufficient, and so the speed of making the measurements is not of major importance. This is not true, however, in the design of such circuits as a compandor.*

To secure the desired relationship between the compressor and expandor that comprise a compandor, it is necessary to secure a very large number of load characteristics, and in determining the behavior of the device, it is essential that a complete characteristic be secured in so short a time that there is no appreciable change in the transmission characteristics of the circuit between the compandor terminals. To make this possible an automatic measuring circuit has recently been developed that will determine the transmission at sixteen loads in about one and one-quarter minutes. A key is operated to start the circuit, and the transmission at the sixteen loads is recorded on a chart automatically.

The method of making such measurements is indicated in Figure 1.

*RECORD, *May*, 1937, *p*. 281.

An oscillator, at the left, supplies measuring current at constant level, and a recorder, at the extreme right, records the received level. Two relay-operated attenuators are inserted in the circuit—one on each side of the apparatus or circuit under test—and as a change is made in the input attenuator, an opposite but proportional change is made in the output attenuator. In this way the level at the input to the recorder remains constant as long as the transmission loss or gain of the apparatus under test remains constant. As long as there is no change in the characteristics of the apparatus under test, therefore, the meter will record a horizontal line. The meter thus directly records the changes in transmission loss of the apparatus as its input level is changed.

Suppose, for example, that the load characteristics of a 75-db gain amplifier were to be determined for sixteen 5-db steps. With 1 milliwatt, or 0-db level, from the oscillator, the input to the amplifier could be varied from 0 to 75 db by cutting in successive 5-db steps in the input attenuator. As each 5 db was added to the input attenuator, however, 5 db would be removed from the output attenuator, so that as long as the gain of the amplifier remained 75 db, the recorder would be at 0 level. The various losses and gains are summarized for six 15-db steps in Table I. If the gain of the amplifier had changed, the recorder would have indicated the amount of the change directly. Thus if the amplifier gain at 0 level input had been only 74 db, the recorder would have dropped to −1 db for this reading.

A narrow-band-pass filter connected in the circuits reduces the noise that otherwise might interfere with the indications of the recorder at very low-level inputs.

This measuring procedure has been used for many years in making load runs. The novelty of the new arrangement is the provision of means for automatically changing the attenuators, and in the use of a new "spread-scale" recorder. The recorder is of the hot-wire type, using a six-inch waxed paper as already described in the RECORD.* Its sensitivity has been greatly increased, however, by changes in the amplifier-rectifier that result in the stylus of the meter moving the full width of the chart on a change of about 2.4 db instead of 24 db as with the original meter. This makes it possible to record much smaller changes in transmission than has been done before.

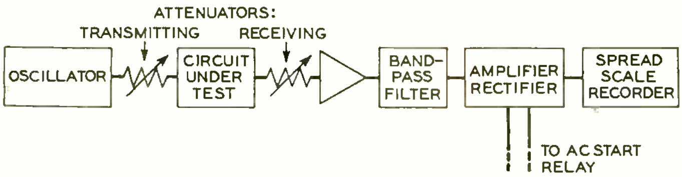


Fig. 1—Block schematic of circuit used to determine load characteristics on an automatic basis

The arrangement of the automatic circuit is indicated in Figure 2. A small synchronous motor serves as a timing unit. It is geared to a three-section cam that makes four revolutions per minute. Every five seconds, the cam closes a contact to operate the stepping magnet of a 206-type selector, which is used to operate the relays that switch in or out the component units of the two attenuators. The selector has several arcs of terminals, each with its brush, and all

*April, 1938, p. 289.

TABLE I

Level at OSC Output	*Loss in Input Attenuator*	*Gain in Repeater*	*Loss in Output Attenuator*	*Level at Recorder*
0	75	75	0	0
0	60	75	15	0
0	45	75	30	0
0	30	75	45	0
0	15	75	60	0
0	0	75	75	0

the brushes rotate together. One arc is used to keep the selector rotating until the entire sequence is run through and then to restore the circuit to normal. The other arcs control the attenuator relays.

Each attenuator consists of four bridged-T resistance pads, which are indicated in Figure 2 as simple series resistances. These resistance pads are of the plug-in type, and may be changed to meet the requirements of the test. Successive units, however, must increase in size in geometric proportion: No. 2 is twice as large as No. 1, No. 4 is twice as large as No. 2, and No. 8 is twice as large as No. 4. By having the four pads in this ratio, it is possible to obtain sixteen steps spaced by the value of the lowest unit by using combinations of the four units. These combinations are shown in Table II. If unit No. 1 gives a 1-db loss, there will be fifteen 1-db steps available, while if the No. 1 unit gives a 5-db loss, the fifteen steps will each be of 5 db, or a total of 75 db. As the selector rotates, the various pads are inserted in the input attenuator to give an increased loss for each step, and in the output attenuator to give a decreasing loss. When the characteristic to be determined is that of an amplifier or of a compandor, the pads of the input and output attenuator are of the same value, but to determine the characteristics of a compressor or expandor alone, one set of pads will be smaller than the other by the ratio of compression or expansion. Thus for a compressor with a 2:1 relationship, the values of the receiving pads would be one-half those of the corresponding transmitting pads.

If both input and output of the apparatus to be measured are available at the measuring point, the circuit is started by operating the start-send

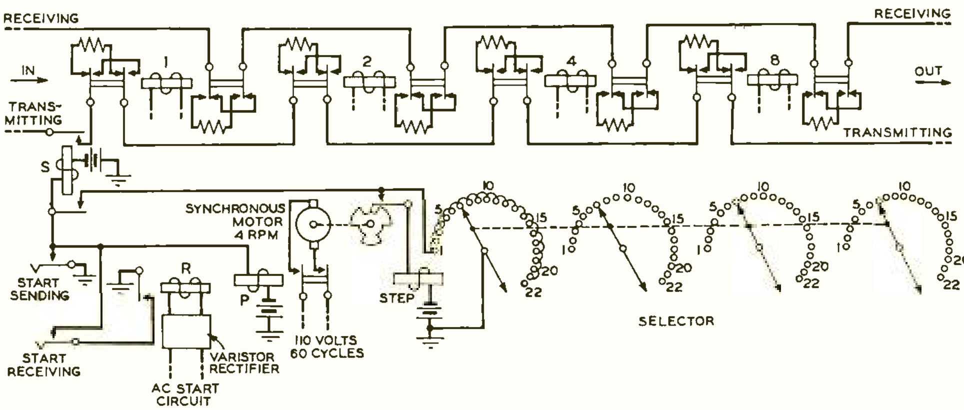


Fig. 2—Simplified schematic of the automatic control circuit

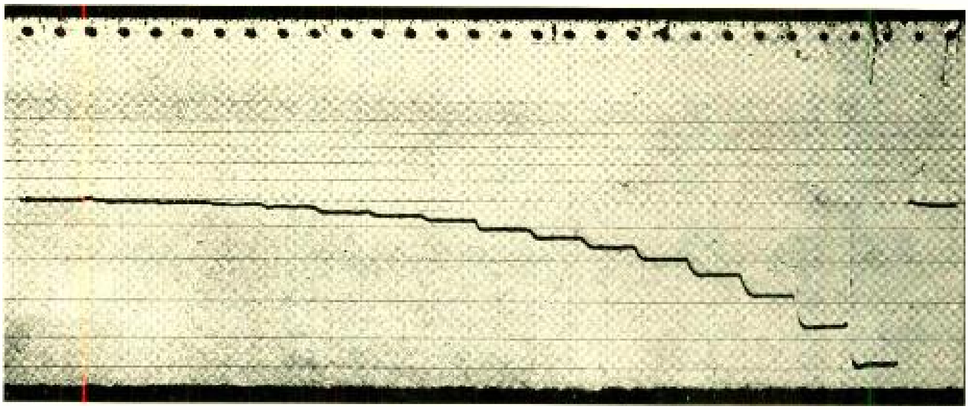


Fig. 3—Measurement on 310A vacuum tube amplifier, with 0.5-db changes in load. Each horizontal line represents a change in gain of 0.2 db

key. This operates the S and P relays and starts the synchronous motor. At the first closure of the cam contact, the selector will move to its terminal No. 1, and the start-send key may then be released since the P and S relays will be held operated until the selector has finished one rotation through the brush and segments of the first arc. As the cam is rotated by the synchronous motor, it will step the selector around one terminal every five seconds. For each of the first fifteen positions, terminals on the other three arcs operate relays that connect in or out the various networks in the two attenuators. From terminals 16 to 22 the selector continues to rotate, but no further changes are made in the attenuators. As it moves off terminal 21, the ground connection to the P and S relays is broken, and these two relays release and restore the circuit to the normal unoperated condition.

When the input and output terminals of the apparatus to be tested are not available at the same point, as when the overall characteristic of a transmission line is to be determined, two of these measuring sets are needed—one set at each end of the circuit. The output set of attenuators of the testing set at the input end will not be used, however, nor will the input attenuators of the set at the terminating end of the line. The oscillator will be at the sending end and the recorder at the receiving end. The attendant at the receiving end operates his start-receive key to throw the control of the receiving apparatus to the sending end. When the start-send key is operated at the sending end, the single-frequency current from

TABLE II

Step No.	*Attenuator Units in Circuit*
0	0
1	1
2	2
3	1 & 2
4	4
5	4 & 1
6	4 & 2
7	4 & 2 & 1
8	8
9	8 & 1
10	8 & 2
11	8 & 2 & 1
12	8 & 4
13	8 & 4 & 1
14	8 & 4 & 2
15	8 & 4 & 2 & 1

the oscillator passes over the line to the recorder. A tap at the amplifier rectifier, however, supplies a portion of the received current to operate the R relay, and thus to start the circuit at the receiving end. The two selectors —one at each end of the line—will then operate nearly in synchronism. Any deviations that do exist are too slight to interfere with the correct interpretation of the records. Since each of the sixteen transmission levels is maintained for five seconds by the synchronous motor, deviations of a fraction of a second due to lack of perfect synchronism or to differences in the operate time of the various relays are of little importance and need not be considered.

Figure 3 shows a measurement of an amplifier using a 310A vacuum tube in the output. Each succeeding step of the measuring set increases the amplifier loading by 0.5 db. This recording shows that at the maximum loading of 16 db above 1 milliwatt, the gain has been reduced by almost 1.0 db. The last step on the chart, corresponding to step sixteen on the selector, is a check on step 0.

New Coin Collector With Handset

To afford greater convenience to public telephone patrons, a new coin box with a handset has been made available. The operator is informed of the coin deposit by hearing a gong struck by the coin, as in the present set; but the transmitter which picks up the tone is not that used for talking but a carbon button mounted for that purpose on a plate which supports the gongs. Resilient support of the plate prevents the noise of the coins passing through the coin gauge, chute and hopper from disturbing the coin signals.

This coin collector, known as the 180-type, contains the induction coil and talking condenser; only the ringer and its associated condenser are mounted in a separate box.

Test for Corrosion of Painted Iron

By R. B. GIBNEY
Chemical Laboratories

TO DETERMINE how well a paint protects metal surfaces against corrosion, plaques covered with it are usually left outdoors in an exposed location. If the paint is good the weathering action is slow and many months may pass before definite results can be obtained. A laboratory test has recently been developed which shortens this time to hours and does not destroy the film. It gives evidence as to how well a paint protects metal but little evidence as to the effect of weathering on the paint itself.

Corrosion of a metal results, in the presence of moisture, from electrochemical action between small adjacent surface areas. Potential differences are set up between these areas, and the potential of the whole surface is the resultant of that of all the small areas involved. This quantity can be measured readily with reference to a standard electrode. The potentials change as the corrosive action progresses and experiments have shown that the extent of corrosion can be determined by continuously recording the potential of the metal over a period of hours.

Surface areas of a corroding metal are of two kinds: anodic or electronegative areas where the metal goes into solution, and cathodic or electropositive areas where hydrogen is evolved. If the metal corrodes freely the cathodic areas tend to become "clogged" with hydrogen and the resultant potential of the plate will become more electronegative since it is then almost wholly controlled by the anodes. This effect is strongly accentuated and unmistakable when oxygen is excluded. If the metal does not corrode, it is because the anodic areas become insulated with an extremely thin film of corrosion products and the potential of the plate will be nearly that of the cathodic areas,

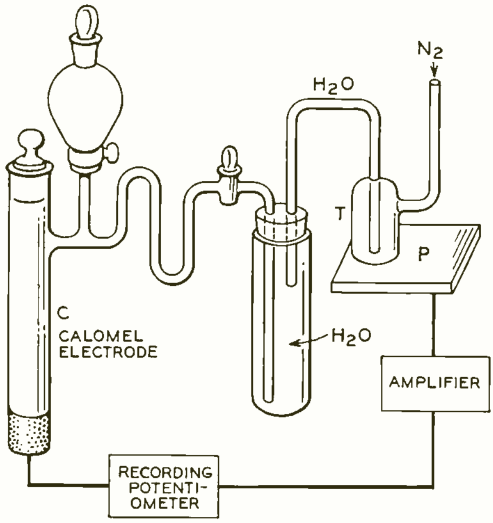


Fig. 1—Apparatus used to follow the potential of a painted panel

which are electropositive. Thus the potential of a corroding metal becomes more electronegative with time, while that of a metal which is not corroding becomes or remains electropositive. This is the basis for the rapid determination of the corrosion behavior of painted iron.

The apparatus used to follow the change is shown in the headpiece and Figure 1. Glass tubes filled with water connect the paint film, P, to a calomel reference electrode C. The end of the tube T rests on the spot to be measured and is surrounded with an enveloping tube through which nitrogen passes. A recording potentiometer connects the calomel electrode to the back of the painted panel through an amplifier similar to one that has previously been described.* An amplifier is required because the high resistance of the paint film permits only very small currents to flow.

Twenty-two representative pigments and four combinations of two pigments in the same paint were compared in a varnish-reinforced linseed oil vehicle. Two panels were prepared for each paint. After conditioning at 20 degrees Centigrade and 50 per cent relative humidity for a week one set of panels was exposed on the roof of the Summit Laboratory; the other set was subjected to the electrochemical test. Small pieces were cut from the outdoor specimens at intervals and the extent of corrosion determined by removing the paint film to inspect the metal surface.

Representative time-potential curves obtained in the electrochemical test are shown in Figure 2. The time required for a curve to indicate corrosion, i.e., to break and reach its lowest value, was taken as the significant feature—the longer the time the better the rating. For comparison with the results obtained by the exposure tests, the paints were divided into four arbitrary groups depending on the time required for corrosion to be indicated by their time-potential curves. The first group (A) consisted of paints which afforded complete protection, since they indicated no corrosion after 100 hours; the second group (B) showed corrosion in from twenty to 100 hours; the third group (C) in from five to twenty hours; and the fourth group (D) in less than five hours. Paints in the first group prevent corrosion chemically, whereas the paints of the remaining three groups protect the metal physically, by excluding water.

Allowing a difference of one class for experimental error, agreement be-

*Record, *November*, 1934, *p.* 74.

tween the ratings obtained by the potentiometric test and by one year of outdoor exposure was obtained in eighteen out of twenty-two cases. In three of the other four cases, the paint film broke in weathering and exposed the base metal. The fourth panel, which was coated with a basic lead chromate pigment, showed less corrosion than was expected, but a time-potential curve run on the panel after it had been exposed for nine months showed that the film had improved to such an extent that it would then be rated in class A rather than class C.

This experiment was repeated on a number of panels which did not corrode in perfect agreement with the potentiometer predictions. In every case a curve was obtained on the aged specimen which checked the actual corrosion behavior very well. Thus the panel coated with a chrome oxide pigment should have corroded quickly according to its initial time-potential curve, whereas actually after nine months it showed very little corrosion. A potential curve run on the exposed specimen, however, required over sixteen hours to reach the low point instead of less than four. Surprisingly enough, this particular paint film had improved with outdoor exposure. The panel which was kept indoors repeated its original time-potential curve.

To determine how well the paint protected the metal at the time the laboratory test was performed, which was before weathering affected the paint, selected spots on the panels were kept wet for four days. Then the paint was peeled off these spots and the extent of corrosion estimated visually. Assuming a possible error of one class in estimating the corrosion, agreement with the potentiometric rating was obtained in twenty-one of twenty-two cases. The one exception was readily explainable by the ability of lamp-black, the pigment involved, to absorb air and nullify the effect of the nitrogen atmosphere during measurement of the time-potential curve.

These experiments show that quick estimates of the corrosion behavior of painted surfaces on iron and steel can be obtained by electrochemical means and that the results agree with those found by exposing painted plaques to the weather for long periods. The occasional exceptions that were noted in these experiments were associated with changes in the paint film caused by long outdoor exposure.

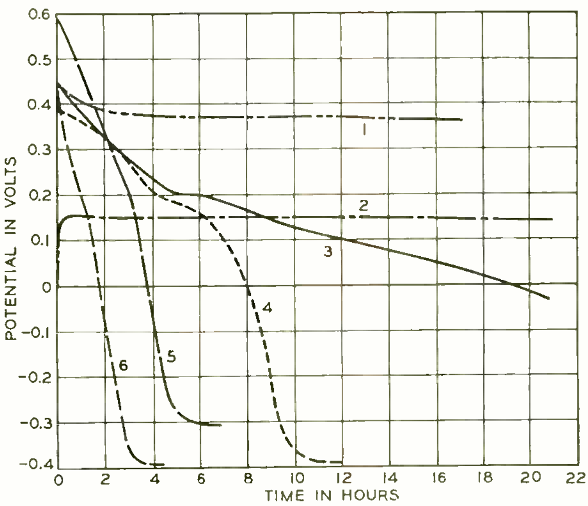


Fig. 2—Time-potential curves of painted panels wet with water and measured in a nitrogen atmosphere. The pigments were all mixed with reinforced linseed oil: (1) *white lead;* (2) *red lead;* (3) *zinc chromate;* (4) *basic lead chromate or lead titanate;* (5) *lead chromate or whiting;* (6) *light cadmium red. Brown iron oxide, black iron oxide, graphite, chrome oxide and silica also gave curves identical to* (6)

D-C Substitution Method of Measuring High-Frequency Attenuation

By H. B. NOYES
Transmission Engineering

IT SOMETIMES happens that a very simple change in a method of approach can be very useful in the solution of a complicated problem. Some years ago, for example, an offhand suggestion was tentatively made by the writer for a simple change in the technique of measuring high-frequency attenuation. It turned out that several engineers, concerned with such measurements, became interested and found the simple modification very useful in connection with special high-precision measurements.

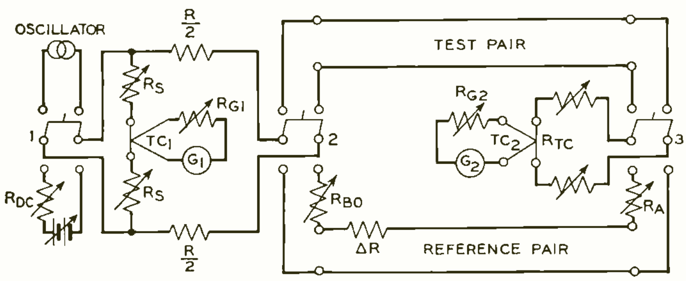


Fig. 1—Simplified schematic of circuit used for the d-c substitution method

One of the basic factors influencing the design of a wire communication system is the attenuation characteristic of the line with which it is to be associated. Designers of high-frequency systems in particular must have available accurate line-attenuation data covering the entire range of frequencies to be used. The effects of temperature and, for open-wire lines, of weather conditions also must be included. The nominal attenuation, which is determined by such factors as the resistance of the conductors, their separation, and their distance from ground can be computed with considerable accuracy. Such calculations, however, cannot take into account small irregularities in wire spacings, effects of neighboring conductors, and other factors, which may be very important in the operation of a long system. Except for preliminary engineering studies, therefore, attenuation data that are obtained by measurement are practically indispensable.

Such attenuation measurements are often made by passing currents of various frequencies over a section of the line and measuring the input and output with thermocouples. The accuracy obtained depends on the stability and accuracy of the thermocouples. Although this method gives satisfactory results for most purposes on fairly long sections of line, higher accuracy is sometimes needed. This is particularly desirable when the effects of temperature are to be measured or the attenuation characteristics are to be determined from fairly short sections of line. In such cases the changes in attenuation between successive fre-

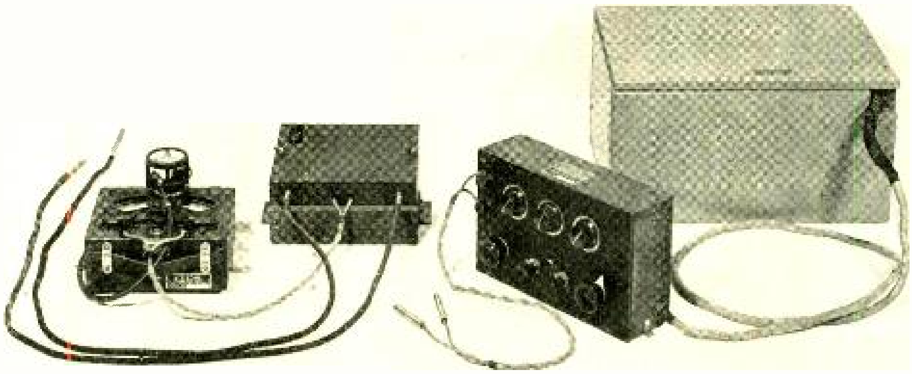


Fig. 2—Sending-end equipment used at Forth Worth

quencies and temperatures are small and the absolute error must be very small. The d-c substitution method has been found to give more precise results on straightaway attenuation measurements of this type. It has the additional advantage of using the direct-current value of a resistance as a standard.

With the d-c substitution method, the accuracy of measurement is practically independent of the calibration and stability of the thermocouple. The thermocouple is used merely to relate the attenuation of the test line to a value of an adjustable calibrated resistance in a d-c circuit. The actual reading of the galvanometer used with the thermocouple, and thus the accuracy of the thermocouple itself, is of no direct concern, and lack of long-time stability of the thermocouple also does not enter because the two measurements are made in rapid succession—the interval between readings being too short for any appreciable change to occur in the calibration of the thermocouple. The method requires, however, that either the d-c and a-c sensitivities of a thermocouple be identical or the ratio between d-c and a-c sensitivities of the sending and receiving thermocouples be identical.

The arrangement of the circuit for such a measurement is indicated in Figure 1. With all three switches thrown up, the conditions are the same as those used in making an ordinary measurement of insertion loss of the test pair between a fixed resistance R at the sending end and a series of three resistances at the receiving end which, as discussed later, are adjusted to value R. For such measurements, the thermocouple galvanometers at both ends are read simultaneously and the true input and output voltages are taken from the calibration charts for the thermocouples. From these, the insertion loss is computed. This procedure is carried through for each applied frequency and for each change in line conditions. Since thermocouples are not particularly stable, changes may occur in their calibration in the course of the measurements.

With the d-c substitution method no calibration charts are required for the thermocouples, and slow changes in their calibration have no effect.

The pointer of the galvanometer at each end of the line is brought to a position on the scale where the sensitivity is greatest by adjusting the output of the oscillator and the resistances R_S, and then an indicating pointer, operated by hand, is brought immediately over the galvanometer pointer to indicate its position. The three switches are then immediately thrown down, and a resistance in the battery supply is adjusted until the pointer of the input galvanometer returns to the position of the indicator pointer. The resistance, R_A, in the d-c reference circuit is then adjusted until the pointer of the galvanometer at the distant end is also brought in line with its indicator. When these two conditions are met, the loss in the reference circuit is the same as that in the test pair. The time that elapses between the two sets of readings is much too short for the accuracy of the measurement to be affected by lack of stability of the thermocouples.

Any convenient pair in the section being measured is selected as the reference pair, and since various pairs differ slightly in resistance and the resistance of any pair varies with temperature, an adjustable building-out resistance, R_{BO}, is added and so adjusted that its values plus the resistance ΔR of the pair itself is always the same for a series of measurements. It is a further requirement that the reference pair have very little d-c leakage. Since $R_{BO} + \Delta R$ is held constant, the insertion loss of the test pair when placed between two resistance terminations R may be determined directly from resistance R_A and a previously prepared chart or table showing the insertion losses under the existing conditions for various values of R_A. With this method, the terminating resistances R at each end of the test pair should be equal, constant, and as nearly nonreactive as possible. The receiving resistance R is composed of the thermocouple resistance plus two adjustable resistances. The adjustable resistances may be set by means of a d-c resistance bridge, which supplies current to the thermocouple equivalent to the test current. As the current through the receiving thermocouple is usually maintained at about the same level

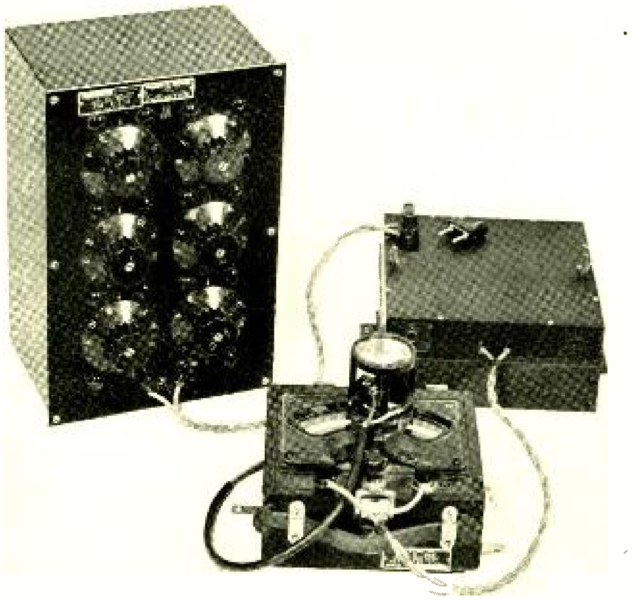


Fig. 3—Receiving-end equipment used for the Fort Worth measurements of high-frequency attenuation

for long periods of testing, the associated resistances do not have to be adjusted frequently. In this connection it is important that the thermocouple chosen shall have a resistance less than R so that this total resistance R may be controlled by series resistances rather than by a resistance in shunt with the thermocouple, because the division of the current at high frequencies between thermocouple and shunt cannot be ascertained with satisfactory accuracy.

Although with this method of measurement, the accuracy and stability of the thermocouple are not of great importance, it is necessary that the thermocouple be perfectly reversible—that is, equal currents must produce the same deflection regardless of the direction of the current. This condition is met by using special thermocouples of the separate heater type.

The galvanometer employed for these tests is a portable microammeter to which has been attached an indicator and a magnifying glass as shown in the photograph on page 29. The glass is mounted on a movable arm and both this arm and the indicator are pivoted coaxially with the meter pointer. In making the first of a pair of readings, the meter pointer is brought to a section of the scale where the meter is most sensitive, and then the indicator is moved to lie directly over the pointer. By using the magnifying glass, this setting can be made with considerable precision.

When measurements are made at frequencies so high that variable resistances having suitable a-c characteristics are not available for R_S, it is desirable to include the resistance R_{G1} and R_{G2} in the meter circuits. These resistances in conjunction with adjustment of the oscillator output make it possible to work the thermocouples at both ends of the circuit near points of maximum sensitivity.

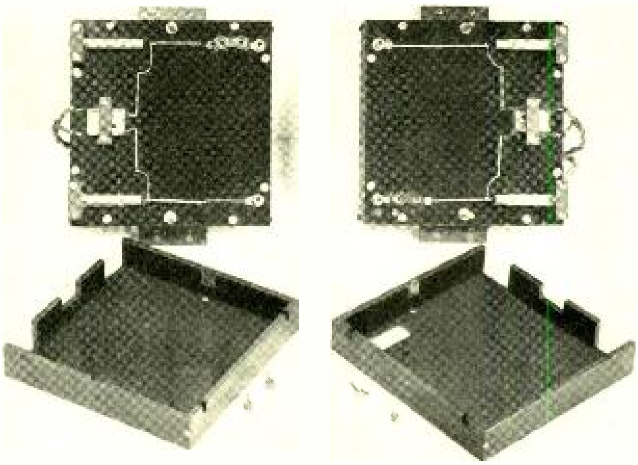


Fig. 4—Thermocouples used with the d-c substitution method

This method of measurement was developed by M. S. Burgess and H. H. Benning, who also developed the pivoted indicator with the magnifying glass. It has been found that very accurate measurements can be made at least as high as five megacycles.

A particular and very simple embodiment of the method, which was built and used extensively by L. F. Staehler on open-wire lines, is shown in Figures 2, 3, and 4. In the sending equipment, Figure 2, the box on the right contains the batteries, and the dial box next to it is the adjustable resistance used to control the direct-current input when the switches of

Figure 1 are thrown down. The next box contains the thermocouple, and at the left is the microammeter. The receiving-end equipment, Figure 3, includes the thermocouple and meter at the right, and at the left, the decade resistance used as R_A.

The sending and receiving thermocouples, designed for extremely high frequencies, are shown in Figure 4. The small resistance units, about the size of a pencil lead, are a special type of carbon resistance, developed by the Laboratories.

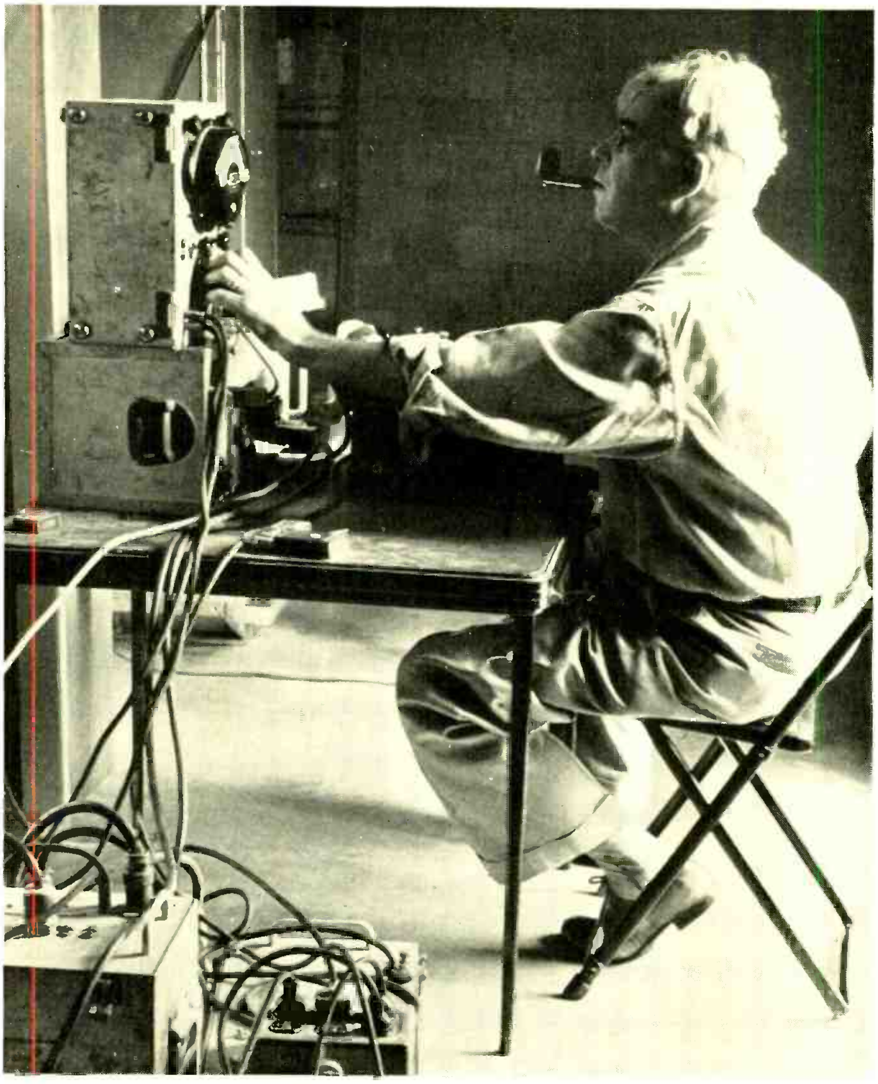
In this particular embodiment of the d-c substitution method, the d-c measurement was made on the test pair. Switching at the sending end was done by plugging the oscillator or battery into appropriate jacks. Switching at the receiving end was done by inserting either a short-circuited plug or the resistance R_A into jacks in one side of the line. The resistances R_{G1}, R_{G2}, and R_{BO} were not used in this case.

To cover a complete temperature range, the attenuation measurements may be made over a wide range of temperatures, for example from twenty degrees below zero to 120 degrees above zero as sometimes encountered in cables. To secure all data on cables with the desired precision and speed, considerably more elaborate and refined equipment was required than is indicated in the illustrations. To prevent errors due to frequency changes, the oscillator frequency was compared on a cathode-ray oscillograph with a 4-kc standard transmitted from New York. Line voltage regulators were used on the 60-cycle a-c supply for the oscillator to prevent variations in the voltage supply line from affecting the oscillator output, and an adjustable filter was used with the apparatus to avoid the effects of harmonic frequencies.

As a result of this refined technique, insertion losses at frequencies from 12 to 68 kc could be determined with a reproducible accuracy or sensitivity of .005 db—a much higher precision than had been attained before. Similar reproducible accuracy has been obtained up to five megacycles with the equipment shown in the illustration. By contrast, a method that depends on the constancy of a thermocouple may be in error by as much as 0.1 or 0.2 db because of thermocouple errors alone. The absolute accuracy of the method, of course, depends also on such factors as the accuracy of calibration of the resistance standard, the absence of harmonics in the oscillator, the equivalence of the a-c and d-c resistance of the thermocouples and the resistance units in series with them, and the skill of the operator.

Since the d-c substitution method has proved successful and extremely accurate for measuring attenuation on transmission lines, it should also be applicable to measurements of attenuation of apparatus and calibration of high-frequency attenuators, especially at frequencies where suitable a-c standards are not available.

NEWS AND PICTURES OF THE MONTH



Making crosstalk measurements at type-K frequencies on the new transcontinental cable line

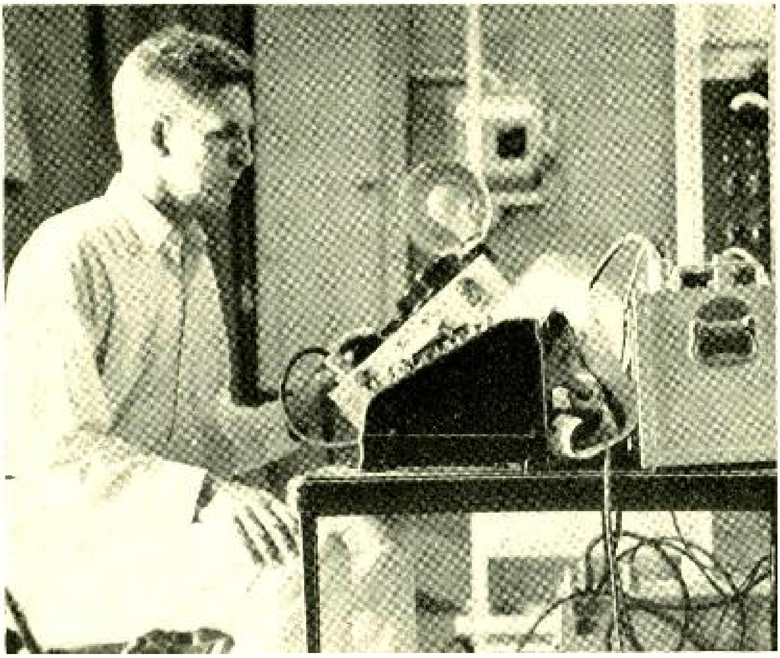
News of the Month

W. H. Harrison Made Director of Production of the OPM

William H. Harrison, Vice President and Chief Engineer of the American Telephone and Telegraph Company and a Director of the Laboratories, who has been on leave since July, 1940, with the National Defense Program, was appointed August 29 to take charge of the Production Division of the Office of Production Management by Director General William S. Knudsen.

As reported by Roland C. Davies, Editor of *Telecommunication Reports* in the issue of September 4, "Mr. Harrison succeeds John D. Biggers, who had headed the OPM Production Division until his appointment as Lend-Lease Administrator in last week's reorganization of the Defense setup, with the establishment of the Supply Priorities and Allocations Board (SPAB) and the revamping of the OPM division chieftains. It was understood that both the White House and Mr. Knudsen sought the services of Mr. Harrison in his new post, which will comprise the OPM's supervision and activation of the production of all finished defense and armament materials and equipment. This covers the very wide range of ordnance, munitions, aircraft, tanks, food, clothing, medical and other supplies for the Army, Navy and the Lend-Lease program of Great Britain, Russia, China and other nations allied with the cause of the United States....

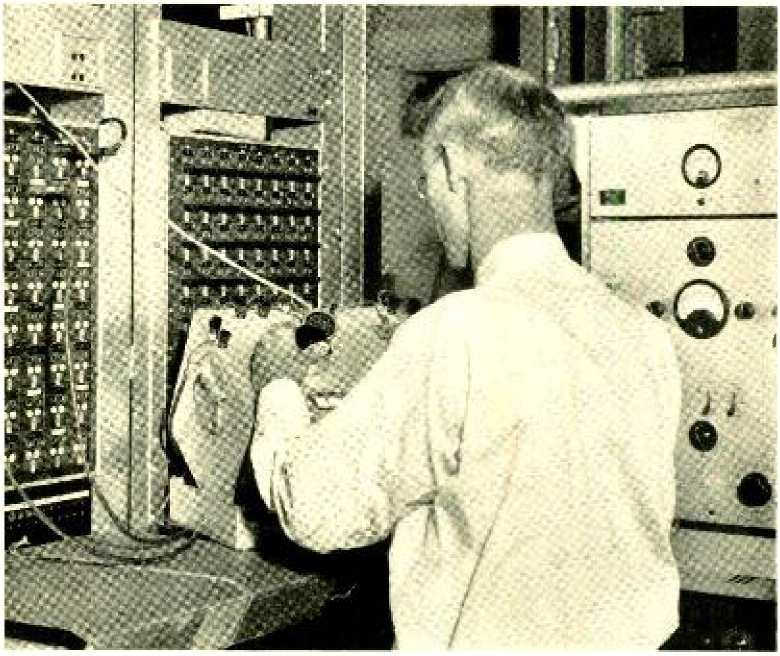
"In his new work as Production Director, Mr. Harrison will face the heaviest cycle of the National Defense task of providing defense supplies during the coming year. This will arise from the expanded Lend-Lease program, as well as the greatly stimulated dispatch of supplies to Great Britain and the British Empire and an increasing tempo of furnishing armament, tanks, and aircraft for the American Army and Navy. During the past fourteen months, the OPM showed September 2, the total cash disbursements for the defense program had been $9,269,000,000, together with $18,000,000,000 of prime contracts awarded, while the aggregate authorized program was $56,637,-



A. L. Whitman observes the performance of testing equipment on type-K circuits at an auxiliary repeater station near Lincoln, Nebraska, part of the Omaha-Denver section of the new transcontinental cable line

000,000. Next year the production and purchases will probably be doubled at least, it is felt.

"Mr. Harrison will thus have the direction of the greatest production program in world history. Ever since he joined the defense program in July, 1940, when Mr. Knudsen named him Director of Construction with the National Defense Advisory Commission, and later with OPM on January 18, 1941, as Chief of Shipbuilding and Construction, Mr. Harrison has been making one of the most notable reputations of any industrialist in the defense organization. Under his direction over 700 Army camps and Naval bases have been constructed, and shipbuilding has got off to an excellent start. He has won the highest admiration and confidence of the Army and Navy officials and is also popular among New Deal leaders."



M. T. Dow, at Cheyenne, Wyoming, with crosstalk bridge and self-tuning detector, measures crosstalk at type-K frequencies on the Omaha-Denver section of the new transcontinental cable line

L. G. Woodford, who as Assistant Vice President has been in charge of O & E during Mr. Harrison's absence, has been appointed Chief Engineer, reporting to Vice President C. P. Cooper pending Mr. Harrison's return. Mr. Woodford entered the Bell System in 1911, and after experience in the Northwestern Bell Telephone Company, joined A T & T in 1923. Here he became Plant Inventory and Costs Engineer in 1927, Plant Extension Engineer in 1933, Operating Results Engineer in 1937, Plant Operation Engineer in 1939, and in 1940 was appointed to the post of Assistant Vice President.

Dr. Williams Honored Again

Modern Americans in Science and Invention, a book by Edna Yost (Stokes Co.), contains biographies of seventeen men who have made important contributions to American welfare and knowledge in recent years. Among the seventeen is R. R. Williams. Before describing in detail his studies of Vitamin B_1, the author reviews his work in the Philippines, in Washington, and in the Laboratories and then says "This, in itself, is a success story. Yet it is but the lesser part of Dr. Williams' scientific achievement. Now and for all time he will be honored as the scientist who discovered the chemical structure of a vitamin of the greatest importance to health and well-being of human beings all over the globe."

Telephone Pioneers

The fall meeting of the Edward J. Hall Chapter of the Telephone Pioneers of America will be held on November 3 at the Hotel Commodore. Members will get together in the main ballroom foyer from 6:00 to 7:00 p.m. Dinner will be at 7:00 and at 8:30 there will be entertainment followed by dancing. Tickets may be obtained from E. D. Johnson or G. F. Fowler. Tickets for members are free and for guests $3.00 each. Tables will seat 10 each and orders for persons desiring to be seated together should be signed individually and then grouped.

There are over 400 members of the Laboratories who are now eligible for membership in the Telephone Pioneers of America. For the information of these 400, W. A. Bischoff, R. C. Mathes, and R. A. Shetzline are on the Membership Committee and will be glad to be of assistance in forwarding your application.

Members of the Laboratories who hold office or are members of committees of the Edward J. Hall Chapter, Telephone Pioneers of America, for the 1940-1941 year are J. W. Farrell, Vice President; H. M. Bascom, member of Executive Committee; L. S. O'Roark, chairman of the Publicity Committee; and G. F. Fowler and E. D. Johnson, members of the Entertainment Committee. Members of the Membership Committee are given in the preceding paragraph.

National Defense, Military and Naval Items

Leaves of absence for civilian duty in the defense program have been granted to A. L. Thuras, National Defense Laboratories, Fort Trumbull, New London; W. L. Tierney, National Defense Research Committee work through the Massachusetts Institute of Technology; H. T. O'Neil, U. S. Navy Radio and Sound Laboratory, Point Loma, Calif.; and Charles C. Rock, Naval training orders, Brooklyn Navy Yard.

Kermit O. Thorp, Major in the Central Air Corps Procurement District

Major Kermit O. Thorp, who joined the Central Air Corps Procurement District on June 7, has spent most of his time since then in various airplane engine factories. At present he is stationed in Indianapolis at the Allison Division of the General Motors Corporation.

Lieut. Joseph E. Fox, formerly Base Signal Officer at Daniel Field, Augusta, Ga., is now at the Aircraft Radio Laboratory, Wright Field, Dayton, Ohio.

George Bukur writes from Fort Dix:

For the past eleven months I have been active in the Intelligence Section of the Battalion, starting as a Private Scout and Observer, advancing to Corporal of the Section and finally to Staff Sergeant, who is the Section Leader and Topographical Draftsman of the Battalion.

During recent maneuvers in Virginia I was responsible for the tactical map on which is kept all information concerning the movement of our troops and all enemy information. By means of this map one can see at a glance the entire situation that confronts the Battalion since all movements such as advancements, defense positions, fire plan, tank traps, etc., are recorded. As a necessary precaution all information is entered on this map in conventional symbols so that one must have a complete knowledge of this symbolic code in order to understand the situation. Besides keeping the situation map I had a section of trained scouts and observers that must function from Observation Posts, Reconnaissance Patrols and Combat Teams. I had to keep a record of all their actions and collect all information that was deemed necessary. After this information had been collected it had to be evaluated and collated in order to be distributed to the units that were in need of the information. Since my job was twofold it received the rank of Sergeant Grade 3 (Staff Sergeant). When not functioning in the field, classes were held in camp on duties of the Intelligence Personnel—at which time I acted as instructor and devised small tactical problems that could be worked out in a few hours in the immediate area of camp.

Capt. Malcom A. Specht, in a letter dated August 17, writes from Fort Ethan Allen, Vermont:

At the time your letter reached me I was at the Field Artillery School, Fort Sill, Oklahoma.

Having graduated from the battery officers' course I was selected to attend an Officers' Specialist Course in Fire Direction and Survey, which was completed about the first of July. I then returned to my unit which in my absence had changed station, being now located at Fort Ethan Allen, Vermont. The regiment (186th Field Artillery) leaves next week to participate in maneuvers in the Fort Devens, Massachusetts, area. It is expected that we will return to our home station (Vermont) on September 12 and leave for the Carolinas on the 23rd for the 1st Army maneuvers. The return from these latter exercises is scheduled for December 6. Although no orders have been issued which indicate that I will then be anywhere but in Ethan Allen for the winter, a great uncertainty seems to pervade our minds as to plans that far ahead.

I am a member of a battalion staff in the 186th F. A. which is armed with 155-mm. howitzers. We are Corps troops, being part of the VI Army Corps, a unit of the 1st Army.

Emil Alisch writes from Fort Dix:

Inducted into service September 16, 1940, as Captain, 71st Infantry (R), Commanding Company "G." Served as Company Commander until end of December, 1940. On January 1, 1941, assigned officer in charge of trainees. This assignment lasted until the trainees had completed a thirteen-week course of basic instruction when they were assigned permanently to units of the regiment. For three months, May to July, inclusive, I was acting Plans and Training Officer during the absence of the Plans and Training Officer who was attending the service school at Fort Benning, Georgia. I am now back in my regular assignment as Intelligence Officer for the regiment.

Major John M. Hayward, who is stationed at Wright Field, Dayton, writes:

At this Field are the principal activities of the Materiel Division of the Air Corps, which is organized to have in readiness for immediate production and service the most advanced types of aircraft, engines, armament and other Air Corps equipment required for national defense.

My assignment here as Chief of the Liaison Branch of the Experimental Engineering Section is concerned with coördination and collaboration with the National Advisory Committee of Aeronautics at Langley Field, Bureau of Aeronautics of the Navy and the National Defense Research Committee. In addition to this I have charge of Foreign Development Projects which involves the continuous study of the characteristics and performance of foreign and domestic aircraft, engines and aircraft equipment; drawing comparisons between them and the requirements of our current experimental aircraft and latest development projects; and making special and periodical reports as soon as information is available. Airplane flights are occasionally required in connection with miscellaneous test work and to retain proficiency in aerial navigation and instrument flying.

Captain Harold T. King writes from the Field Artillery Replacement Training Center at Fort Bragg, N. C.:

Arriving here at Fort Bragg early enough to be classed as a "charter member" of the training

Major John M. Hayward, Chief of the Liaison Branch of the Experimental Engineering Section and of Foreign Development Projects at Wright Field

center, I found myself assigned to a "Basic" or "Gun" regiment. Within a month my civil life background in the communications field found me transferred to the so-called "specialist" regiment where I was placed in command of a "Radio" battery.

The task of this organization was to take men (specially selected for high intelligence) as they came from Induction Centers such as Fort Dix and Camp Upton and ship them out in thirteen weeks as soldiers who are trained as radio specialists. These men are required to learn code, know four or five types of Signal Corps radios, how to set them up and operate and care for them. They must know the proper procedure for handling traffic on the air, how to encode and decipher messages of a secret nature, and how to communicate with airplanes by means of panels displayed on the ground. They must learn semaphore, know the organization of the Army and of the Field Artillery, have a working knowledge of the principles of camouflage and concealment, and defense against chemical attack. They must be able to fire a rifle creditably, to stand guard, and to know "squads east" from "squads west." In short, they have a terrific amount of material to assimilate in a fleeting three months.

The job of supervising and scheduling all this, in addition to administering the feeding, cloth-

Harold T. King, Battery "D," Twelfth Battalion, Fourth Field Artillery Training Regiment, Fort Bragg, N. C.

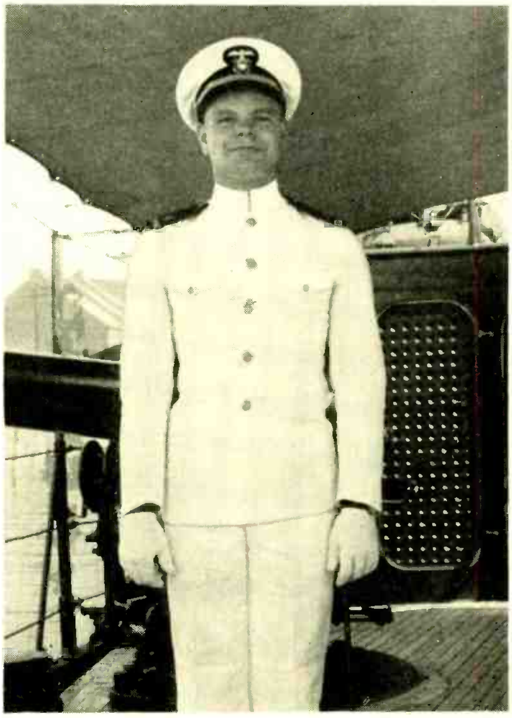
ing, housing, and amusements of 250 men, of disciplining and counselling them, of writing replies to worried or inquiring wives, mothers, sweethearts, and fathers as well as tending to a thousand and one other details the like of which no one but the army could think of, is certainly the most difficult and interesting job that I have ever tackled. It carries a great many rewards which have to be experienced to be understood. It has been with a great deal of pleasure and personal satisfaction that I have seen my young men come in green and awkward, knowing little of army life or procedure, to go out a short time afterward to field outfits as snappy, well-trained soldiers, fully capable and willing to carry their share of the load. These men have earned instant praise from the units to which they were assigned.

I have seen and heard a great deal about poor morale in the army in recent weeks and would like to be able to have some of the writers and speakers of this "horrible" condition see the fine spirit displayed by our units here at the Field Artillery Replacement Training Center. The boys I come in contact with are by and large a mighty fine lot who respond most gratifyingly to instruction, who need little discipline, and who will make excellent soldiers and in some cases fine officers.

LIEUT. CLARENCE UNNEWEHR, U. S. N.:

Since ordered to duty last winter I have been serving aboard the U.S.S. *Dubuque* as a watch and division officer. My duties are twofold. As officer of the deck I have charge of handling the ship underway one watch out of every four. As division officer I am responsible for the training, personnel, and operation of a deck division of approximately 45 men.

The *Dubuque* is a gunboat. She has a displacement of 1200 tons and carries a crew of ten officers and 160 men. We are at present assigned



Clarence Unnewehr, Lieutenant in the United States Navy on the U.S.S. Dubuque

College Men Who Spent the Summer at the Laboratories

Top row: S. E. Clements, R. B. Hoxeng, R. G. Treuting, W. L. Mraz, A. P. Boysen, F. G. Merrill, G. W. Atkins, J. B. Russell and R. L. Sproull

Center: E. A. Hertzler, W. G. Taylor, R. W. Hull, G. H. Found, A. S. Hall, O. C. Worley, A. C. Wilkie, J. T. Bangert, T. A. Hoy and F. E. Bothwell

Bottom: A. B. Bronwell, F. K. Willenbrock, J. C. Shay, R. P. Siskind, C. G. Braun, R. C. Williamson and C. W. Thulin. (H. L. Messerschmidt not present when photograph was taken)

to coastal patrol work in the North Atlantic and are operating on a rather rigorous schedule which affords little free time ashore. One assignment we have had which may be of interest was that of furnishing two boarding parties last spring for taking over two Danish ships tied up in Boston. I had charge of one of these parties and was much impressed considering the circumstances by the cordial attitude of the Danish crew and by the excellent condition of their ship. All of the crew had learned English and attended night school during the period their ship was interned in Boston.

. . . I enjoy receiving the Record very much and find it affords at least one tangible measure of continued contact with the Laboratories.

Summer College Group

For several years the Laboratories have offered summer employment to a group of college students and faculty members. This year the group was composed of the following men, the departments in which they worked being given in parentheses: A. B. Bronwell, Assistant Professor of Electrical Engineering, Northwestern (2110); S. E. Clements, Assistant Professor of Electrical Engineering, University of Kansas (3540); A. S. Hall, Instructor, Purdue (2250); E. A. Hertzler, Faculty Member, Pratt (2420); J. B. Russell, Assistant Professor of Electrical Engineering, Columbia (2120); and R. P. Siskind, Professor of Electrical Engineering, Purdue (2120).

G. W. Atkins, Bucknell (3410); J. T. Bangert, University of Michigan (3230); F. E. Bothwell, M.I.T. (3430); A. P. Boysen, University of Illinois (2320); C. G. Braun, Brooklyn Polytechnic (3510); and G. H. Found, Yale (1210).

R. B. Hoxeng, Iowa State (1230); T. A. Hoy, Williams (2110); R. W. Hull, M.I.T. (1450); F. G. Merrill, Worcester Polytechnic (3230); H. L. Messerschmidt, Rutgers (2210); W. L. Mraz, Purdue (3530); and J. C. Shay, Yale (3230).

R. L. Sproull, Cornell (1450); W. G. Taylor, Bowdoin (1170); C. W. Thulin, Worcester Polytechnic (2110); R. G. Treuting, Yale (1210); A. C. Wilkie, University of

Michigan (3230); F. K. Willenbrock, Brown University (3230); R. C. Williamson, M.I.T. (2250); and O. C. Worley, University of Illinois (2230).

On August 7, these men were brought together for a short program of information. E. W. Waters described to the group the purpose of the summer employment program, the organization of the Laboratories, the functions of its various departments, and the place of the Laboratories in the Bell System. The qualifications sought when new college men are considered for employment with the Laboratories were also discussed.

In the afternoon the men were taken for an inspection trip through the building by G. F. Fowler, C. D. Hanscom and B. A. Clarke. This trip included the microchemical laboratory where the work was described by H. V. Wadlow; dial apparatus laboratory, W. W. Seibert; microphonic action studies, J. R. Haynes; magnetic materials laboratory, D. M. Chapin; microscopic laboratory, Miss A. K. Marshall; timber products, C. H. Amadon; mechanical wear testing, W. A. Krueger; step-by-step switching, W. H. Scheer; toll switching, E. L. Baulch; and crossbar and panel switching laboratories, W. I. McCullagh.

E. D. Prescott testing the power circuits in the 503A FM radio transmitter

Out-of-Hour Courses

The fall term of Out-of-Hour Courses is scheduled to begin during the week of October 13. The following nine courses have been arranged by the Personnel Department under the supervision of E. W. Waters:

The Combination of Frequency Curves in Engineering by R. I. Wilkinson. To cover the elementary principles by which an engineer can determine the characteristics of the frequency distribution resulting from the joint action of two or more independent variables. The exact combination of variables will first be covered and then approximate methods of performing the same and more complex operations will be taken up. Numerous examples drawn from telephone and general engineering will illustrate the principles involved. One term.

Interpretation of the Conductance Characteristics of Pentodes by T. Slonczewski. Methods of predetermining the performance of vacuum tubes from the examination of their conductance characteristics. The subjects treated will include the computation of voltage gain and current-carrying capacity of amplifier, modulator and rectifier tubes, loading, crosstalk and harmonic products in amplifiers, modulators and rectifiers produced by second, third and fourth order modulation. Special attention will be given to the carrier and signal leaks that occur in modulator tubes. Two terms.

Frequency Modulation Theory by J. G. Chaffee. Offered for those who wish to acquire a general understanding of the fundamentals of frequency modulation theory and practice. The topics to be studied are elementary concepts, analysis of phase and frequency-modulated waves, frequency detection, noise reduction, interference, generators, and receiving systems. Theoretical conclusions will be supplemented with experimental corroboration wherever possible. Two terms.

Toll Telephone Switching by C. A. Parker. A broad picture of toll telephone switching from the viewpoint of operating methods, trunking and switching facilities. Circuits will not be studied, but salient features will be enumerated. An attempt will be made to obtain a unified picture, a glossary of toll terms and a familiarity with the sources of further information on the more important elements of toll systems. Some consideration will be given to factors that are expected to affect trends in the pending and future developments in this phase of the art. Two terms.

Electromagnetic Theory and Its Applications by S. A. Schelkunoff. Devoted to a comprehensive study of electromagnetic waves and is intended to furnish fundamental, theoretical background for modern electrical communication of intelligence. A few introductory lectures on vector analysis, functions of complex variables, partial differential equations, and bessel functions will precede the main work of the course. Two terms.

Network Analysis and Feedback Amplifier Design by R. L. Dietzold. The mathematical theory of linear active networks and its application to the problems of feedback amplifier design. The first part of the course is devoted to a discussion of the general properties of stable networks, both active and passive, with special reference to the relations which must exist between the real and imaginary components of impedance and transmission in physical systems. This background is then utilized in a study of the design of the various components of a feedback amplifier to secure a maximum of feedback with stability. Two terms.

Telephone Switching Systems by J. W. Dehn. Method of operation of the various telephone switching systems at present in use in the Bell System. The possibilities and limitations of each, as well as the equipment quantities involved, will be discussed. Circuits will be described in some detail in order to provide a general understanding, not only of what each part of the system is expected to do, but also how it carries out its functions. Two terms.

Practice in Shorthand Dictation by Miss M. C. Brainard. Designed primarily for those who have a knowledge of shorthand and are interested in increasing their speed in taking dictation. Subject matter will be selected largely from technical literature. One term.

First Aid. Standard course of the American National Red Cross. A First Aid certificate will be issued jointly by the Red Cross and the Laboratories to those who satisfactorily complete the work. There will be two classes—one for men with C. Erwin Nelson as instructor and one for women with L. E. Coon as instructor.

H. A. Hesch in the stockroom on the tenth floor of the Graybar-Varick building

Symposium on Non-Linear Circuit Theory

L. A. MacColl and W. R. Bennett are two of the six lecturers chosen by the Basic Science Group of the A.I.E.E. New York section to participate in a lecture series on non-linear circuit theory. The main objects will be to acquaint electrical engineers with the material available in this field, to present the more important analytical and graphical methods for solving non-linear equations, and to stimulate further interest and research in this work. The lectures will be simplified and coördinated on the assumption that the listeners have had no advanced mathematical training.

Power Series Solutions will be the subject covered by Dr. MacColl on December 10 and *Fourier Series Solutions* by Mr. Bennett on January 7. These two will be preceded by *General Nature of the Problem of Non-Linear Circuits and Outline of the Various Methods of Attack* by Prof. E. Weber of Brooklyn Poly., November 5, and followed by *Graphical Methods*, A. Preisman, R.C.A.

Institute, February 4; *Numerical Step-by-step Method*, Prof. Alan Hazeltine, Stevens, March 4; and *Analytical Methods* by Dr. P. Le Corbeiller, Lecturer of Harvard Graduate School and of N.Y.U., April 1.

The Telephone Business

The specialty products division of the Western Electric Company, on $37,000,000 of government orders now in production, has farmed out more than $16,000,000 in purchase orders. This represents an efficient means by which the services of skilled workers and the combined plant facilities of scores of smaller manufacturers can be mobilized to speed the delivery of vital communication apparatus and at the same time relieve the pressure on the machine-tool builders of the nation.

On the largest single contract included in the above total, a $17,000,000 order for radio equipment, Western Electric has sublet contracts in excess of $10,000,000 consisting of some 1400 purchase orders on 250 different suppliers in 14 different states. Principal items for which the manufacturer is making these sub-contracts include vacuum tubes, transformers, generators, meters, and radio parts.

* * *

Members of the Laboratories who have received Manhattan Classified Telephone Directory will note the new cover design which shows the symbolic figure, "The Spirit of Communication," in gold against the familiar red background. This "Red Book," the largest ever published in Manhattan, lists some 184,000 business and professional concerns and individuals under 3,100 headings. There are about 3,000 more listings than in the last book. Approximately 467,000 copies have been delivered to subscribers in Manhattan.

* * *

American youngsters seem to think pretty well of the Bell System, judging from the answers to a recent questionnaire sent by the magazine *Young America* to elementary and junior high school students in nine states.

In response to a question listing a number of companies and asking, "Which of the following do you think has done the most for America?" 56 per cent of the students who filled out questionnaires answered "A T & T." General Electric Company, named by 17 per cent, was in second place, and Radio Corporation of America was third with 8.9.

News Notes

O. E. Buckley has been elected Associate of the Roscoe B. Jackson Memorial Laboratory of Bar Harbor, Maine. This organization specializes in genetics and cancer research work. In July Dr. Buckley gave an informal talk before members of this institution in which he outlined the work of the Laboratories.

During the 1940-1941 year seventy-five different members of the technical staff of the Laboratories presented one hundred and three papers or talks in seventy-five different cities before appreciative engineering or scientific audiences.

The engineer shown in the frontispiece on page i is E. S. Wilcox of the Transmission Engineering Department. The photograph was taken at a type-K auxiliary repeater station near Lincoln, Nebraska.

R. M. Burns presided at the five-day Research Conference on Corrosion held at Gibson Island, Md., and was reëlected chairman of a similar conference to be held next summer. These conferences are sponsored by the A.A.A.S.

C. J. Frosch discussed production problems attending the manufacture of the plastic telephone set with engineers at the Hawthorne plant.

C. C. Hipkins, on August 19 and 21 in Washington, attended meetings of the Protective Coatings Section of the OPM.

C. H. Sample has accepted the chairmanship of the recently formed A.S.T.M. subcommittee on Conformance Tests for Electro-deposited Metallic Coatings. A few months ago he was elected vice-chairman of the A.S.T.M. subcommittee on Atmospheric Corrosion of Non-Ferrous Metals.

A. B. Bailey and C. N. Anderson spent several days in Boston in connection with a frequency modulation radio telephone project for serving motor vehicles.

H. B. Coxhead spent several weeks at Cleveland and Marblehead (Ohio) coöperating in tests of automatic alarm devices for boats in the Great Lakes. C. C. Taylor was present during some of these tests.

Wanted—Books for Fort Monmouth!

"What's there to read?"

"Not a thing, soldier. We're all out. Too many men, not enough books."

That's been the answer at Fort Monmouth, where 12,000 men are being trained for the Signal Corps. Because up to about a year ago there were only 2,000 men in camp, and when you try to divide up books enough for 2,000 among 12,000, you aren't going to get very far.

Have you any interesting books that you don't expect to read again? Bring them in! They'll be read and enjoyed over and over again at Monmouth. Those men in the Signal Corps are special friends of Bell System people, because they are fellow-workers in communication. We want to give them a hand, and we will!

What the men like to read are detective stories, Westerns, adventure tales, travel books—anything with a lot of action and excitement. Nothing depressing or introspective. None of those thousand-page sagas of disillusion.

Bring your books to any of the people listed below, by October 17.

West Street . . Miss Ackerman, Room 143
Graybar-Varick . . . R. C. Hersh, Room 1025
Davis . . . . Miss Hake, Room 1403
Whippany . . . . . . J. V. Kelly
Summit . . . . T. J. Crowe
Deal . . . . J. P. Schafer
Holmdel . . . . W. B. Angerole

F. H. Willis has been in San Francisco conducting a transmission survey of an ultra-high frequency radio telephone circuit.

H. W. Hermance, at Chicago, discussed the installation of a micro-chemical laboratory at the Hawthorne plant. He also visited Buffalo and Pittsburgh in connection with contact performance studies being made in these areas.

At the Atlantic City convention of the American Chemical Society held during the week of September 8 the following papers were presented by members of the Laboratories: *The Electrographic Method of Analysis and Precision* and *Accuracy in Analytical Methods* by B. L. Clarke; *The Relation of Dielectric Properties to Structure of Linear Polyamides and Polyesters* by W. A. Yager and W. O. Baker; *Brittle Point of Rubber Upon Freezing* by M. L. Selker, G. G. Winspear and A. R. Kemp; and *The Effect of Heat Solvents and Hydrogen-Bending Agents* by W. O. Baker, C. S. Fuller and N. R. Pape.

P. A. Reiling of the Circuit Research Department has received a B.S. degree from C.C.N.Y. and A. R. Kolding of the Transmission Development Department a B.S. in E.E. degree from Brooklyn Poly.

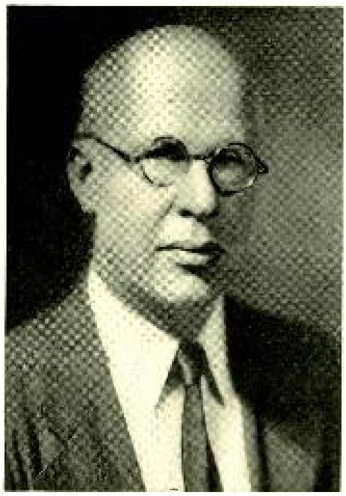
R. W. King and K. K. Darrow attended meetings during the second annual conference on Science, Philosophy and Religion in Their Relation to the Democratic Way of Life. The conference was held at Columbia University from September 8 to 12.

Dr. Darrow spoke at Stanford University on August 5 on the topic *Liquid Helium*. During July and August he also visited the University of California and the California Institute of Technology.

A. W. Ziegler, who was transferred to the Western Electric Company at Kearny last March and who is now back at the Laboratories, completed twenty years of service with the Bell System on July 5.

A meeting of the Executive Committee of the Basic Science Group of the New York A.I.E.E. section, held on September 4, was

A. L. Fox
of the Outside Plant Development Department completed thirty years of service in the Bell System on September 30



R. C. Johnson
of the Equipment Development Department completed thirty years of service in the Bell System on September 23

E. L. Vibbard
of the Switching Development Department completed thirty years of service in the Bell System on September 3

attended by R. W. DeMonte, R. F. Crane, J. D. Tebo and R. L. Shepherd.

Laboratories' representatives at the American Red Cross and Bell System Regional Conference at Princeton, September 10 to 12, were L. E. Coon and J. S. Edwards. This was the first of a series of regional first aid conferences which will result in new contracts between the associated companies and the American Red Cross and a substitution of the Red Cross Standard Course in First Aid for the Bell System Course, continuing, however, the first aid features applicable to the telephone industry. The Laboratories has been teaching the American Red Cross Standard Course since 1937 and was among the first of the Bell System companies to make the change.

J. W. Van de Water has recently gone to Omaha as Field Engineer and W. T. Jervey has returned from there and is now with the plant systems group of the Outside Plant Development Department. G. N. Queen has been made Field Engineer at Atlanta and F. I. Smith, formerly there, has returned to the Quality Assurance Department at West Street. In connection with these changes, G. D. Edwards went to Denver, Omaha, Des Moines, Minneapolis and Fargo with Mr. Van de Water and to Atlanta with Mr. Queen to introduce the new Field Engineers to the telephone people in these areas. R. E. Friedley has replaced W. S. Eno as Assistant Field Engineer at Cleveland and Mr. Eno is now back at West Street.

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

Apparatus Development Department

R. I. Crisfield — A. B. Reynolds

Systems Development Department

L. H. Allen — Oscar Myers
E. L. Erwin — George Riggs
J. K. Jones — A. L. Whitman

Research

H. W. Wightman

General Service

V. J. Mayer

D. R. Brobst visited the Western Electric Company at Point Breeze on matters relating to cord development problems.

F. Hardy, at the central office in Atlantic City, investigated the lubrication of step-by-step switches.

B. F. Runyon was in Buffalo in connection with panel noise studies.

J. R. Townsend attended a meeting of the Standards Committee of the A.S.T.M., held in Philadelphia on August 25.

Patents Issued to Members of the Laboratories During the Month of August

T. Aamodt	H. K. Frantz	W. A. MacNair	C. D. Richard
D. G. Blattner	F. Gray (2)	E. B. Mechling	L. C. Roberts
A. E. Bowen	J. E. Harris	J. M. Melick	T. Slonczewski
F. G. Buhrendorf	H. C. Harrison (3)	M. E. Morrell	G. C. Southworth
C. J. Calbick	R. S. Hawkins	R. S. Ohl	J. B. Stucky, Jr.
J. C. Cook	W. H. T. Holden	G. L. Pearson	E. Vroom
H. J. Fisher	A. W. Horton, Jr.	C. E. Pollard	C. H. Wheeler
H. Fletcher	E. Lacey	J. N. Reynolds	J. R. Wilkerson

G. R. Gohn visited Cleveland to attend a meeting of Committee B6 of the A.S.T.M. This meeting was called at the request of the Office of Production Management to take part in a discussion of the aluminum content in zinc-base die castings.

R. Burns, at the Plax Corporation, Springfield, Mass., discussed the extrusion molding of plastics.

T. S. Huxham spent some time at the Western Electric Company at Hawthorne in connection with molding material problems.

O. S. Mesch discussed cotton tape for cleaning step-by-step switches at the Wm. F. Wright & Sons Company; exhausters for pressure cleaning at the J. S. Poppen Manufacturing Company; and apparatus for cleaning plunger-type line switches at the S. S. White Dental Manufacturing Company. At the Windsor office in Brooklyn he tried out a cutting tool to prevent oil leakage on friction-roll drives.

J. A. Kater visited the Allen Cardwell Condenser Manufacturing Company to discuss the manufacture of some special air condensers.

H. T. Wilhelm, at Kearny, discussed a test circuit for measuring the time constant of resistors.

On September 29, members of the Transformer Development Group tendered a luncheon in the Laboratories restaurant to H. K. Farrar who has transferred from the Laboratories to the engineering force of the Southern California Telephone Company.

C. G. McCormick and P. B. Drake visited Hawthorne to discuss manufacturing problems of step-by-step apparatus.

G. E. Dustin, also at Hawthorne, discussed graded multiple arrangements for trunks from selectors in step-by-step offices.

J. W. Geils was in Haverill, Merrimac and Georgetown, Mass., in connection with trial equipment for community-dial offices.

T. J. O'Neil visited Philadelphia and Princeton on matters pertaining to the L1 carrier telephone installation.

A. S. May was in Cleveland during August supervising the installation of the

L. von Nagy
of the Equipment Development Department completed thirty years of service in the Bell System on September 25

Donald Ross
of the Equipment Development Department completed thirty years of service in the Bell System on September 19

81B1 teletypewriter switching system at the Republic Steel Corporation.

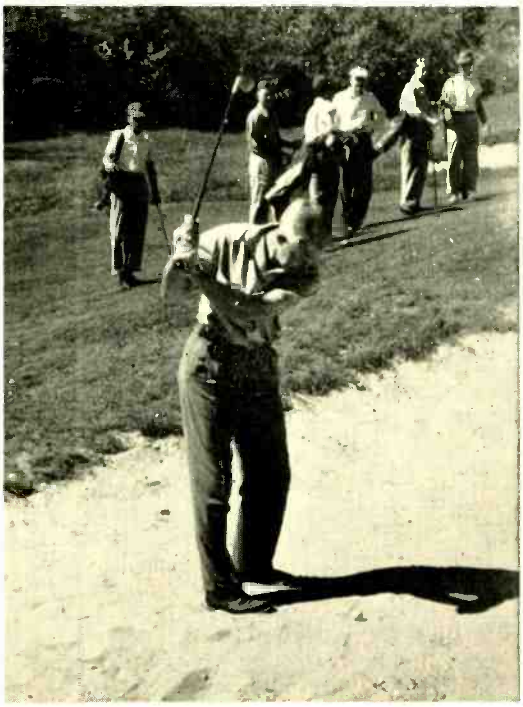
I. W. BROWN, at Hawthorne, discussed general analyzation problems.

J. H. SOLE visited the Leland Electric Company at Dayton and the General Electric Company at Ft. Wayne to discuss machine design.

A. J. WIER inspected type-K carrier installations along the Denver-Omaha route and discussed manufacturing problems with Hawthorne engineers. With H. A. LEWIS he also discussed installation questions concerning the trial of K2 equipment between New York and Pittsburgh with representatives of the Western Electric Installation Department at Harrisburg.

C. H. MCCANDLESS and O. H. WILLIFORD were in St. Louis where the first crossbar office in that area is being installed.

The Long Island Fall Tournament of the Laboratories Golf Club was held on the Black Course at Beth Page on September 13. P. B. Hill had low gross with an 87 and W. W. Carpenter, low net with a 78. B. F. Lewis won the kickers' prize.
Left—W. L. King, S. Brand and B. F. Lewis. Below left—J. B. Kelly. Below — B. F. Lewis



H. W. Everitt

R. E. Kuebler

P. F. Jones was in Chicago and in Joplin, Mo., making transmission performance studies of type-K carrier systems.

M. L. Almquist and J. A. Coy inspected the type-L carrier system between Stevens Point and Minneapolis.

Twenty-Five-Year Service Anniversaries

Erich von Nostitz joined the student course of the A T & T following his graduation by the University of Michigan in 1916 with a B.S. degree. Upon the completion of this course he went into the manual switching group of the A T & T Engineering Department and during the war period did considerable work in writing specifications for the various private branch exchanges used by the Army and Navy as well as by other government departments. With the D & R, when this was formed in 1919, he continued on manual switching work with particular reference to the equipment required for the larger manual offices and auxiliary services. He came to the Laboratories in 1934 and is now with the Switching Engineering Department.

Mr. von Nostitz was intimately associated with the development of the 17C intercepting desk which was the first desk for handling intercepting service on a central basis, the No. 2 information desk the first desk for handling both information and intercepting service and with the No. 3 and No. 4 information desks which provide call distribution and sequence answering, subsequently applied to information service in all of the large cities of the country. In these projects and others of similar nature he provided the requirements, coöperated in the design of equipment, and followed the progress of field trials. He also worked on the provision of a service-observing desk which provides for observing all types of manual, dial, toll and auxiliary services at one desk, either on a local or on a centralized basis. He is now concerned with the design of portable observing equipment for use in small manual or dial offices as well as changes in the No. 11 switchboard for use as a combined local and toll switchboard. Since 1916 he has been responsible for the methods involved in issuing drawings to the Associated Companies and in 1934 collaborated in providing the methods for coördinating the A T & T equipment engineering group as part of the systems engineering group of the Laboratories.

Mr. and Mrs. von Nostitz live in Westfield, New Jersey, with their twelve-year-old boy. Mr. von Nostitz is a camera enthusiast and is a member of the Edward J. Hall chapter, Telephone Pioneers of America.

* * * * *

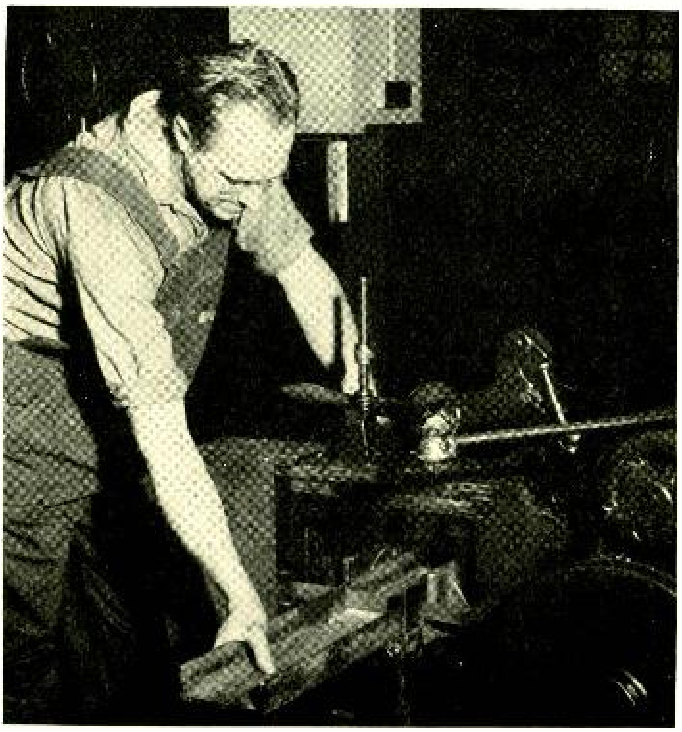
B. H. Jackson, one of the Laboratories' patent attorneys, is a graduate of Ohio State University from which he received an A.B. degree in 1915 and an M.A. degree in 1916. He joined the Patent Department just at the time that our radio development program was expanding rapidly and his first work dealt with radio systems and apparatus, including the complicated problems involved in vacuum-tube structures. During the latter part of the First World War he was in the radio laboratory of the Signal Corps at Camp Alfred Vail.

Following the war Mr. Jackson's patent work covered voice-frequency systems and apparatus, loading, lead-covered cables and deep-sea cables. From 1925 to 1933 he was mainly concerned with the protection of Bell System inventions in foreign countries. From 1933 to 1938 he handled not only foreign patent matters but also U. S. inventions on telephone coin collectors and inductance devices. Since then he has, in addition, been in charge of a group responsible for the protection of chemical inventions. After Mr. Jackson came to New York he studied law and was admitted to the New York bar in 1921.

* * * * *

For five years following his graduation by Virginia Polytechnic Institute in 1911 with a B.S. degree, A. G. Jeffery was a switchboard engineer with the General Electric Company, first at Schenectady and later with the Sprague Electric Division in New York. He then joined the panel development group of the Western Electric Engineering Department where he was concerned with equipment engineering for the semi-automatic system being installed in the Waverly, Mulberry and Branch Brook offices in Newark. Upon the completion of this work he transferred to the group making cost studies on machine-switching systems to determine the most economical full-automatic system to adopt and later to the group engineering the panel offices and helped engineer the Germantown office, the first to use the panel line finder.

Early in 1921 Mr. Jeffery went to the A T & T on a loan basis, where, for a year and a half, he was with a group which made a study of the merit and economy of using the panel system as we know it today in all large metropolitan areas. Upon his return to West Street he was with the fundamental cost study group covering all types of proposed telephone systems, and later with the manual group of the Equip-



Al Stark of the millwright group cutting a channel iron in the automatic power saw

B. H. Jackson

A. G. Jeffery

E. von Nostitz

ment Development Department where he was associated with the development of the No. 3 Information Desk and other equipment of this general type. In 1937 he returned to the equipment cost group where he has since been engaged in making economic studies in connection with the crossbar system.

Mr. Jeffery, who lives in Elmhurst, Long Island, has been very active in Boy Scouts work and is at present vice-chairman of the Activities Committee of the Queens Council, Boy Scouts of America. For his service to boyhood he has been awarded the Silver Beaver. He is also interested in photography and is a member of the Telephone Pioneers of America. The Jefferys have a son, James, who graduated from V. P. I. in 1936 and is now with the Carbide and Carbon Chemicals Corporation and a daughter, Ruth, now in the Transcription Department.

* * * * *

Practically all of J. L. Allison's twenty-five years of service in the Bell System has been spent in designing and developing power plants and associated apparatus for central-office systems. After receiving the degree of B.S.E. from the University of Michigan in 1916 he joined the student course of the A T & T and then was assigned to power plant work in the Engineering Department and continued this work in the D & R when this was formed in 1919. He came to the Laboratories at the time of the 1934 consolidation of the D & R and for most of the time since then has been in the power group of the Equipment Development Department.

The Allisons live in Maplewood, New Jersey, and have two daughters, the older entering Carleton College (Northfield, Minn.) this fall while the younger one is in high school. Mr. Allison is interested in photography and woodworking, the latter being confined mostly to the making of violins. He is a member of the Telephone Pioneers of America.

* * * * *

E. G. Fracker's first contact with the Bell System was with the New York Telephone Company where he was an installer of subscriber station apparatus from 1911 to 1913. He then left the New York Company and for most of the next five years was with the New York *Tribune*. He came to West Street in 1918 and entered the Apparatus Development Department to take part in the development of radio telephone transmitting and receiving apparatus. In 1921 he transferred to the Specifications Department where he first was concerned with the preparation of manufacturing information on keys and later in charge of a group handling relays.

Soon after the Commercial Products Development Department was formed Mr. Fracker joined this Department on the mechanical phases involved in the develop-

E. G. Fracker

J. L. Allison

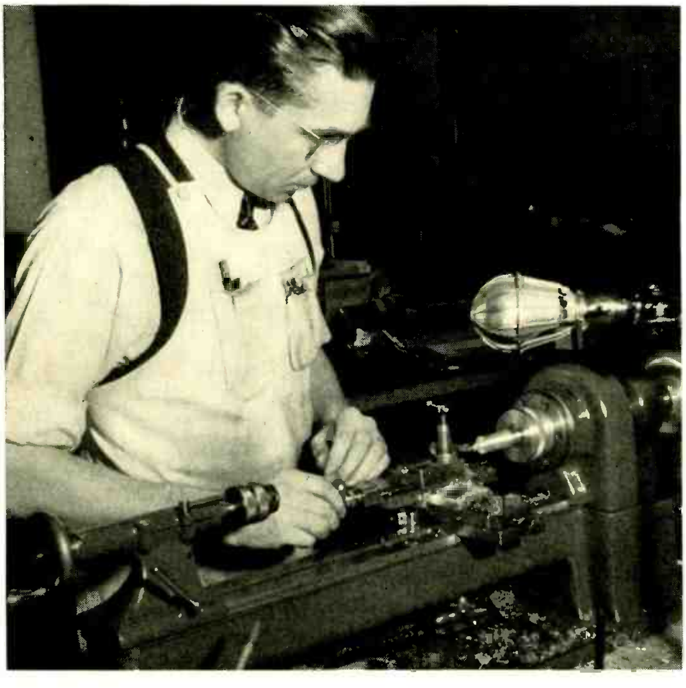
J. M. Hudack

ment of radio receivers. For most of the time since 1928 he has been associated with the development of public address, music reproducing and sound picture systems together with the mechanical design of amplifying and other apparatus for these systems and for speech input equipments. For the past six months he has been engaged in the development of apparatus for naval announcing systems and for other government projects.

Mr. Fracker is a member of the Bell Laboratories Sailing Club and is Rear-Commodore of the Princess Bay Yacht Club. He is also a Telephone Pioneer. The Frackers live on the South Shore of Staten Island and have a married daughter and a son in eighth grade.

* * *

J. M. Hudack joined the Engineering Department of the Western Electric Company in 1916 as a member of the Transmission Research Department and for the first few years assisted in the development of various types of testing apparatus. During this time he studied at Cooper Union from which he was graduated in 1924 with a B.S. degree. About this time he transferred to the Commercial Products Development Department where he was engaged in work on power-line carrier telephone, public-address and loudspeaker equipment. Since 1928, in what is now the Transmission Apparatus Development Department, he has been engaged in



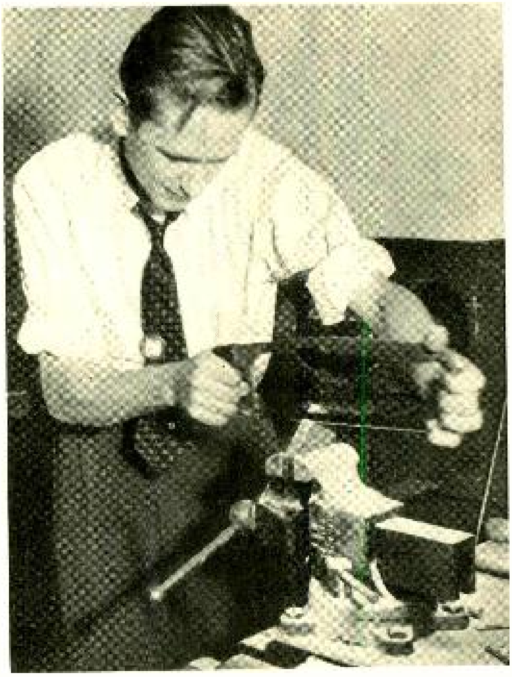
Fred Schank turning a detail for an experimental motor the development of testing apparatus such as oscillators, detectors, harmonic analyzers, phase-measuring sets and similar apparatus. He was intimately associated with the development of the 19C oscillator and 13A transmission-measuring set, handling most of the electrical phases of each of these, and was co-author of an article describing them that was published in the December, 1939, issue of the RECORD. More recently he has completed the development of a self-tuned detector for transmission measurements on networks.

Mr. and Mrs. Hudack live in Lincoln Park, New Jersey, and have a daughter in eighth grade. Mr. Hudack is active in fraternal affairs and is a member of the Edward J. Hall chapter of the Telephone Pioneers of America. Tennis and photography are his recreations.

* * * * *

A. H. SCHIRMER visited Pittsburgh to investigate an unusual case of contact between power and telephone plant.

E. D. SUNDE, R. W. GUTSHALL, J. J. MAHONEY and MISS E. M. BALDWIN conducted surge tests on the Kansas City-Dallas cable near Joplin, Mo., similar to those conducted on the Stevens Point-Minneapolis cable earlier in the summer.



H. K. Meyer making a detail for a model in the Whippany Shop

IN COÖPERATION with engineers of the New England Telephone and Telegraph Company, A. J. AIKENS made a series of noise tests on cable circuits at Boston, Westboro and Worcester.

E. B. MECHLING and M. A. LOGAN made crosstalk tests in a large step-by-step central office in Springfield, Mass., under summer humidity conditions.

L. Y. LACY, D. F. HOTH and G. W. ATKINS have been carrying on field tests at various points in New Jersey in connection with a study of metropolitan program circuit loops.

W. M. BISHOP, A. R. KOLDING, and L. W. MORRISON spent some time at Wright Field, Dayton, in connection with work for the United States Signal Corps.

O. D. GRISMORE went to Princeton and Philadelphia to check up testing equipment on the New York-

L. S. ARMSTRONG
of the General Accounting Department completed twenty-five years of service in the Bell System on August 3

H. B. GILMORE
of the General Accounting Department completed twenty-five years of service in the Bell System on September 26

Philadelphia coaxial cable.

G. B. Engelhardt and T. M. Odarenko visited the Whippany and Holmdel laboratories in connection with measuring apparatus.

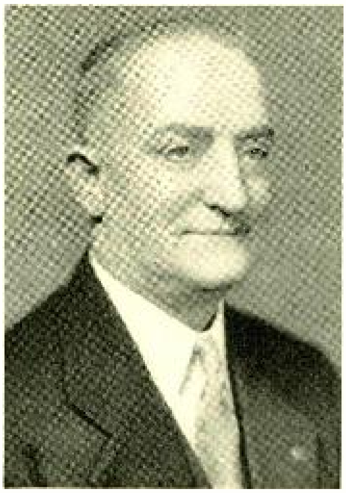
D. A. Quarles and J. F. Wentz conferred at the National Bureau of Standards with representatives of the National Defense Research Committee on equipment for the Navy.

K. C. Black spent several days at Minneapolis studying the results of the first two months of commercial operation of the coaxial system.

J. J. Jansen went to Minneapolis to dismantle the television terminals on the coaxial cable preparatory to shipping them to New York and Philadelphia.

B. A. Fairweather and J. C. McCoy were at Philadelphia and J. P. Radcliff and R. W. Marshall were at Princeton during most of the month in connection with the trial installation of coaxial cable equipment.

R. L. Tambling has returned from Boston where he participated in testing a trial installation of a program channel on a type-K carrier system.



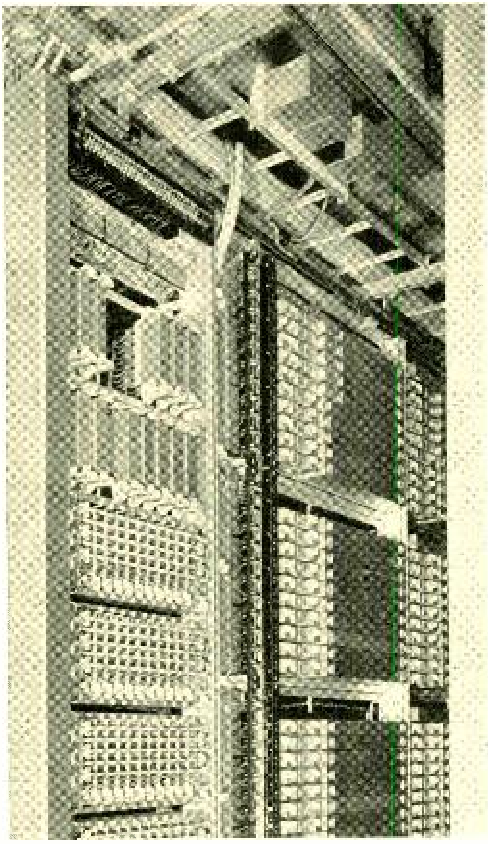
J. J. Lohrey

John J. Lohrey of the Development Shop, with over forty years of service with the Bell System, retired on September 30. Mr. Lohrey joined the manufacturing organization of the Western Electric Company as a milling machine operator and later became a foreman. In 1913, when the manufacturing group moved from New York to Hawthorne, he went to Chicago but returned to the Development Shop of the Engineering Department at West Street in the middle of the following year. During the First World War he was placed in charge of the night shift of a newly formed milling machine group working on special government work. At the conclusion of the war he returned to the Development Shop and since then until his retirement had been concerned with milling machine work.

Mr. Lohrey has been active for many years in the civic development of his home community of Ridgefield, N. J., and is at present president of the City Council, Fire Department commissioner, and chairman of the Department of Public Works.

Decentralized Filters for Central-Office Battery Supply

By L. J. PURGETT
Power Development



WITH the introduction of commercial generators for charging central-office batteries about 1927, it became necessary to use a filter* in the talking battery supply to localize the a-c noise currents arising in the generator. The filter consisted of a coil of about one millihenry inductance in series with the talking battery feeder, and two or more electrolytic condensers bridged across the feeder on the office side of the coil. These filters were large and expensive, but afforded the most practicable remedial measure at the time. One filter per office was used, located in the rear of the power board. Since then, however, much smaller and less expensive coils and condensers have become available. This new equipment has made possible marked improvement and economy in the talking-battery supply by the use of small, individual filters at each switchboard or bay of switching apparatus where talking battery is needed. These decentralized filters have been found even more effective than the common filter in suppressing crosstalk and battery-supply noise, and their use has therefore proved beneficial to transmission.

In supplying talking battery, the major concern—other than that of safe and reliable electrical distribution—is to prevent generator noise in objectionable volume from reaching the talking circuits, and to reduce crosstalk between the various talking circuits resulting from the common impedance of the supply feeders and battery. The nature of this latter problem is illustrated in simplified form in Figure 1, where a battery and charging generator are shown supplying two talking circuits over a path of impedance z. Voice currents in circuit 1, for example, in flowing through this impedance produce voltages 1z across points 1 and 2, and these voltages will produce corresponding currents in circuit 2. The value of these latter currents is directly proportional to z, and thus if z is reduced, the crosstalk will also be reduced. The filters developed for suppressing noise components from the generator, illus-

*RECORD, *Dec.*, 1927, *p.* 113.

trated in Figure 2, provide at the same time the very low shunt impedance required to reduce crosstalk. The series inductance coil is of very low d-c resistance, and thus readily conducts the desired direct current to the talking circuits. Its high impedance at voice frequencies, however, in combination with the relatively low shunting impedances of the battery and the electrolytic condensers, effectively reduces the flow in the talking circuit of noise components arising in the generator. The condenser, if properly located, provides a very low value for the impedance z of Figure 1, and thus satisfactorily limits the amount of crosstalk between talking circuits.

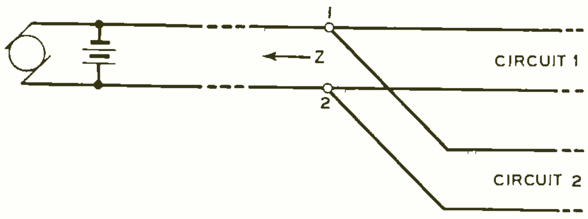


Fig. 1—Crosstalk due to common battery supply arises from the impedance of the common circuit

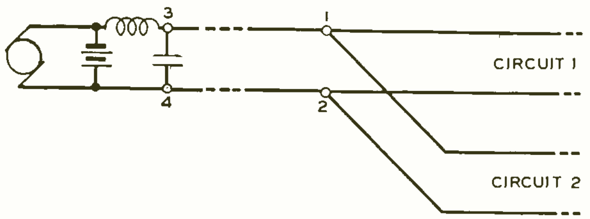


Fig. 2—The installation of a filter at the battery reduces this common impedance and at the same time increases the impedance in the path of noise currents

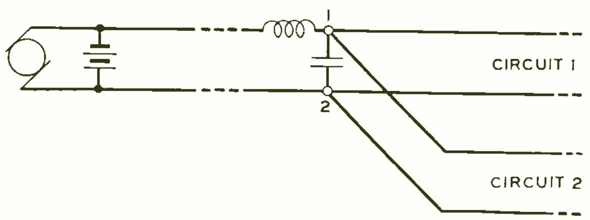
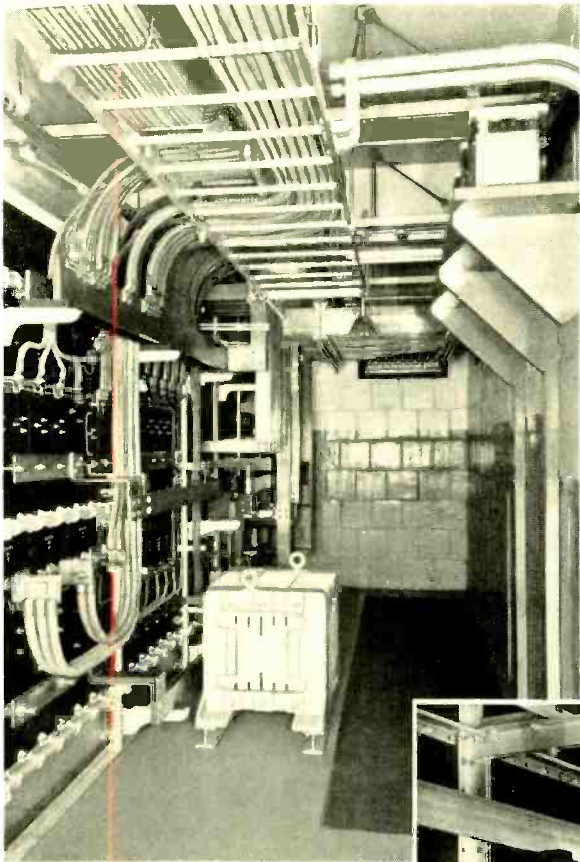


Fig. 3—By placing filters at each point of utilization the common impedance path, indicated in Figures 1 and 2, is almost completely eliminated

Where a common filter of this type is installed at the power board, feeders run from it to the various floors or sections of the building. Some of these feeders may be of considerable length and may parallel other conductors which are unfiltered. There is a possibility, therefore, that considerable noise may be picked up by induction in the filtered leads. Furthermore in some cases there may be appreciable lengths of common feeder between the filter and the points at which battery is to be supplied, such as between points 3-4 and 1-2 in Figure 2. This increases the common impedance z of Figure 1, and thus increases the crosstalk between talking circuits. Moving the filter out to point 1-2, however, indicated in Figure 3, reduces the common impedance between the talking circuits 1 and 2, and blocks any noise fed back from circuits on other frames. The overall effect of using individual filters at battery-supply points rather than a common filter located in the power room is a reduction of about 6 db, or a ratio of 2 to 1, in the talking-circuit noise contribution of the central office.

The improvements effected in noise and crosstalk are not the only advantages of the decentralized filters, however. A considerable simplification of the feeders has been made possible as well. To decrease the impedance of the feeders —the z of Figure 1—it has been customary for years to



of the total load, about one-third is for talking and two-thirds for signaling. These signaling feeders were separated on the cable racks by three inches or more, depending upon the length of exposure, from those supplying talking current to reduce any cross interference. The rear of a power board with the central filter would appear as shown in Figure 4. The choke coil, or reactor, is on the floor just behind the switchboard, and the condensers are on the shelf

Fig. 4 (left)—Rear of power board showing large inductance coil and condensers, and the separate feeders for talking and signaling

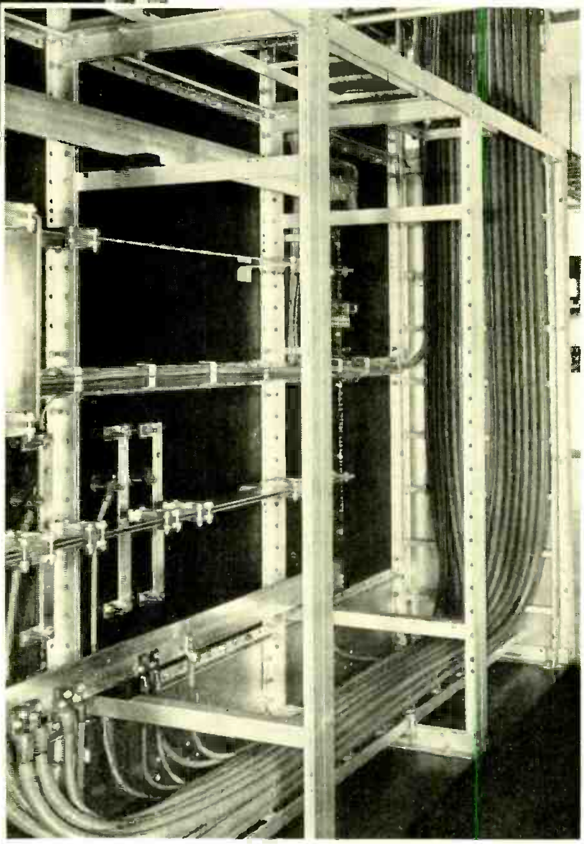


Fig. 5 (right)—Rear of power board where decentralized filters are employed

"pair" the feeders. Positive and negative leads from the power board to the points of utilization would be laid close together alternately — both horizontally and vertically. In addition, a separate group of feeders, not passing through the filters, were run for the signaling circuits. Thus, two separate battery feeder networks were run throughout the office. This was done to avoid the necessity of making the filter large enough to carry all the battery current, since at the upper right, while the two groups of feeders may be seen on the racks overhead. With the decentralized filters all this is avoided, and the rear of the power board appears as in Figure 5. Only one set of feeders is run from the power board to the various distributing locations. Here the connections to the talking supply pass through the small filters. These are mounted on the frames as shown in the headpiece.

These small filters have the same inductance and capacitance as the large ones used at the power board, but they are available in a number of current-carrying capacities since their load will depend on their point of application. Their reduction in size is partly due to the smaller amount of current they are required to carry, but by far the greater part of the reduction, both of size and cost, comes from the improvements in design made possible by the availability of new materials and techniques.

Magnetostriction in Permalloy

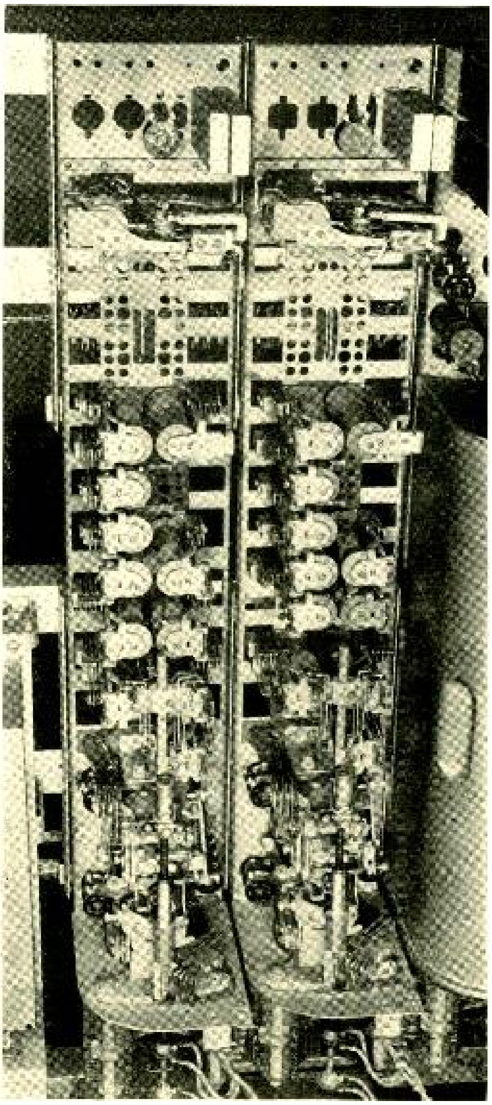
When a piece of iron or other magnetic substance is magnetized it expands or contracts very slightly. This effect, known as magnetostriction, can be explained by the domain theory of magnetization which assumes that a ferromagnetic substance, even in an unmagnetized state, consists of groups of atoms called domains and that these groups orient themselves more or less completely in the direction of a magnetic field when placed in it. The reorientation of the domains changes the dimensions of the specimen.

Messrs. Williams, Bozorth, and Christensen of the Laboratories staff have found that magnetostriction in 68 per cent nickel permalloy varies by a factor of ten when it is subjected to heat treatments while oriented in different directions in a magnetic field. Magnetization was also found to affect the elasticity and rate of damping of mechanical vibrations of this material.

A hollow rectangular specimen, shown wound with long thin coils in the photograph, was used for the tests to give a closed magnetic circuit and thus to avoid demagnetizing effects. The minute changes in dimensions—a few millionths of a centimeter for each centimeter of the specimen's length—were measured by reflecting light from a small mirror, which was rotated slightly by the expansion or contraction of the material caused by magnetostriction.

"Thru" Selector for Dial Toll Calls

By R. J. HOPF
Switching Development Department



BY THE use of circuits and intertoll selectors already described in the RECORD,* the operators at certain outward toll boards may dial subscribers in a distant step-by-step area directly over the toll lines. These selectors, used at the distant end, send back the necessary supervisory signals to the operator. In some places, however, there is need for dialing over two or more toll lines in tandem or for connecting to ringdown toll lines from a dialing toll line. The toll line to the office of the called subscriber may not terminate at the toll board of the calling office but at a toll board in some other town that in turn is reached by a toll line from the calling office. A typical situation is indicated in Figure 1. The dialing over these toll lines and the proper operation of the selectors is essentially the same as when only a single toll line is involved. It is necessary, however, to transmit additional supervisory signals to the outward operator. Besides the possibility of the subscriber's line being busy, there is also the possibility that the toll trunks from the intermediate to the terminating office may be busy. To indicate properly such a condition it is necessary to transmit toll-tandem-type busy and overflow signals. Because of this, a "thru" selector, shown in the photograph above, has been developed for installation at the intermediate offices.

When an operator finds all of the trunks of the desired group at an intermediate office busy, it is desirable for her to hold her connection until one of them becomes idle, and then to take down her connection and dial again to secure the idle trunk. To be able to carry out this procedure, she must get a signal to tell her when all trunks are busy, and another one to

*May, 1940, p. 266.

indicate when a trunk becomes available. Sometimes, however, not only will all the trunks be busy but there may be several other calls already waiting for idle trunks. Under these conditions it is better for her to take down her connection at once, and to dial the operator at the intermediate office, and allow her to handle the call over an alternate route or over the regular group when a trunk becomes available. A third signal is therefore desired to indicate that all trunks are busy and that other calls are already waiting.

These three signals are called the "all trunks busy," the "circuit available" and the "master busy" signal, respectively. With the new thru selectors, the first is at 30 interruptions per minute, the second is at 120 i.p.m., and the third is an irregular 60-i.p.m. signal with a long and a short flash. To provide these signals, the thru selector is equipped with a "minor" switch and some additional relays, and a "group-busy and overflow" circuit is provided for each group of outgoing trunks served by the thru selector. Under the various busy conditions, this circuit is connected to some of the added relays of the selector through those terminals of the minor switch associated with the group of trunks involved, and returns suitable signals to the operator at the outward toll office. These signals are transmitted over the supervisory lead from the thru selector to the composited signaling circuit at the intermediate office. This latter circuit transmits them over the toll line to the outward toll operator by a method already described.*

An ordinary step-by-step selector consists of two semi-circular banks of terminals at the bottom of a high, narrow frame, and above them a group of relays. The thru selectors differ from these in appearance in using a higher frame and more relays, and in having a minor switch, which —as may be seen in the photograph— is mounted near the top of the selector frame. The minor switch consists of a small bank somewhat similar to the regular selector bank but with only two rows of terminals instead of ten. Its rotary magnet operates in step with the vertical stepping magnet of the selector. The wiper of the minor switch thus moves to the first set of terminals as the wipers of the main selector move up to the first level, and so on. Each of the ten levels of the main banks is reserved for one group of trunks, and thus there is a set of terminals on the minor switch for each group of trunks. Since a thru selector can serve only one call at a time, a large number are required in each office and the terminals of the minor switch banks are multipled to corresponding terminals of other minor switches in a manner similar to the multipling of selector banks.

A schematic of a group-busy and overflow circuit is shown at the right of Figure 2, and at the left are those relays of a thru selector through which it operates. In this diagram the overflow circuit is assumed to be the one associated with the group of trunks on the fourth level of the selector, and is thus connected to the relays of the selector through the fourth set of terminals of the minor switch. The A relays, two of which are shown at the extreme right, are operated when a trunk is busy, but since their contacts that connect to the GB relay are connected in parallel, GB will remain operated as long as there is one idle trunk in the group. When all trunks are busy, however, GB will re-

*Record, *July*, 1940, *p.* 337.

lease. This will light the white group-busy lamp to indicate to the traffic-control operator at the intermediate office that all trunks of that group are busy, and will also associate ground with the fourth terminals of the minor switches of all the through selectors. The two rows of terminals of the minor switch are marked H and J on the diagram; for the H terminals, the ground is connected through the D resistance, and for the J terminals, through the P winding of OF.

When a selector is not in use, no connection is made between its relays and the terminals of the minor switch, because the wiper is at the left of the bank. After a selector is seized and stepped to the desired level, however, the wiper establishes a connection between the G, L, and H relays of the selector and the group busy and overflow circuit. If there are still idle trunks in the group associated with this level, no ground will be connected to the H and J terminals of the minor switch from the group busy and overflow circuit. Under these conditions, the rotary action of the main switch starts at once—through relays not shown on the diagram—and the wipers of the main bank will rotate until the first idle trunk is reached. The thru selector will "cut through" to the trunk to allow dialing to the selector at the distant end, or ringing if it is a ringdown trunk.

Had all the trunks on this level been busy, however, the GB relay would be released since all the A relays would be operated, and the ground connected to the H4 lead through resistance D would operate relay L, which locks itself closed to ground on the sleeve lead. The operation of L releases the rotary magnet interrupter relay E, which in turn opens the rotary magnet circuit of the main switch so that the wipers will not rotate, and also closes a connection to the supervisory lead over which the supervisory signals will be returned to the operator. Relay G, in series with L, is a marginal relay and will not operate so long as the resistance D is in the circuit. The ground from the GB relay also would be extended—through the P winding of relay OF—to the J4 lead and thence to the H relay, which would operate. The operation of the H relay connects the 30-i.p.m. interrupter to the supervisory lead, and thus gives the all-trunks-busy signal to the operator.

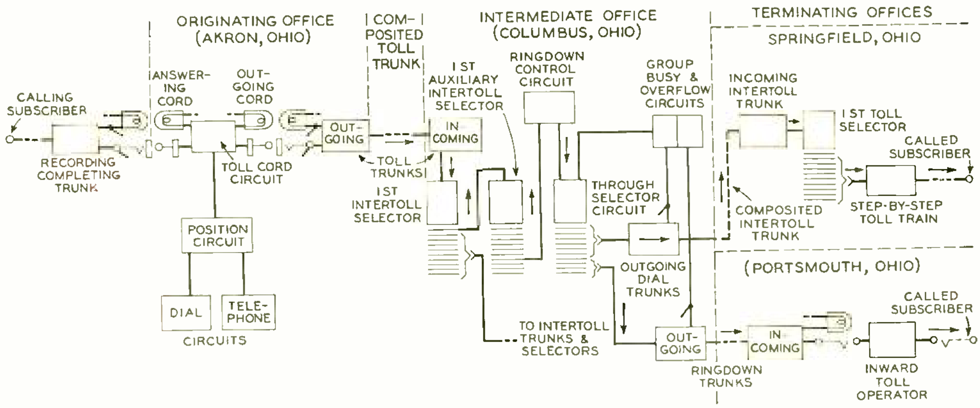


Fig. 1—A typical step-by-step toll connection showing use of "thru" selector at an intermediate office

Under these conditions, the operator will hold the connection until one of the trunks becomes idle. When this occurs, the GB relay will reoperate, removing ground from both the J and H leads. Relay L will be held operated through its lock-up winding, as already noticed, but relay H will release, and by doing so change the signal from 30 i.p.m. to 120 i.p.m., thus notifying the operator that a trunk is now available. On receipt of this latter signal, the operator withdraws her plug to release the selector, and then reinserts it and dials again. Since a trunk is now available, she will be able to obtain a connection in the usual manner.

Occasionally, not only will all trunks be busy, but there may be a number of other calls already waiting for an idle condition to occur. Under these conditions it is not desirable to have the operator hold her connection, since the waiting time may be protracted. It is preferable for her to dial an operator at the intermediate office and to allow her to set up the connection over an alternate route or the regular group when a trunk becomes available. The distinctive master-busy signal notifies the operator of this condition. Its application is brought about through the operation of the OF relay. Ground from the GB relay is connected to one side of both windings of OF, but the currents that flow through the two windings have opposite effects: that through the P winding tends to move the armature to the front contact, while that through the S winding tends to hold it against the back contact. The amount of current through the P winding depends on the number of calls waiting for idle trunks, since for each selector waiting for trunks on this level there is one H relay connected to the P winding of OF. The amount of current through the S winding may be adjusted by changing the resistance in its circuit. This resistance is varied by strappings A, B, E, and F, so that the relay OF will operate when there are the particular predetermined number of calls waiting. The number of calls waiting may be one, two, three, or four as is predetermined.

Suppose, for example, that the circuit was adjusted to give the master-busy signal on the arrival of a third call with two waiting. When the selector used for the second call stepped to the fourth level, the OF relay operated and removed ground from the H4 lead. To insure the operation of the L relay of the second switch under this condition, the circuit from the H relay to the P winding of the OF is held open until after the closure of the L relay circuit. When the selector being used for the third call has stepped to the fourth level, however, no ground will be connected to the H4 lead and, as a result, L will not operate, and the rotary magnet of the selector will at once start stepping the wiper around in search of an idle trunk. Should all trunks remain busy, however, the wiper will step completely around to the eleventh rotary step, in which position it operates the eleventh rotary step springs indicated at the left of Figure 2. This at once connects the master-busy signal to the supervisory lead. On receipt of this signal, the operator takes down her connection and dials the operator at the intermediate office. The operation of OF has also lighted a red light in front of the traffic control operator to apprise her of the situation.

If such a busy condition tends to continue, it may be desirable to have all calls for this group of trunks routed through the operator at the intermediate office rather than to maintain a number of selectors waiting for idle trunks at all times. For this reason, the traffic-control operator at the intermediate office is provided with a "posted-delay" key, which when operated actuates the PD relay. The operation of this relay lights the white lamp to indicate an all-trunks-busy condition, and also connects ground directly to the H lead. Under these conditions the G relays of all waiting switches will be operated. The operation of G closes the open circuit in the rotary stepping circuit caused by the operation of L, and causes the wipers of all waiting switches to step around at once to the eleventh rotary step. The eleventh rotary step springs return the master-busy signal to the calling operators. On any other calls coming in while the posted-delay key is operated, the wipers will also at once step around to the eleventh rotary step and return the master-busy signal, since all the G relays of that group will be operated.

Besides these provisions for sending the toll-tandem signals, the new through selector is equipped with left and right normal post springs to indicate the levels on which ringdown trunks or trunks served by a sender are located. These normal post springs may be set to operate at any levels desired. When the left post spring is operated, a "stop dialing" signal is sent to the operator, so that having reached the desired trunk, she will not dial further until she has received a signal informing her that a sender is ready to receive the pulses. When the right post spring is operated, it sends a signal to the ringdown control circuit that a ringdown trunk has been reached, which starts an automatic two-second ringing signal. If an all-trunks-busy condition is encountered, both of these signals are prevented by the operation of the L relay.

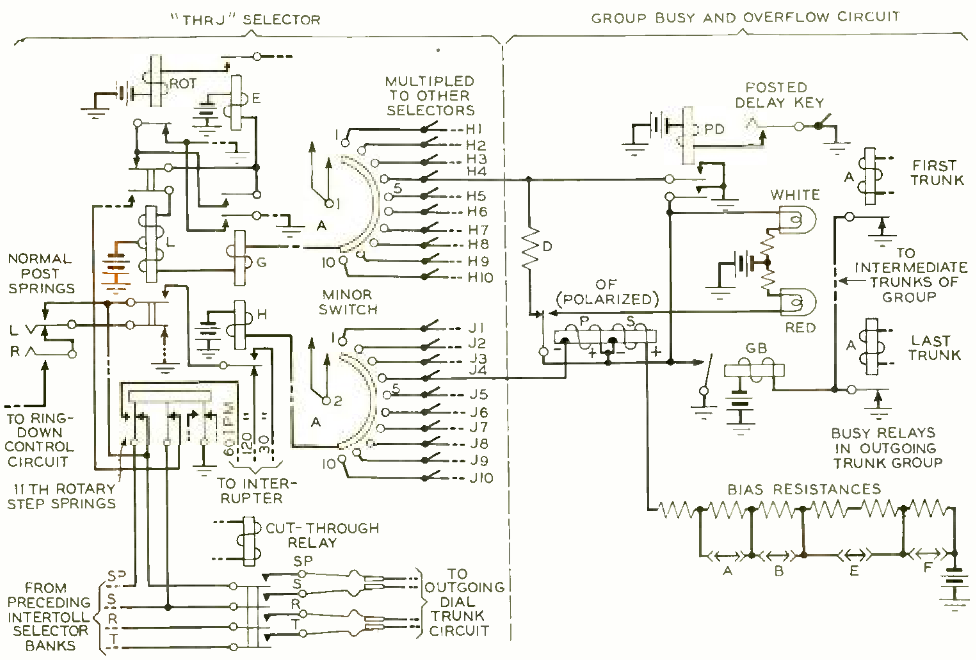
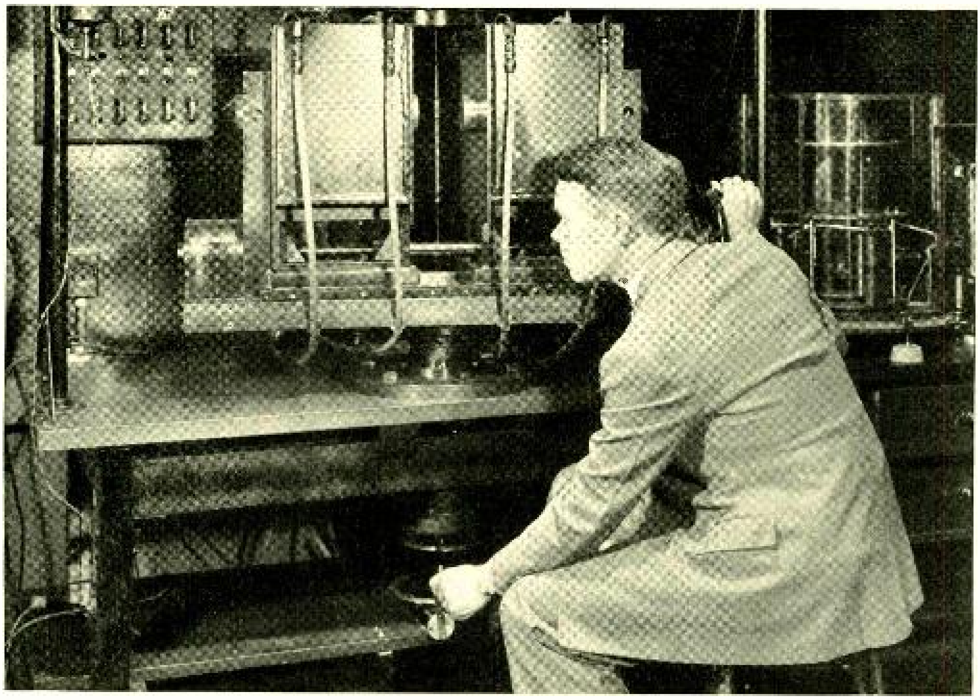


Fig. 2—Simplified schematic of the signaling features of the "thru" selector



Torque on Silicon Iron Crystal in a Magnetic Field

A DISK cut from a single crystal of a ferromagnetic material when placed in a magnetic field will generally try to rotate into a "preferred" position. In most instances this tendency increases with the strength of the magnetic field to saturation, but for some directions of magnetization it has recently been found to pass through a maximum and then decrease with further increase of field strength. This is contrary to previous conceptions of what should happen. R. M. Bozorth and H. J. Williams of the Laboratories' staff recently showed, however, that this behavior can be explained by the domain theory of magnetism, which describes a magnetic material as consisting of groups of atoms which act as units. When placed in a magnetic field these units tend to turn out of their normal positions into the direction of the field, and there is consequently a tendency of the specimen to rotate as a whole. For some directions of magnetization actual calculation shows that this tendency passes through a maximum as the domains change their alignment under the influence of an increasing field. These calculations are confirmed by the authors' experiments in which the tendency of the crystal to rotate—the torque—is determined by supporting it on a taut wire between the poles of an electromagnet and measuring the twist of the wire necessary to counteract this torque. The apparatus is shown in the photograph.

Crossbar Central B Board

By W. B. STRICKLER
Switching Development

WHEN both manual and dial offices are included in a central-office area, a B board is required for completing calls to a dial office that originate in a manual office. Originally such a B board was provided for each dial office. Arrangements have been available for some time in panel areas, however, to permit a single central B board to handle calls for a number of dial offices. In many locations this gives a more efficient and economical method of operation.

When the crossbar system* was introduced, it was necessary to provide means for associating crossbar offices with these central B offices. The arrangement provided employs a "split sender" to handle all incoming manual calls at a crossbar office. Part of the sender is at the crossbar office and part at the central B office. The arrangement is indicated in Figure 1. The part of the split sender at the crossbar office is essentially the same as the crossbar terminating sender,† and it completes calls through the same equipment and in the same manner. The part of the sender at the central B office is of the all-relay type, and is equipped with a 22-point position selector of the rotary type to select an idle operator on a call-distributing basis as already described in the RECORD.‡ The two parts of each split sender are connected by two cable pairs. The B positions and positional equipment are identical to those now used for call-distributing B boards except for a slight modification required because in the crossbar system two crossbar offices in the same building may be served by a common marker group. A common line of call-distributing B positions can serve to complete traffic to both panel and crossbar offices.

The interoffice trunking arrangement of this system is indicated in Figure 2, which shows one manual office and four crossbar offices, indicated by numerals I to IV inclusive. It will be noted that the interoffice trunks go directly from the manual

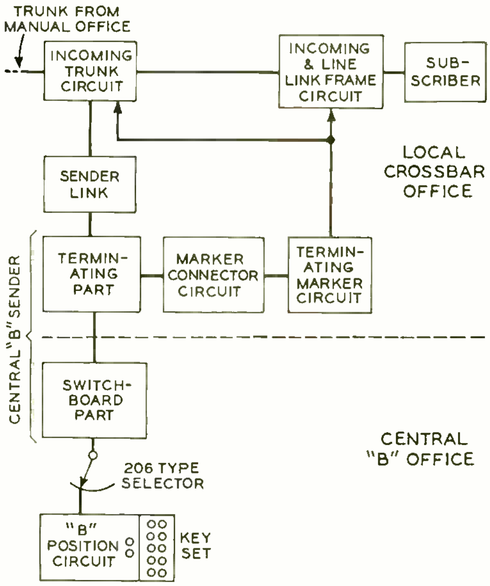


Fig. 1—Block schematic for centralized crossbar B service

*RECORD, *Feb.*, 1939, *p.* 173.
†RECORD, *April*, 1939, *p.* 234.
‡*Dec.*, 1930, *p.* 162.

office to each of the crossbar offices, as contrasted with the panel arrangement in which all of the trunks loop through the location of the central B switchboard before reaching their respective local offices. The split senders are indicated by small letters "s"—the part of each sender at the central B office being primed. When

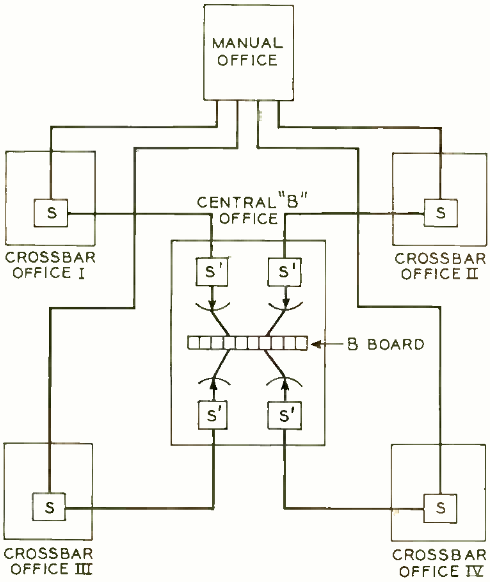


Fig. 2—Each crossbar office in an area, I *to* IV, *has one part of a group of split B senders, and the other parts are at the centralized B office*

a manual subscriber places a call for a subscriber in a crossbar office, the manual A operator plugs into a trunk terminating in the crossbar office called. Here a sender link establishes a connection to an idle B sender of the split type. The part of this sender at the central B office then hunts for an idle B position, and when one is selected, two pulses of order tone are returned to the originating operator as a signal for her to pass the number of the called subscriber's line. The central B operator writes up this number on her key set as soon as it is received, and it is transmitted to the part of the sender at the crossbar office by way of the part of the sender at the B office. As soon as the last digit of the number has been written up by the B operator, the position is released to be ready to serve another call. The completion of the call at the crossbar office then proceeds in the usual manner.

Had the call been to an office that was one of two served by a common marker group, the part of the sender at the B office would have received a signal indicating this fact, and as a result would have caused the position circuit, instead of sending two pulses as an order tone to the manual operator, to send one long pulse. On receipt of this order tone, the operator passes the office name as well as the number of the line wanted. The B operator's position is equipped with office keys as well as numerical keys, and an office key is depressed corresponding to the office name received. The depression of this key transmits a distinctive signal to the marker by way of the sender and marker connector to indicate in which of the two offices the subscriber's number is located.

In providing this crossbar centralized B service, it has been recognized that manual offices in the multi-office areas are decreasing in number, and may ultimately completely disappear. With this situation in view, the crossbar-office part of the split sender has been designed so that with a few minor changes, it can be converted to the full-selector type.

Contributors to this Issue

After graduating with the degree of B.S. in Electrical Engineering from the Pennsylvania State College in 1915, W. B. Strickler joined the student course of the Western Electric Company at Hawthorne. A year later he associated with the circuit laboratory of the Engineering Department, and since then has been continuously engaged with the design, testing, and analysis of circuits used with manual, private branch exchange, dial, and toll telephone systems in what is now the Switching Development Department. For the past five years he has been particularly concerned with the development of sender circuits for both local and toll services.

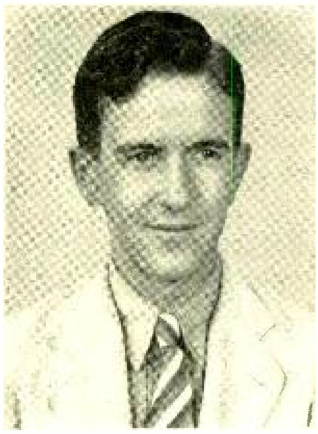
D. Robertson joined the Engineering Department of the Western Electric Company as a messenger in 1920, becoming a technical assistant in 1923. He attended night school at Cooper Union, and graduated in 1927 with a B.S. degree. Since then he has been associated continuously with toll and transmission development. He has worked on the design, test, and analyses of toll switching and signaling circuits, and voice-frequency and single- and multi-channel carrier telephone systems. He has also been concerned with arrangements for connecting radio links into the toll network, and with privacy systems.

R. B. Gibney graduated from the University of Delaware in 1932 with the degree of B.S. in Chemical Engineering, and received his Ph.D. from Northwestern University in 1936. He joined the Chemistry Laboratories that year and has been doing electrochemical research since then. Dr. Gibney has been specializing in corrosion problems, storage batteries, investigations and studies concerning electrographic papers.

R. J. Hopf joined the Engineering Department of the Western Electric Company in 1916, after three years' experience with the Electrical Testing Laboratories, and was associated with the testing and design of printing telegraph equipment until 1921. During this period he attended Cooper Union, and received a B.S

W. B. Strickler

D. Robertson



R. B. Gibney

R. J. Hopf

L. J. Purgett

H. B. Noyes

in E.E. degree in 1921. He later took additional courses at Columbia and Cooper Union and received an E.E. degree from the latter in 1936. In 1921 he transferred to the laboratories of the Switching Development Department where he was associated with the testing of circuits for step-by-step systems. For the last five years, in the toll laboratory group, he has been concerned with the testing of step-by-step intertoll dialing and crossbar toll systems.

After discharge from the U. S. Army in 1918, L. J. Purgett returned to Purdue, receiving the degree of B.S. in Ch.E. in 1920, and the degree of Ch.E. in 1940. He spent a year with the Aluminum Company of America and a year with the William A. Baehr Organization, Consulting Engineers, and joined the Western Electric Company at Chicago in 1922. Until 1928 he was concerned with the engineering, manufacture, and installation of telephone central-office equipment. At that time he transferred to the Bell Telephone Laboratories, where he has since been engaged in the development and design of power supply and other equipment for central offices.

H. B. Noyes graduated from Harvard in 1924 with the A.B. degree. He then joined the Purchase Engineering Division of the Western Electric Company where he engaged in analyses of statistical data for commodities used by the Bell System until 1927 when he transferred to the Chief Statistician's Division of the A T & T. In 1928 he transferred to the Department of Development and Research to work on crosstalk and noise problems important in the design of voice and carrier-frequency circuits. Since coming to the Laboratories in the 1934 consolidation he has continued in this work, particularly on the type-J and type-K carrier systems. Most recently he has headed a field testing crew investigating the effects of various cable installation procedures on crosstalk in type-K systems.