BELL LABORATORIES RECORD

INDEX

VOLUME 25

January 1947 to December 1947

Bell Laboratories Record

Editor
Paul B. Findley

Science Editor
Philip C. Jones

Associate Editor
R. Linsley Shepherd

Assistant Editor
Helen McLoughlin

Circulation
Leah E. Smith

Bell Telephone Laboratories, Incorporated
463 West Street, New York 14, N. Y.

LIST OF ISSUES IN VOLUME 25

BELL LABORATORIES RECORD

VOL. XXV NO. 1 — JANUARY 1947

A NEW YEAR GREETING

TO ALL THE MEMBERS OF THE LABORATORIES

THE season of the New Year is traditionally one of stock-taking and appraisal. We have completed a year of notable progress, and a year of great opportunity lies ahead. Projects suspended because of the war are again under way, and new lines of investigation and development are being launched.

We in Bell Telephone Laboratories are fortunate in having clearly defined objectives and the freedom to choose the best way to their attainment. We have the added satisfaction of seeing the products of our efforts used and appreciated by the public. We can take great pride in our contributions to the service rendered by the Bell System, of which we are a part, and can gain inspiration from our vision of things which lie ahead.

While we are pressed with practical problems for immediate application, our responsibilities are for the distant future as well. Our program must always provide for both, and our team must be so organized that both immediate and remote fronts are covered. With this double pressure upon us, we must guard jealously our reputation for imaginative research and for high standards in the products we design and the systems we devise. These ends can only be accomplished by the sharing of responsibility by all members of our team, and every employee of Bell Laboratories is a member.

Just as every one of you deserves great credit for the accomplishments of the past year, so does each of you have a direct and personal interest and responsibility in the realization of the opportunities ahead. Let us together strive to set a new record of achievement in the year 1947.

Oliver E Buckley

EXAMINATION OF POWER COILS

L. E. MILARTA
Transmission
Apparatus
Development

Unprecedented demand for specially designed small power coils for use in radars, sonars, battle-announcing, and radio and telephone communications systems placed a heavy load on the Laboratories during World War II.

More than five hundred different power transformers and power retardation coils were designed for circuits varying in output from a few watts to thousands of watts. It is estimated that several million coils were manufactured by seven different Western Electric shops and some twenty sub-contractors from specifications issued by the Laboratories on these designs.

Diversity of manufacturers necessitated full-scale examination by the Laboratories to make certain the manufactured coils were up to the standards demanded in equipment for military use. Requirements included power frequencies from 50 to 2,400 cycles, and operation in temperatures ranging from −55 to +85 degrees Centigrade in relative humidities up to 95 per cent, in atmospheric pressures corresponding to altitudes up to 50,000 feet, and after immersion in hot and cold salt water. They were also subjected to test voltages as high as 35,000 a-c, and to severe vibration and shock tests.

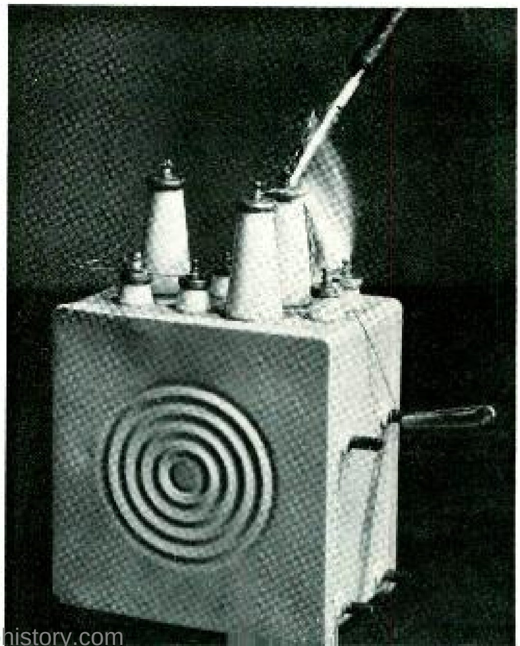
Each supplier was required to submit tool-made samples of each type of Laboratories-designed coil he produced, and during the war years more than 1,500 samples were received and tested. Because of the magnitude of the job, the Laboratories organized a special group to examine and approve these samples for the Western Electric Company.

Examination of a tool-made sample in a sense reversed the process of manufacture. The examiner started with the finished product, he made certain tests, and then he dismantled the sample, piece by piece, to determine whether assembly, materials, parts, and processes conformed with the given specification.

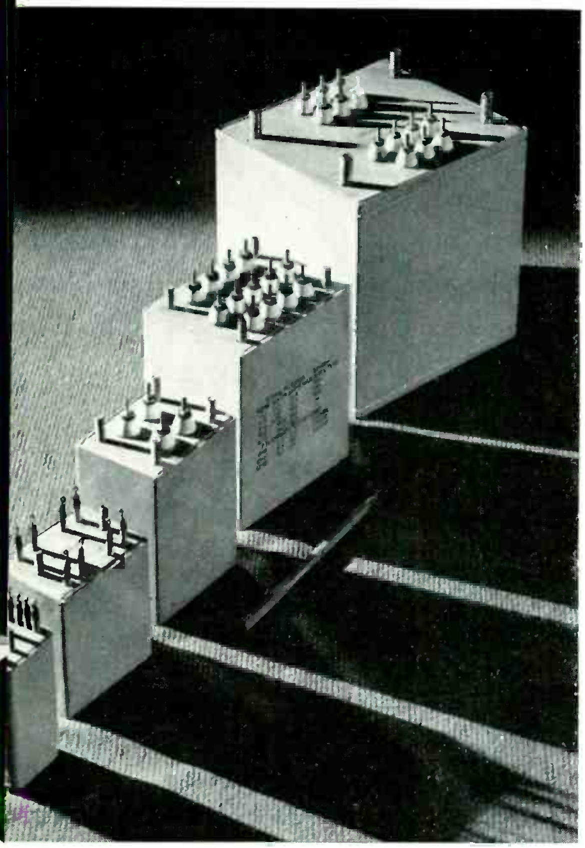
First business on the schedule was examination for damage suffered during transportation. Packing must insure safe arrival of the finished product at its destination. After that the examiner inspected mounting centers, over-all dimensions, markings, finish, solderability of terminals, etc.

Routine electrical tests indicated whether or not the coil had the correct electrical characteristics for its intended circuit. However, to determine the reliability of performance over a long period of time under severe conditions, coils must be subjected to even more strenuous electrical tests and a thorough examination of the materials and processes used in the construction. Samples were given dielectric strength tests to find the value at which corona occurred and at voltages high enough to break down

Nineteen thousand volts a-c is jumping between terminals of this coil during a dielectric strength test



the insulation, as shown on the preceding page, thus establishing the factors of safety with respect to the operating voltage. Dielectric strength tests of coils used in aircraft were made at pressures corresponding to the various operating altitudes by placing in a bell jar and exhausting to the proper levels. After such tests, the coils were taken apart for detailed examination of the internal parts and materials.



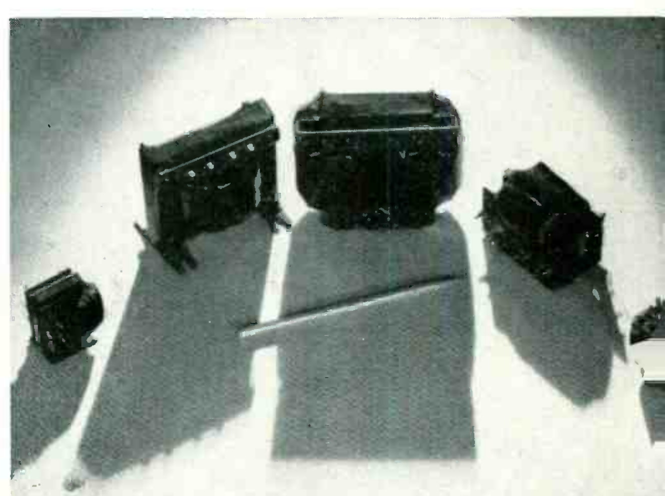
A row of encased, potted coils, hermetically sealed, and designed for ground and shipboard use

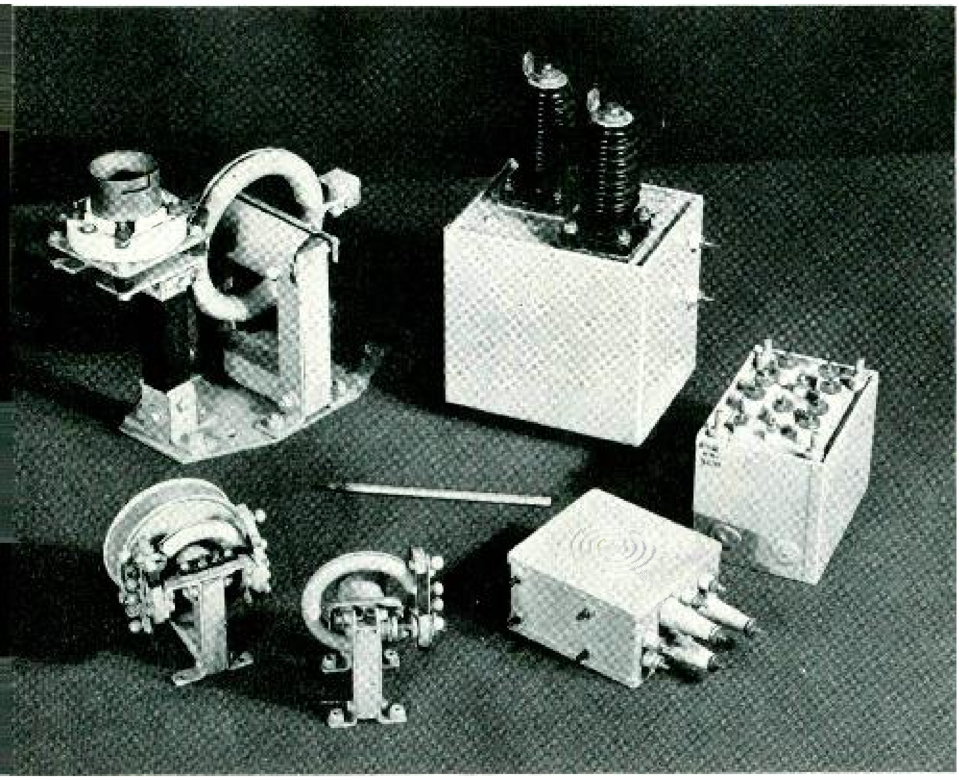
Mounting brackets were important items because they supported the entire weight of the apparatus in service. The three materials used, aluminum, brass, and steel, were readily differentiated from each other by such simple tests as appearance, cutting with a hacksaw, and testing with a permanent magnet. Bends in the brackets were gauged as to radius and examined for strains or cracks—sharp bends and cracks usually result in early fatigue and breakage under vibrations encountered in service. Welded parts were tested by prying or chiseling the pieces apart at the welds. Potting compounds in encased coils were inspected for air pockets or bubbles. Winding assemblies were cut apart to reveal the condition of impregnation, the amount and type of insulation, the condition of the enamel and textile insulation on the wires, evidence of corrosion, and the condition of soldered connections and splices.

Deviations from specification were brought to the attention of the manufacturer. If they were such as to seriously affect the use or life of the apparatus, as would be the case in improper mounting dimensions or electrical characteristics, defects in insulation or use of corrosive materials, they were rejected and the supplier was asked to submit additional samples to demonstrate correction of deviations. If they were of minor importance, the samples were approved and steps taken to prevent a recurrence.

Although much of the examination was conducted in the power transformer laboratory with its tools and equipment, the diverse personnel and equipment resources of other groups in the Laboratories were utilized when necessary to make special tests and analyses, and answer questions

Lightweight, non-encased coils are moisture-proofed for protection against such atmospheric conditions as rapidly changing or extreme humidities and temperatures





High voltage coils: ring type coils on the left and oil-filled coils on the right

which had arisen. The Chemical Laboratories, for example, analyzed samples of potting compounds for softening point and composition, and tested soldered joints and connections to find out whether corrosive fluxes had been used. Questions relating to the quality of impregnants, paper and phenol fibre insulation, wire, and strength of materials were referred to the groups specializing in them. Other groups were called upon for such specialized operations as vibration and impact tests and studies involving the behavior of apparatus when subjected to a wide range of temperature, humidity, and water immersion.

Such specialized attention to the technical problems was an important factor in achieving reliable performance. The very fine service record of these power coils is evidence of the success of the program.

THE AUTHOR: L. E. MILARTA, entering the Laboratories from high school in 1925, studied at Cooper Union and received the B.S. degree in E.E. in 1930. For several years he was an assistant in the transformer laboratory, but became a member of the power transformer group when it was formed in 1929. Since then he has been engaged in designing rectifier transformers and their associated choke coils. He carried on similar work for war projects and during the latter war period was in charge of an inspection group.

JOSEPH JULEY
Switching
Development

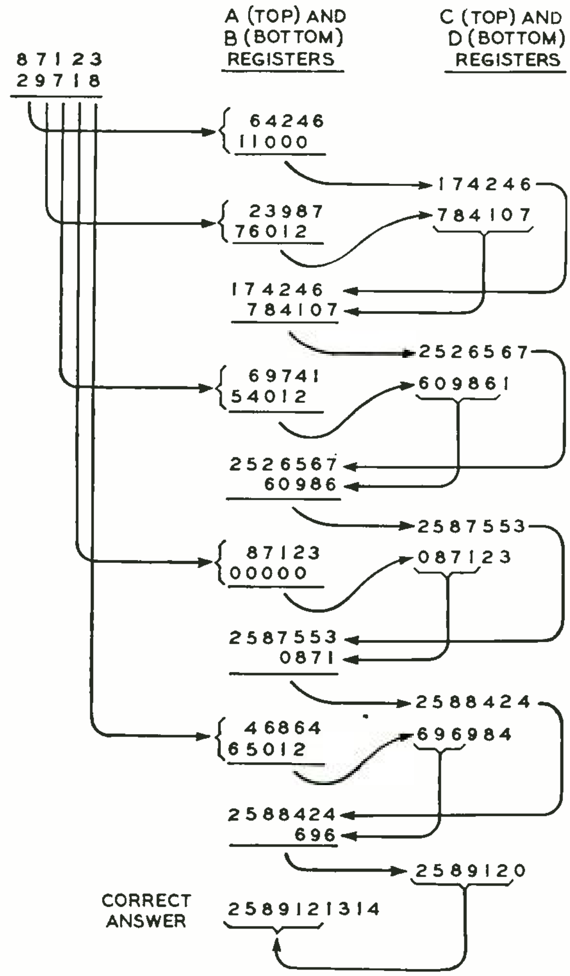
THE BALLISTIC COMPUTER

Under ideal conditions the operators at the tracker of an anti-aircraft gun director should see each shell burst at the plane and on the crosshairs of the telescopes. If the target were flying an unaccelerated straight-line course, and the atmospheric conditions and shell ballistics were as assumed, a series of repeated conjunctions of shell burst and target would be proof that all the complicated circuits of the director were functioning properly, that all constants were correct, and that all adjustments were properly made. Proof of this direct type, however, could be obtained only under battle conditions, while in testing a new design or type of director it is preferable to test the director alone so that all the other errors are eliminated. To get such proof, a plane would be flown as if on a bombing run, and the director operators would track it in the usual manner. Since shells obviously cannot be fired at our own planes, however, no actual firing was done during these trial runs. Instead, the indicators on the director showing the present position in terms of angular height, azimuth, and range of the plane, and those showing gun orders—quadrant elevation, angle of train, and fuse setting—were photographed at one-second intervals. With these data available, a group of computers calculated for a successive series of instants, which might be at one-second or shorter intervals, exactly where the plane and shell would have been at the time of shell burst. The difference between the positions of shell and plane at that instant is the director error, which would be given as errors in range, azimuth, and angle of elevation.

Transmitters, for problem and interpolator data tapes, and reperforator

Since such a trial run may last as long as two hundred seconds, and for each second a large number of computations are required, it would take a team of five computers at least a week to obtain the results desired. To save this time and manpower, it was decided to build a relay computing machine to carry out the calculations automatically. The ballistic computer is the result. The work that required five men working steadily for a week is accomplished by the computer in five or six hours.

All data are supplied to the computer in the form of perforated teletype tapes.



Typical multiplication as carried out step-by-step by the ballistic computer

One, called the interpolator tape, carries, for each second of time, codes for the present position of the plane. Using keyboard perforators, operators perforate the tape from the data on the one-second photographs taken of the present-position indicators on the director. Another tape carries in a similar manner the gun orders for each second of time. These are also obtained from one-second photographs taken during the test run. A third tape carries ballistic data for the type of gun and ammunition in use in terms of position and drift of the shell. This tape is arranged in blocks, corresponding to the pages in a book of ballistic tables, and the block required for any particular calculation will depend on the quadrant elevation and range. This tape may be moved through its transmitter in either direction to reach the desired block. A fourth tape, formed in a loop, is the master control tape. It carries orders to guide the calculations for the particular type of problem being solved at the time. It will make one revolution for each set of calculations required for each second of time.

With information from these tapes available to it, the ballistic computer notes the quadrant elevation and fuse setting from the gun order tape, turns to the proper block of the ballistic table, and from these data calculates the angle of elevation and range of the shell at the instant it bursts.

It then adds the time of travel of the shell, which it derives from the fuse setting and quadrant elevation, to the time at which the shell was assumed to have been fired so as to secure the time at which the shell would burst. With this time available it turns to the interpolator tape and notes the position data for the two integral seconds preceding the time of shell burst and for the two integral seconds following it, and by an elaborate process of interpolation determines the position of the plane at the exact instant of shell burst, recording it in terms of angle of elevation, azimuth, and range. By comparing these values for angle of elevation and range with the corresponding ones calculated for the position of the shell at the time of burst, it is able to determine the error in both of these parameters. The error in azimuth is determined by comparing the azimuth of the computed position of the plane at the time of shell burst with the angle of train of the gun, corrected for drift at the shell, at the time of firing.

The ballistic computer, like the relay interpolator already described,* uses a bi-

*Record, *December*, 1946, *page* 457.

quinary system, and adds and subtracts similarly with a set of A and B register relays. Multiplication and division, however, are accomplished in a different manner. Besides the A and B register relays used for adding, there is a set of multi-contact relays* which is used in multiplying and dividing. One of the two halves of a multi-contact relay is employed for each of the digits from 0 to 9, inclusive, and there is a set like this for each digit of the number being multiplied. If the number was 87123, for example, the number 8 multi-contact relay would be operated for the first digit, the 7 for the next digit, and so on. The multiplier, on the other hand, is set up one digit at a time on a set of bi-quinary register relays. Circuits through the contacts of these relays are arranged in such a way that for any digit recorded, ground will appear on two leads. There is thus a total of twenty leads—two to represent each digit—leaving the bi-quinary registers, and these twenty leads are wired through contacts of the various sets of multi-contact relays to the register relays on which the products are recorded in such a way that for each digit of the multiplier, a number equal to the product of it and the multiplicand will be indicated on the product registers.

The multiplication procedure is based on one of the common methods of long-hand multiplication. The more usual method of multiplying is indicated at A in the first table, while the computer uses the method indicated at B. For both methods, the complete process is indicated at the right. Seven times one, for example, is seven with a zero "carry-over," and the zero is written below and to the left of the seven. Seven times seven, on the other hand, is forty-nine, and the nine is placed above the carry-over zero of the previous digit, and the carry-over four is again placed below and to the left. This same procedure is shown for both the A and B methods. In the ordinary method shown at the left, the carry-overs are added mentally to the multiplication product of the next digit, but the ballistic computer uses one set of register relays for the carry-over and one for the right-hand digits of each multiplication. The principal advantage of the B method is that multiplier digits may be taken from the ballistic or interpolator tape in sequence as the tape progresses step by step. Had the A method been employed, all the digits of the multiplier would have had to be first recorded on a group of register relays in order to make the last, or right-hand, digit available. As the multiplication proceeds from one multiplier digit to the next, the partial products are accumulated, but those digits which do not contribute to the first six places are discarded.

Table I—Multiplication is usually performed as at A, but it may also be carried out taking digits in reverse order as at B. In long-hand methods shown at the left, carry-over digits are added mentally, but with the relay computer they are placed on separate registers.

A		B	
871	871	871	871
297	297	297	297
6097	697	1742	642
7839	540	7839	110
1742	239	6097	239
258687	760	258687	760
	642		697
	110		540
	258687		258687

Table II—Long division requires only multiplication and subtraction, and thus may readily be carried out with the computer circuits. In using the computer for dividing, therefore, the same groups of relays that multiply can also be employed by setting the divisor on the multi-contact relays.

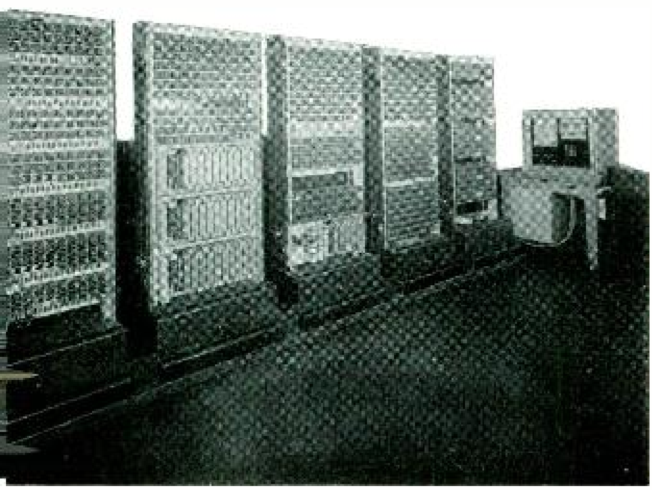
	29717
87123	√258912
	174246
	846660
	784107
	625530
	609861
	156690
	87123
	695670
	609861

The major steps in carrying through the multiplication of 87123 by 29718 are indicated in the first diagram. The two sets of product digits obtained by multiplying 87123 by 2 are set up on the A and B adding relays, and their sum is immediately transferred to a set of C register relays. After this, the A and B relays are restored to normal, and the multiplying relays for the second digit are operated. The product digits for this multiplication are

*RECORD, *May*, 1939, *page* 301.

again placed on the A and B registers, and their sum is transferred to a D register. The numbers of the C and D registers are now transferred to the A and B registers, the D register number being shifted one place to the right. The sum of these numbers is then transferred to the C register. This process is repeated until the complete multiplication has been performed. The A, B, and C registers are arranged for seven-digit numbers, and the D for six-digit numbers. Digits beyond the seventh place are lost. A precision of five places, however, is ample for the work the computer performs.

In ordinary long division, the actual processes involved are multiplication and subtraction. Thus in the problem indicated in the second table, the divisor 87123 is first multiplied by 2, and the product subtracted from the dividend 258912. This process is then repeated for digits 9, 7, etc. In using the computer for dividing, therefore, the same groups of relays that multiply can also be employed by setting the divisor on the multi-contact relays. In the dividing process indicated, however, the various digits of the quotient are determined by trial, mental or otherwise. In the computer, this is done by first multiplying the divisor by 5 and subtracting the result from the dividend. If the difference is negative, successively smaller digits, 4, 3, 2, etc., are tried until a positive difference is obtained, and the digit used for the quotient that first gave a positive remainder is retained as part of the answer. Had the difference after multiplication by 5 been positive, the higher digits, 9, 8, 7, or 6, would have been tried successively, and the first one of these to produce a positive difference is retained as the true quotient digit. This process is repeated for each digit of the quotient. The complete process becomes complicated, of course, and need not be carried through here. All operations in the calculator, such as transferring numbers between the A, B, C, and D registers, shifting them to the left or right as required, and recording the complements to the B registers for the subtractions are automatic once the process of multiplication or division is started.



Equipment for the ballistic computer is mounted on five relay racks and on several tables

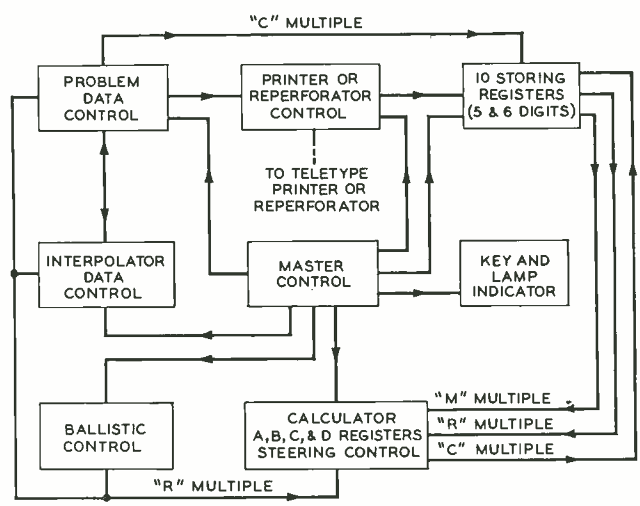
Apparatus for the ballistic computer consists principally of some 1,300 U-type relays and thirty-five multi-contact relays arranged on five frames. A separate frame provides the power supply. Close to the relay rack equipment a table mounts the transmitter for the master control and the ballistic data tapes with their chutes. This table also mounts a key and lamp panel used for analyzing troubles during the operation of the computer. A second and a third table, shown in the photograph at the head of this article, and usually placed in a separate room, carry the transmitters for the problem and interpolator tapes, a keyboard perforator for perforating the tapes from the original data, and a reperforator for rapidly duplicating tapes.

The component circuits of the computer are indicated on page 9. Besides the A, B, C, and D registers already referred to, there are ten storing registers on which intermediate data and final results may be recorded. Information between these storing registers and the A, B, C, and D registers is passed over three groups of wires referred to as the M, R, and C multiple. The M multiple is used for transferring numbers from the storing relays to the multi-contact relays; the R multiple, for transferring from storage to the multiplier relays; and the C multiple, for transferring computed results from the calculator to storage, or data from the problem tape to be used later for printing purposes.

One of the more common computing operations for one second of data, or "time-point," will consist of over forty multiplication operations, most of them involving five-digit numbers, and over twenty addition and subtraction operations. To calculate one line of data and print the result requires approximately two and a half minutes. The operation of the computer is entirely automatic after the transmitters have been loaded with their proper tapes and the power switches have been operated. Enough data can be loaded to run the computer continuously for twenty-four hours or longer. Should troubles in the equipment develop, such as dirty contacts or open wires, the computer is arranged for two types of operation. Normally, the machine stops further computation and sounds an alarm, at which time the trouble can be run down and traced. If a key is operated at the control panel, however, the master control circuit recycles all the circuits involved, drops the computations for the particular time-point the machine was engaged in when the trouble occurred, and starts the computations for the next time-point. The printed record indicates the time-point computation involved.

The computer can be reset to repeat the computations of the time-point at which the trouble occurred without repeating the whole course. This procedure facilitates operating the computer when no attendants are available to determine the cause of the failure. Many other features have been built into the computer to prevent troubles from grounds, crosses, or opens, and to avoid wrong answers in the computations. It will stop in every case should such troubles occur, and also for many types of errors in perforating the tapes, such as wrong codes or too many or too few digits.

A key and lamp indicator circuit is provided to assist in analyzing equipment troubles and some of the errors arising in perforating the tapes. Manipulation of the keys allows the computer to operate each of the circuits on a step-by-step basis with lamp indications of the progress made, the numbers used in the process, and the codes perforated on the various tapes used.



Block layout of circuits of the ballistic computer

THE AUTHOR: JOSEPH JULEY joined the Bell System in 1905, and through evening study received a B.S. degree from Cooper Union Institute in 1908, a B.E.E. degree in 1911, and an E.E. degree in 1914. During this time he was with the physical laboratory, and later was in charge of the electrical apparatus analysis group. In 1920 he transferred to the Systems Department as head of a group working on call indicator and key indicator equipment. In 1926 he was placed in charge of the group testing all panel equipment, and in 1928 he took charge of the group designing routine test circuits and maintenance desks. Since Pearl Harbor he has devoted his time exclusively to writing instruction books and to developing relay computers.

RELAY COILS WITH IMPROVED LONGITUDINAL BALANCE

C. M. MORRIS
Transmission Engineering

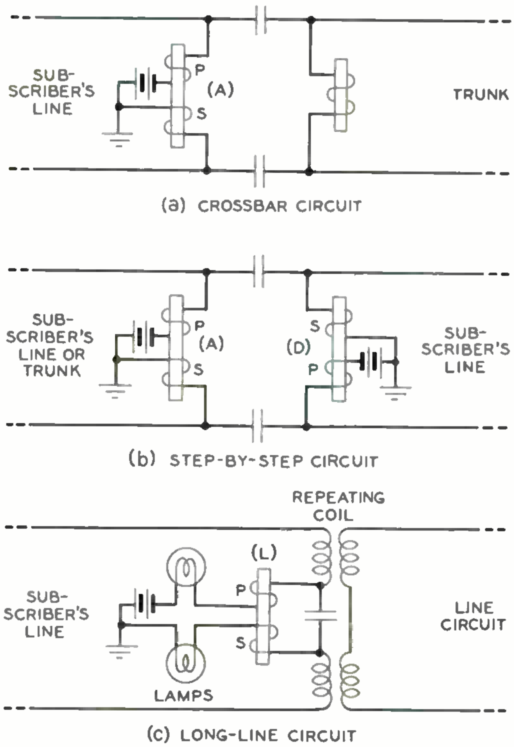
Voltages induced in the conductors of a telephone line are likely to result in noise in the listener's ear unless preventive measures be taken. One of these voltages is called "metallic" because it acts around the metallic loop composed of the line wires and the terminal equipment; the other, called "longitudinal," sets up currents along both line wires in parallel, with return circuit through capacitance to ground or through terminal equipment which may be connected to ground. The first component can be reduced by transposing the line at intervals, thus making the induced voltages in adjacent sections nearly equal and opposite. The second component is negligible if the circuits have equal impedances in each one and from each of the wires to ground. If this balance is not good, however, the induced currents produce unequal drops in voltage in the conductors and cause noise in the line. To realize all of the advantages of the continuous metallic telephone circuit in reducing noise caused by induction from adjacent power lines, good balance against the longitudinal component is required in central-office transmission apparatus as well as in other parts of the circuit.

Relays are one of the chief sources of longitudinal unbalance in central-office equipment, and any appreciable difference of impedance in their primary and secondary windings is likely to cause noise. To secure the optimum balance in two-winding relays, a number of requirements must be met: first, each winding must have the same number of turns; this insures inductive balance when the permeance of the magnetic structure is high, since the flux links the turns of both windings equally; second, the air core inductances must be equal to obtain balance when the magnetic structure is saturated; third, the coils must be co-extensive in length to maintain, in conjunction with the two preceding requirements, inductive balance when air gaps and other dissymmetries are introduced in the magnetic return path; and finally, the direct-current resistances must be equal to insure balance at the lower frequencies where the direct current resistance is an appreciable part of the impedance. The first three of these requirements are of approximately equal importance; the last requirement is ordinarily of lesser importance.

Relays with two concentric windings have been in use for many years and can be designed easily to meet the first requirement for balance. If this condition is met, however, the second cannot be met because the outer winding, due to its greater mean radius, has a considerably greater air core inductance than the inner one. The third requirement is inherently met, and the fourth can be, if the correct choice of wire gauge is made.

Coils with nominally identical front and rear windings are called tandem wound. They have been used for many years and

Testing relay coils for balance



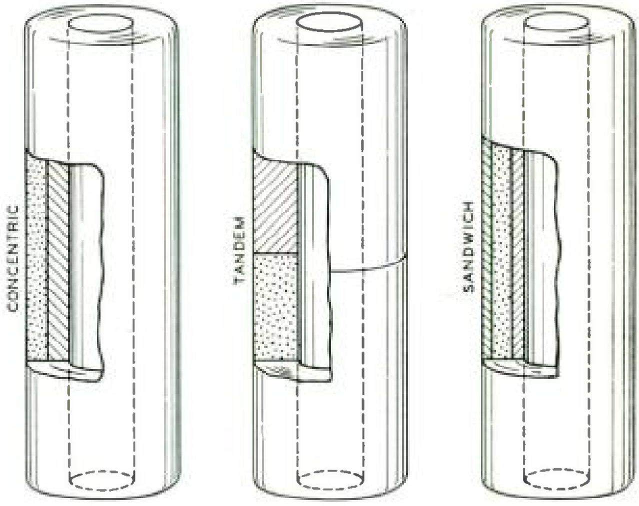
...ematic of typical crossbar (a), step-by-step (b), and ...-line (c) circuits showing relay connections

is allowed to increase. In some cases, therefore, operating ranges would be reduced if parallel wound coils were used.

The sandwich, or three concentric winding, is an improvement on the previously mentioned arrangements. The inner and outer windings are connected in series and serve as the primary; the middle winding is the secondary. If the sum of the turns on the inner and outer windings is equal to the turns on the middle winding, the first requirement for balance is satisfied. By varying the number of turns on the inner and outer windings but keeping their sum constant, one particular apportionment will satisfy the second requirement. This may be explained as follows. First assume that all of the turns on the outer winding are removed and added to the inner winding. In this condition the secondary has a higher air-core inductance than the primary, because of its greater mean radius. Then assume that all of the inner winding is removed and its turns added to the outer winding. The primary now has a higher air-core inductance than the secondary, because of its greater mean radius. Since the air-core unbalance between the primary and secondary changes from minus to plus

easily meet all but the third requirement. They fail in this respect, however, because the flux leakage of the winding nearest the armature and air gap is quite different from that of the other winding.

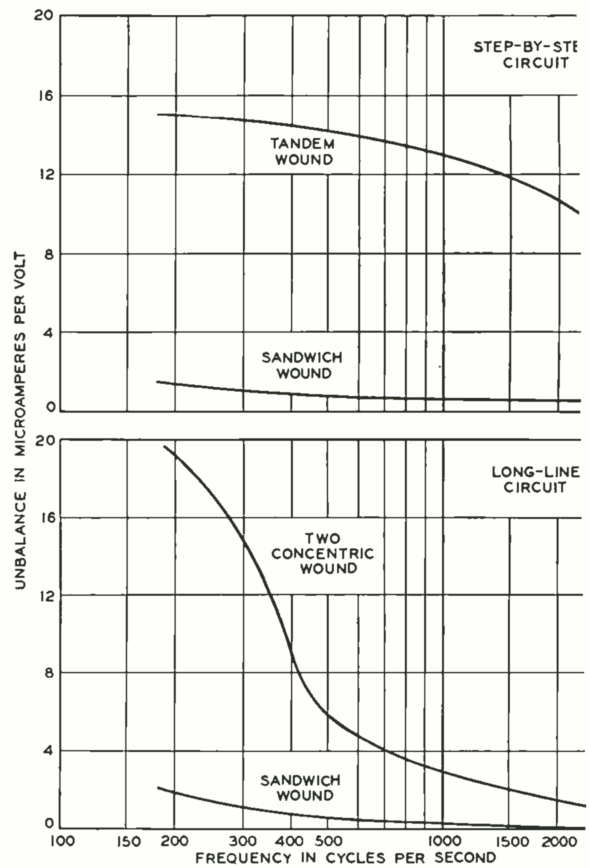
To reduce the unbalances inherent in these two arrangements, parallel winding has been used frequently in recent years. The wires of the two nominally identical windings are placed together, so that each turn of one is adjacent to the corresponding turn of the other. This arrangement easily satisfies all of the four balance requirements. To prevent breakdown between the closely spaced windings on voltage surges, however, it is necessary to use wire with enamel and silk rather than with the plain enamel insulation which is satisfactory in the concentric and tandem arrangements. This additional insulation consumes winding space so that fewer turns must be wound unless the direct current resistance



Methods of windings relays: two concentric windings (A), tandem windings (B) and sandwich windings (C) as a result of this extreme shifting of turns, for some intermediate condition the unbalance can be made zero. In the actual design of a coil, it is possible to find the correct apportionment of turns on the inner and outer windings by air-core inductance formulas. The third requirement is met inherently and the fourth may also be fulfilled by the proper choice of wire gauges. Plain enamel insulated wire is satisfactory from a voltage breakdown standpoint with the sandwich winding as it is also with the tandem and concentric arrangements.

To conserve silk and provide greater operating ranges, a parallel wound relay in the crossbar circuit has been replaced by one with a sandwich winding, which has an average unbalance of approximately one microampere per volt over the frequency range of 180 to 3,000 cps. The improved balance is obtained in the step-by-step circuit by replacing tandem with sandwich wound relays, and in the long line circuit, where the sandwich winding has replaced concentric wound relays. The unbalance is determined by measuring or computing the metallic current per longitudinal volt with the equipment in question connected to an unbalance-rating circuit.

The improved balance of the new step-by-step relays has proved to be very helpful in many noise problems, and in a number of cases has reduced by at least ten decibels the total noise in rural areas in which the telephone lines are fairly well transposed and the exposures to power lines are somewhat greater than the average.



Improvements in balance are obtained in step-by-s and long-line circuits by using relays that emplo windings of the sandwich type

THE AUTHOR: CHARLES M. MORRIS, after graduation from George Washington University in 1929, entered a group of the Transmission Research Department working on telephotograph and television problems. In 1935 he transferred to local telephone transmission to work on the transmission features of central office apparatus and circuits. In this connection he invented the sandwich-wound round relay which he describes in this issue of the RECORD. During the war Mr. Morris worked on transmission design for Army switchboards and information centers. Since then he has resumed his former transmission design work which has been broadened to include station as well as central office apparatus and circuits.

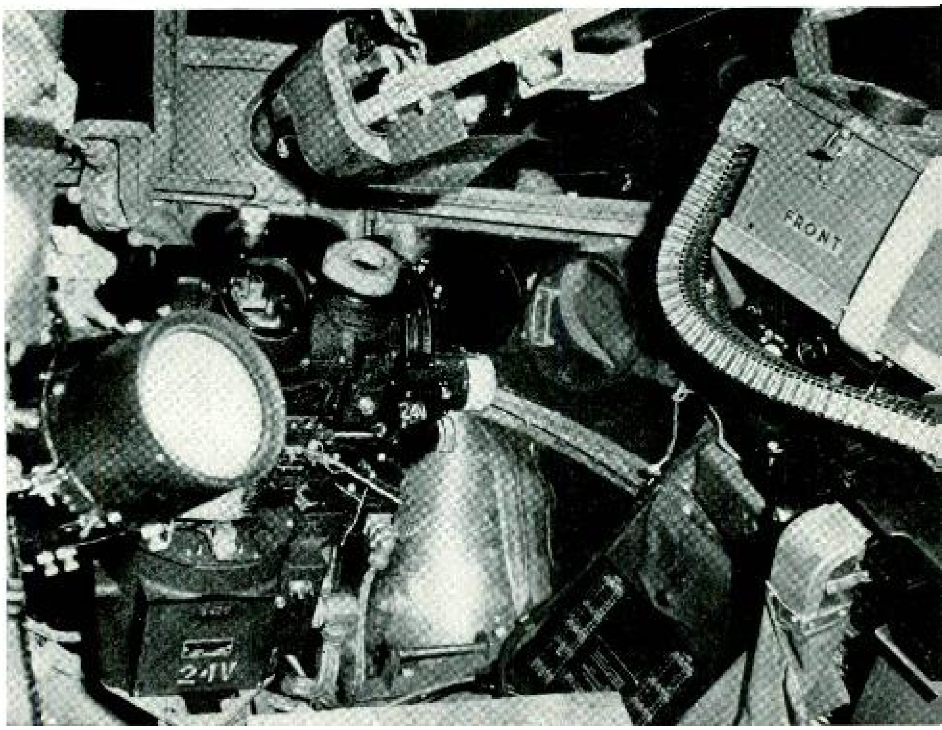
J. W. RIEKE
High-Frequency
Transmission
Engineering

LOW-ALTITUDE RADAR BOMBSIGHT

One of the top secrets of the early years of the war, and one of America's most effective weapons, was the Norden bombsight. Using skillfully designed apparatus and ingeniously devised methods of operation, the Norden bombsight raised bombing to greater precision than had ever been attained before. With all its advantages, however, it had a limitation that seriously restricted its use. Employing optical methods for locating a target, it was useless at night or whenever overcast skies, all too common in many of the battle zones, interposed an optically impenetrable layer between the airplane and earth. Radar, which was already being used for locating enemy aircraft from the ground, held promise of correcting this shortcoming, and Bell Telephone Laboratories, who were already developing directors and other radar devices, were asked to develop the equipment needed to adapt radar to precision bombing. The low-altitude bombsight AN/APQ-5, generally shortened to LAB, was the first result of this work.

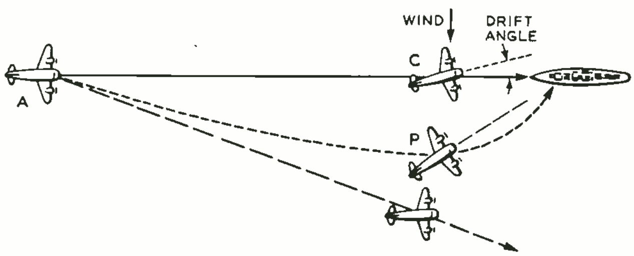
A telescope mounted so it can be rotated either horizontally or vertically provides the basic control element of the Norden bombsight. Horizontal motion of the telescope, aided by a directional gyroscope, steers the plane so as to approach the target in a straight line, and vertical motion

Installation of AN/APQ-5 equipment in bombardier's compartment of a B-25



of the telescope determines the speed of approach. A constant height is maintained by the pilot during the bombing run, and this height—taken from the plane's altimeter—together with the vertical angle of the telescope and the rate of change of this vertical angle, permits the correct time of release of the bomb to be determined with a high degree of accuracy.

Unless there is no wind component across the course the plane is flying, and unless the target is stationary or moving in line with the plane's course, flying a course so that the plane approaches the target in a straight line and at constant speed is not so simple as it might appear. With a wind component at right angles to the course, as



If an airplane in a cross-wind flies without changing its heading, it will be down-wind from the target when passing it. If it continuously changes its heading to fly toward the target, it will fly a pursuit course, P; while if it directs its heading up-wind by the amount of the drift angle, it will approach the target along a straight line

indicated in the drawing, a plane that began by heading directly toward the target, as at A, and then holding this heading fixed, would soon find that it was down-wind from the target. To keep heading toward the target it would have to change its course continuously. Instead of flying along the straight course C, it would fly the curved course P, which is called the pursuit course. Along a pursuit course, however, the plane's direction is changing continuously, and since when a bomb is dropped it continues along the course the plane was flying at the moment of release, it would not hit the target. Its horizontal direction would be tangent to the pursuit course at release, and as a result it would hit down-wind from the target.

For a bombing run, this difficulty is overcome by directing the plane's heading up-wind by an angle just sufficient to offset the transverse velocity of the wind. This is known as the drift angle. Heading at the drift angle up-wind from the target, the plane approaches the target along a straight line course marked C in the drawing, which is called the collision course.

With Norden technique, the plane is set on a heading toward the target and held on this course until the target has moved perceptibly from the crosshairs of the telescope. Small knobs on the telescope mount give control of the steering as well as of the position of the telescope, and when the target is found to have moved away from the vertical crosshair, the telescope is brought back onto the target and the steering is over-corrected. After a few decreasing adjustments of this type, the plane will be flying the true collision course, and from this time on a bomb dropped at any time will have a horizontal component directly toward the target.

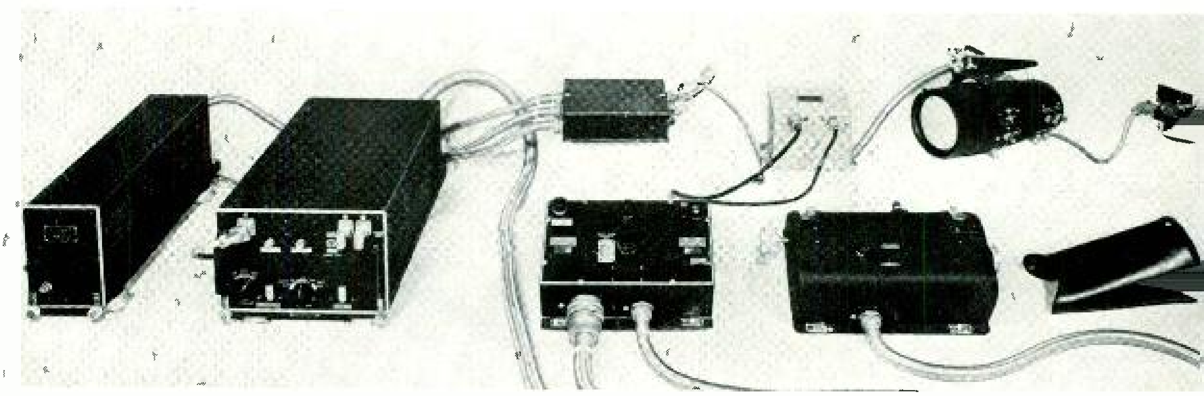
At the same time, guided by the operator's adjustment of another knob, the telescope is rotated continuously downward so as to maintain the target on the horizontal crosshair as the plane approaches it. This rate of downward rotation is a measure of the speed of approach to the target. It is fed continuously to a calculating circuit that, from it and the altitude already transmitted to it, calculates the vertical angle of the telescope at which the bomb should be released. When this angle is reached, the bomb is released automatically.

Thousands of men had been trained in this technique of bombing and thousands of planes had been equipped with the Norden apparatus. In applying radar to bombing, therefore, it was highly desirable to maintain the same operating technique as far as possible, and to use as much as possible of the Norden equipment. The telescope is removed, but the dials that steer the plane and move the telescope horizontally are maintained, but are modified to connect with the new apparatus. Knobs similar to those for controlling the vertical angle of the telescope and the rate of change of this angle are also provided, although they actually control different quantities. Instead of the telescope, a cathode-ray scope is provided on which the position of the target may be seen.

This scope employs "B" presentation; slant range is given by distance along the vertical axis, while azimuth to right or left of the plane's course is given by distance horizontally to the left or right of the vertical axis. An electrical range line which is adjustable in range appears on the screen. When the target is tracked, this range line and the inscribed vertical axis take the place of the horizontal and vertical cross-hairs of the Norden telescope.

The LAB scope is in addition to the regular radar scope of the plane, but is operated by the same signals. Its range is much less than that of the main radar scope, being a maximum of ten miles, but while tracking, the scale is expanded to make the field cover only one mile. Normally, a target would appear on the vertical axis when the plane was headed directly on it, but a knob concentric with that used to steer the plane permits the indication of the target to be shifted horizontally so that when the plane is travelling up-wind from the target by an amount equal to the drift angle, the target can be brought to the central vertical axis of the scope.

The target is first picked up on the ship's main scope and is followed on a pursuit course. After the plane is within ten miles of the target, the switch of the LAB scope is turned to its "track" position. This narrows the field to one mile and brings the range line to the middle. The bombardier then immediately takes over control of steering to obtain a collision course. He turns the plane up-wind and brings the target to the middle of the scope, repeating this adjustment until the target shows no tendency to move away from the vertical axis. The pilot meanwhile holds the plane at a constant altitude. Under these conditions, the speed of the plane is constant and along a straight line. The target spot may be brought down to the range line by turning the outer of two knobs on the range tracking unit. The inner knob on this unit adjusts an automatic "range-rate" movement of the range line to keep it on the target as the plane approaches it. If the adjustment already made for rate is correct, the target will remain on the line, and if not, it will drift off. Under these conditions, it is brought back by turning both knobs, one moving the target to the line and the other adjusting the rate in much the same manner as for horizontal tracking. This inner dial, operating a potentiometer, also establishes a voltage proportional to the rate of decrease of the slant range. That voltage, together with voltages representing the altitude, is applied to the computer circuits, which from them calculate the value of slant range at which the bomb should be released. The slant range steadily



Major components of the AN/APQ-5 include, left to right, a power supply, a synchronizer, a control unit, a tracking unit, and a cathode-ray tube above and to the right of it

WESTERN UNION

NE167 LG GOVT-NEW YORK NY 12 729P

DR O E BUCKLEY PRES BELL TELEPHONE LABS

463 WEST ST JANUARY 12. 1944

AFACO 27.37. PD DIRECTLY AS A RESULT OF THE OUTSTANDING CONTRIBUTION MADE BY YOUR ORGANIZATION IN THE DEVELOPMENT OF SPECIAL ELECTRONIC EQUIPMENT AND IN THE MAKING OF PRE-PRODUCTION MODELS THEREOF IT HAS BEEN POSSIBLE FOR THE ARMY AIR FORCES TO TAKE THE OFFENSIVE WITH TELLING EFFECT AGAINST JAPANESE SHIPPING IN THE SOUTH AND SOUTHWEST PACIFIC AREAS AT A MUCH EARLIER DATE THAN WOULD OTHERWISE HAVE BEEN POSSIBLE AND UNDER CONDITIONS WHICH NORMALLY WOULD HAVE MADE SUCH OPERATIONS IMPOSSIBLE PD PARAGRAPH IT IS MY GREAT PLEASURE IN BEHALF OF THE ARMY AIR FORCES TO EXPRESS OUR APPRECIATION FOR THIS CONTRIBUTION AND TO CONGRATULATE YOU AND YOUR PEOPLE ON THEIR ACHIEVEMENT PD

ARNOLD WASH DC.

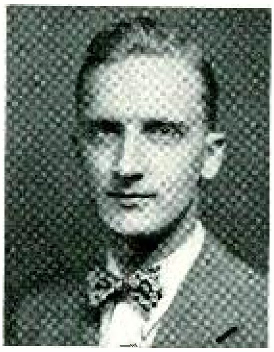
decreases as the plane approaches the target, and when it reaches the value calculated as proper for release, the bomb is released automatically.

With this apparatus so arranged, the bombing technique is essentially the same as when using the Norden bombsight. The bombardier uses the same knob to establish his collision course as with the Norden bombsight, but instead of maintaining the target on the crosshairs of the telescope, he maintains the radar image on the vertical axis of the scope. Provided instead of the knobs controlling the vertical rotation of the telescope, which establish a rate of change of vertical angle to the target, are two similar knobs on the LAB tracking unit which are moved to set the target image on the range line and to synchronize the rate of change of slant range with the speed of approach to the target. This is used instead of rate of change of angle to determine the proper time of release. Operation of the two systems is thus essentially the same.

The major units are the synchronizer, shown second from the left, which contains the vacuum-tube circuits; the control unit next to the right of it, on which the altitude is set up and certain other adjustments made; the tracking unit at the extreme right on the lower line, which carries the knobs for adjusting the rate of change of range; and the indicator above and to the left of the tracking unit. Besides these, there are three other small units and a rectifier that is shown at the extreme left of the illustration.

AN/APQ-5 found widest application in low-altitude attacks on Japanese shipping from Guadalcanal to Okinawa. Another Army Air Corps group operated from bases in China to harass coastal and river shipping. It was used also by the Navy and Marine Corps and to some extent by the British. The Marine Corps applied the device to the aiming of airborne rockets. Many other radar bombsights have been developed during the war, but "APQ-5" will always remain a "Historic First." The value of the equipment toward winning the war is expressed in the above telegram from General H. H. Arnold. The electronic equipment referred to can now be identified as the AN/APQ-5.

THE AUTHOR: J. W. Rieke received the M.S. degree in Electrical Engineering from Purdue University in 1940 and at once joined the Technical Staff of these Laboratories. With the Transmission Development Department he first worked on the development of television transmission circuits. During the war period, however, he devoted all his time to radar developments. Among the many war projects he worked on was the low-altitude bombsight described in this issue of the Record. Since the war, he has returned to television circuit design.



H. A. SAUER
Chemical
Laboratories

HIGH-SPEED LIFE TEST FOR CAPACITOR PAPER

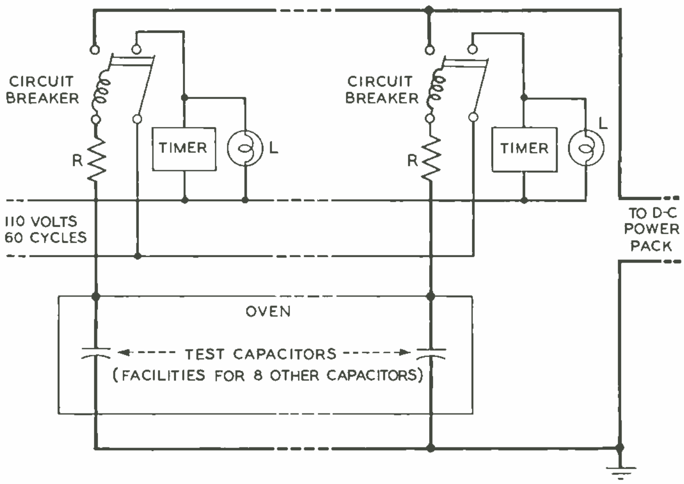
Accelerated life tests on capacitors with paper insulation show wide variations in performance, depending on the paper used. Differences are observed not only in those made by different manufacturers but also between papers produced by the same concern in different mills as well as by those made at the same location under different conditions. To evaluate a paper by these life tests usually requires from ten to twenty days* and no other practical means has been available because chemical and physical tests usually do not correlate well with actual performance. The desire for a life test which could be used to determine the quality of paper and which could be made in a fraction of the time now required led to the development of the apparatus described here. The test is based on experimental evidence that the process of deterioration under selected temperature and voltage conditions is principally of a chemical nature† and also on the well-known fact that rates of chemical reaction approximately double for each 10-degree C rise.

Based on these principles, high-speed life testing apparatus was designed and constructed for determining, in a few days, relative ratings of capacitor materials. The component parts of the equipment are assembled in a cabinet and consist principally of a 2,000-volt rectifier, an oven and a control circuit. The unit is equipped with safety devices that protect the operator by cutting off the high voltage when the cabinet, which houses the apparatus, is opened.

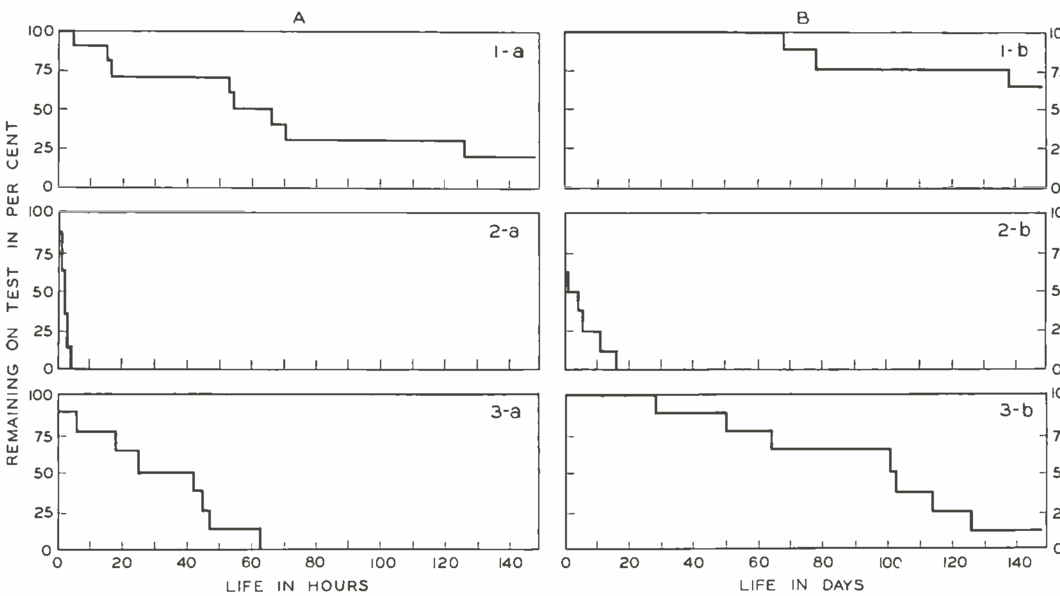
The tests are made on capacitors wound with two layers of the paper under consideration. These units are held by constant spring pressure between metal plates during the entire preparation and testing procedure. They are first dried and then impregnated with a chlorinated organic compound containing a stabilizer. The life of capacitors has been found more critically dependent on the quality of the paper when this impregnant is used. After impregnation, the samples are mounted in a

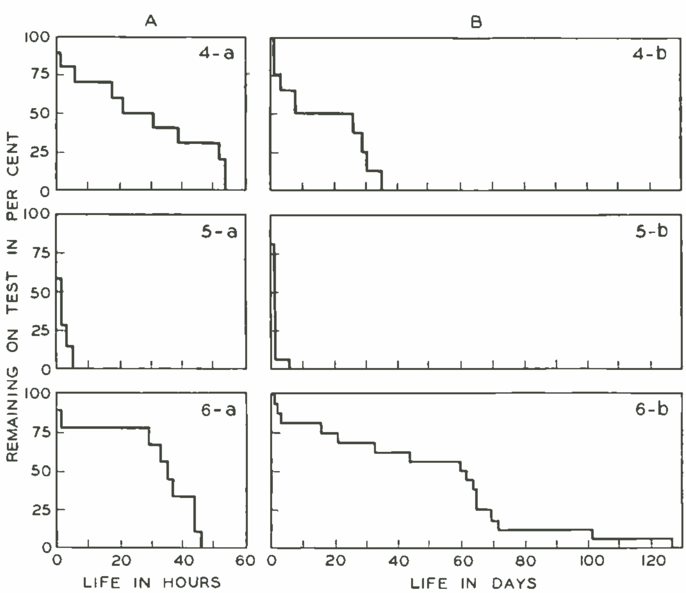
Life tests are carried out by applying high voltages across the terminals of samples and determining the time required for breakdown

*Record, *August*, 1946, *page* 296.
†Record, *March*, 1945, *page* 65.



Simplified control circuit of the high-speed test for paper insulation. The capacitor units are placed in an electrically heated oven. When the paper breaks down, the circuit breaker opens and stops the timer. R is a resistance in series with each capacitor to protect the circuit breaker and to minimize interaction between adjacent parallel circuits. L is a lamp which goes out when the circuit breaker operates





Comparison of different papers when tested in the form of two-layer capacitors. The life in hours to breakdown, A, under the high-speed test at 130 degrees C. is compared with the life in days, B, under the test at 85 degrees C.

Ten test capacitors are mounted in a container which is filled with liquefied impregnant and sealed to prevent the escape of vapors when the container is heated

container which is then filled with the liquefied impregnant. The container is sealed with a cover to prevent the escape of vapors and placed in the oven. After the contents have reached temperature equilibrium, voltage is applied to start the test. Ten capacitors are tested at a time. Each one is in circuit with a double-pole breaker which applies the voltage to the specimen and also controls the timing. The recording of the time of test is by a counter driven by a synchronous motor and is read directly to one-tenth of an hour. Failure results in a sharp rise in the leakage current through the capacitor circuit which actuates the breaker at a value of about 0.025 ampere, thus simultaneously removing the voltage from the failed specimen and opening the timing circuit. A lamp operated by each breaker is lighted while the capacitor is on test.

Most of the tests have been made at 130 degrees C., which speeds up deterioration on the average about thirty-fold over the 85 degrees C. rate. The equipment is designed to operate from room temperature to 150 degrees C. and from 300 to 1,500 volts d-c. If it is desired to operate at voltages lower than 300, the resistors in series with the samples are replaced by others of lower value.

In general, life tests carried out by the high-speed technique on two-layer capacitors correlate well with the milder, 85 degrees C., accelerated test. Some typical life charts comparing the two tests are on the opposite page. Repeat runs with the same paper and under identical test conditions produce duplicable results.

Avoidance of the tendency toward local internal heating at high test temperatures requires that the capacitor units be kept relatively small. Accordingly, they are wound to controlled dimensions. Inspection of over one thousand two-layer units, which had been tested, indicates that overheating is virtually absent and that in all probability the normal phenomenon of deterioration prevails.

Investigation of this high-speed test still continues, but it has already proven to be a valuable laboratory tool. The use of the high-speed test for routine inspection of capacitor paper is contemplated and promises to be useful to both manufacturer and consumer of capacitor materials.

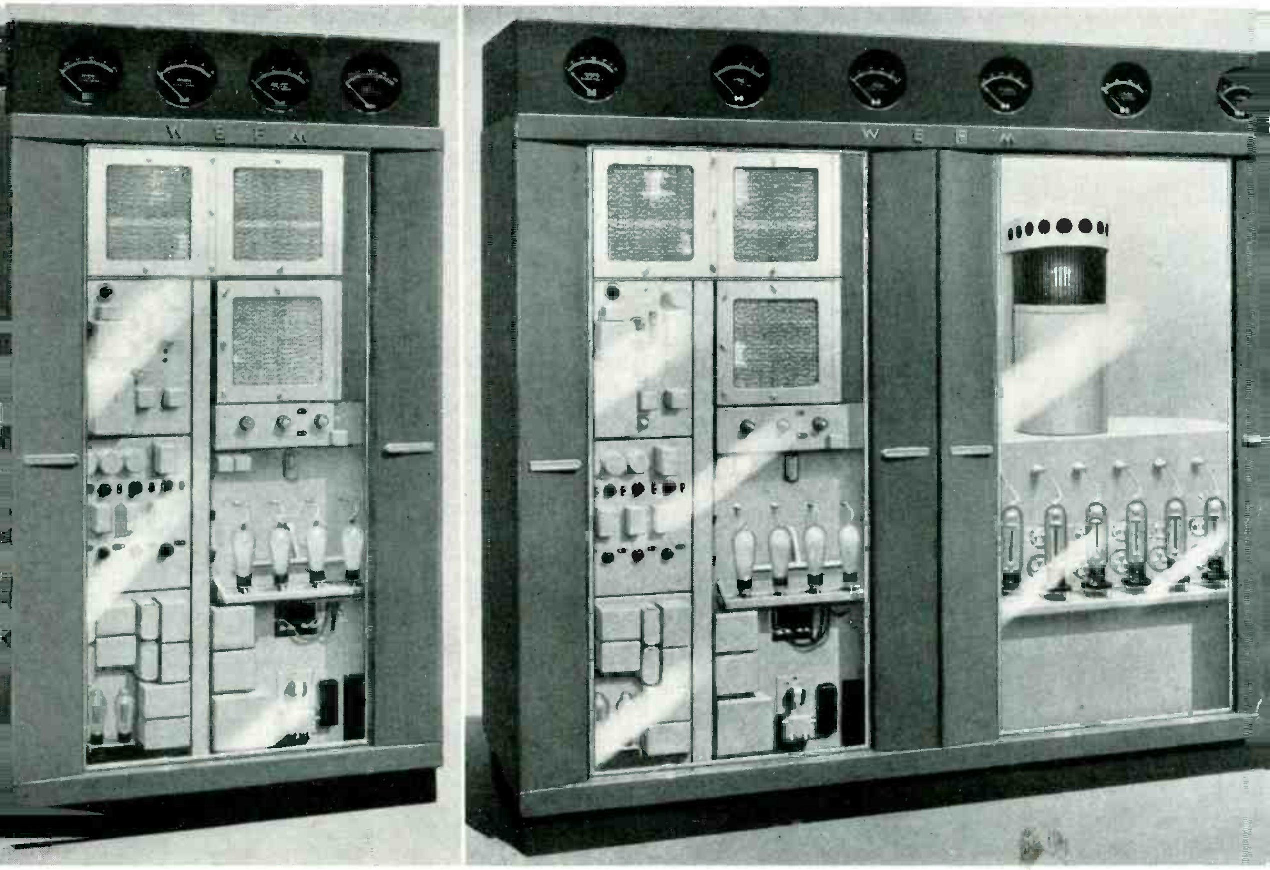
THE AUTHOR: H. A. Sauer joined the Laboratories in 1929. In 1930 he received the B.S. degree in Chemical Engineering from Cooper Union and the M.S. degree in Physics in 1939 from New York University. From 1929 to 1939 he was engaged in the study of organic finishes, particularly of the electrical insulating type. In 1939 he transferred to the dielectrics field where he has since been principally associated with the investigation of dielectric materials for condensers and the development of test equipment and techniques.

NEW FM BROADCAST TRANSMITTERS

The demand for frequency modulation broadcasting equipment is rising rapidly. Offering, as it does, improved quality, reduced background noise and interference, and the possibility of a greatly increased number of stations, FM promises to rival in importance to the American public the long-established amplitude modulation method of broadcasting. The Laboratories has developed a new line of FM broadcast transmitters for this service.

The first Western Electric FM broadcast transmitter, a one-kilowatt equipment coded the 503A-1, was brought out in 1940. Some fifteen of these, one with a 10-kilowatt amplifier added, have been in operation since that time. Recently a new frequency band, 88 to 108 megacycles, was

The 503B-2, at left, a complete 1-kw FM transmitter. The 504B-2, at right, a 3-kw FM transmitter which consists of a 1-kw transmitter plus the additional amplifier shown to its right



assigned for FM broadcasting. With the ending of the war, Laboratories engineers immediately applied themselves to the conversion of the pre-war transmitters in the field to operate in the new frequency band, and then to the development of a new line of transmitters incorporating electrical and mechanical improvements stemming from experience in the intervening years in the design of war equipment, and embodying the most up-to-date ideas in operating convenience and appearance.

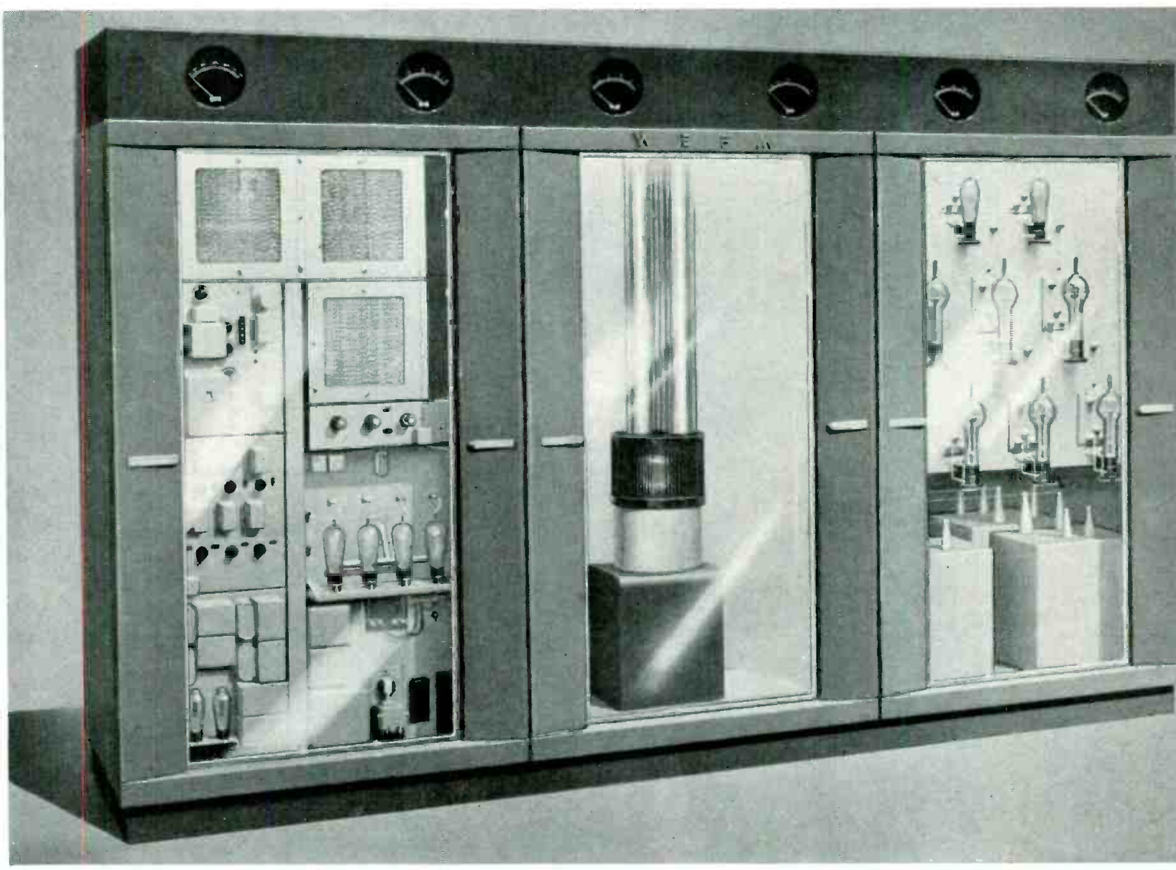
In the new line, the one-kilowatt unit, coded 503B-2 can be installed as a transmitter or can be used as the driver unit for higher-powered stations. Requiring only minor modification when incorporated in larger equipments, it is ideally suited for stations which look forward to authorization of increased output subsequent to the original installation. Views of the 1-kw, 3-kw and 10-kw transmitters are shown herewith. The glass-front doors on the units, affording view of all tubes, are a feature of the new styling employed.

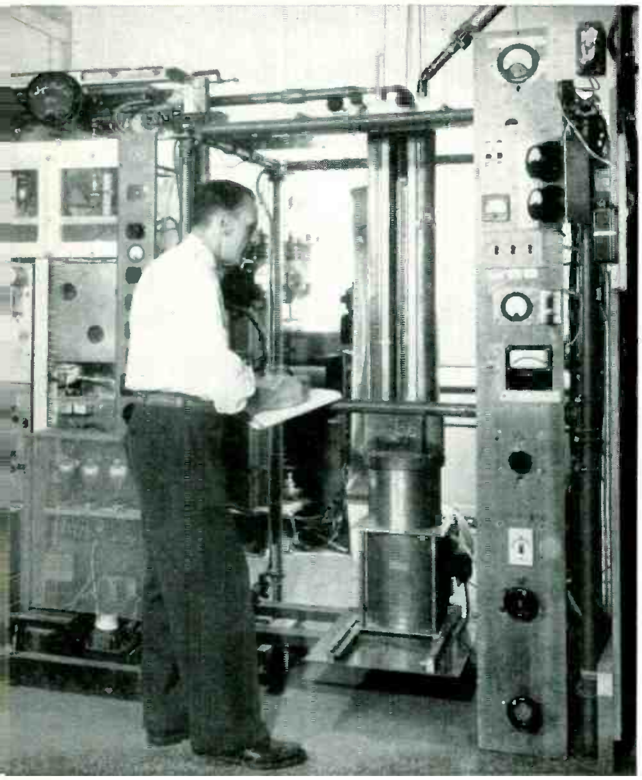
In its electrical circuits and mode of operation, the basic 1-kw unit retains the features which proved so successful in its predecessor before the war, particularly the method of stabilizing the mean frequency of the FM signal shown in the diagram on page 23.

In frequency modulation, the varying voltage of the program signal is converted into corresponding variations* in the transmitted frequency. This conversion is effected through electron tubes known as "reactance tubes," so called because they behave like reactances. The modulator con-

*Record, *February*, 1940, *page* 177.

The 506B-2, a 10-kw FM transmitter. Consists of the 1-kw unit plus an amplifier (center) and associated rectifier (right). Amplifier is of grounded plate type, coaxial-tuned and air-cooled





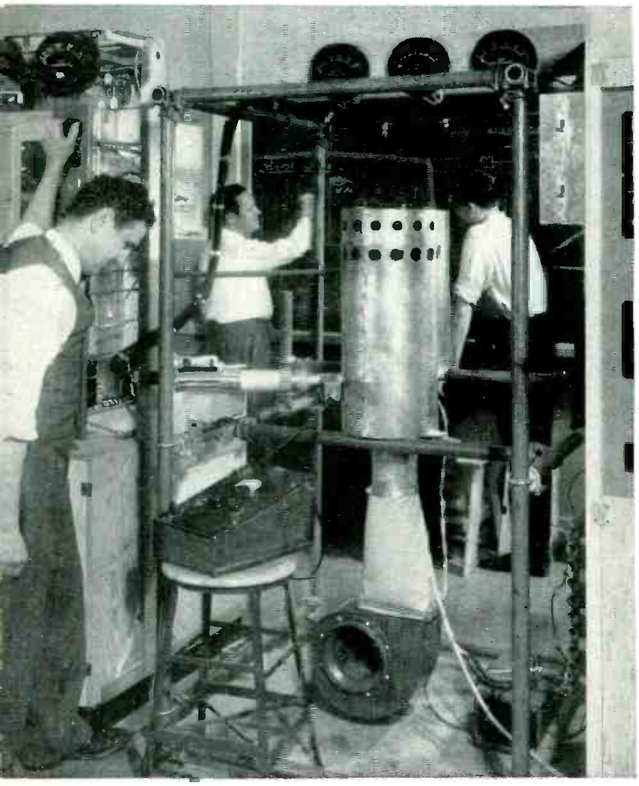
R. E. Coram recording data in experimental run on laboratory model of the new 10-kw FM broadcast transmitter amplifier. The dummy antenna is shown at top right

taining such a tube is connected to the radio-frequency oscillator circuit, and the tube reactance controls the frequency of oscillation. The reactance value exhibited by the tube depends on the voltage applied to its grid; hence by applying the audio-voltage of the program to the grid of the tube, the tuning reactance, and therefore the frequency of the oscillator, is caused to vary in unison with the changing voltage of the program signal.

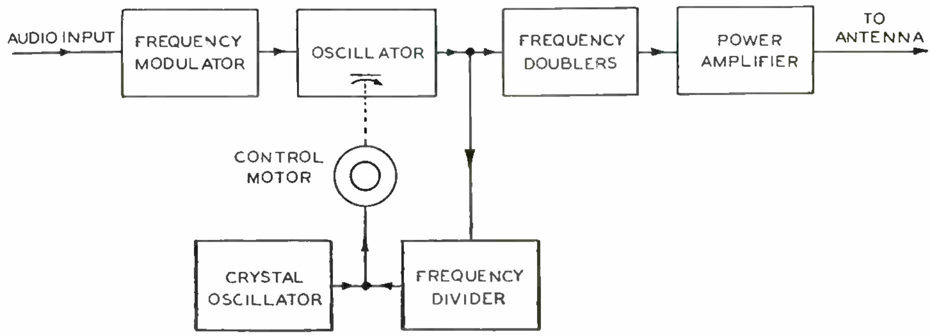
The carrier frequency at which modulation is effected is chosen to be one-sixteenth of the final frequency of transmission, or about 6 megacycles. Several frequency doublers are therefore used ahead of the final power amplifier to build the frequency up to the desired transmitting range. A major problem in FM is that of maintaining the mean frequency at the stable value needed to minimize distortion and prevent interference with adjacent channels. This is done through a method of frequency synchronization,* wherein part of the frequency-modulated output from the oscillator is passed through a series of frequency dividers which step down the frequency by a factor of 2^{10}, or 1024, to about 6 kilocycles. This sub-multiple sample is then practically free of frequency modulation and can be compared with the output of a 6-kc quartz crystal oscillator. When the two values differ, an armature is caused to rotate, turning a tuning capacitor in the oscillator so as to bring it back into exact synchronization.

Thus the frequency synchronizer and the frequency modulator are entirely separate and a failure in the frequency synchronization system cannot in any way affect the quality or continuity of transmission. Also,

*Record, *September,* 1940, *page* 21.



F. C. Ong makes a test run on an experimental model of the new 3-kw FM broadcast transmitter. The exhaust fan on floor cools the power tube. At the blackboard, J. F. Morrison (left) and R. V. Lohmiller figure circuit problem



Method of stabilizing the mean frequency of the FM signal

relieved of the frequency-stabilizing function, the modulator may be designed and operated at the optimum point for linear modulation. Distortion is less than 0.5 per cent for a swing of ±75 kc.

The frequency response of the transmitter is flat within 0.25 db from 30 to 15,000 cycles. Transmitted noise is down 65 db.

These new transmitters, like the radio communications systems which American tanks carried into battle, embody the results of extensive research carried on by the Laboratories in FM. Another practical application is in mobile radio-telephone systems. However, FM is but one of the ways in which electrical energy can be modulated to carry intelligence. Fundamental research continues into every type of modulation which promises better communication by wire or radio.

J. Leighton is regulating the water supply for cooling the dummy antenna for the 10-kw broadcast transmitter

TEMPERATURE CONTROL IN COAXIAL CABLE REPEATER HUTS

J. H. GRAY
Outside
Plant
Development

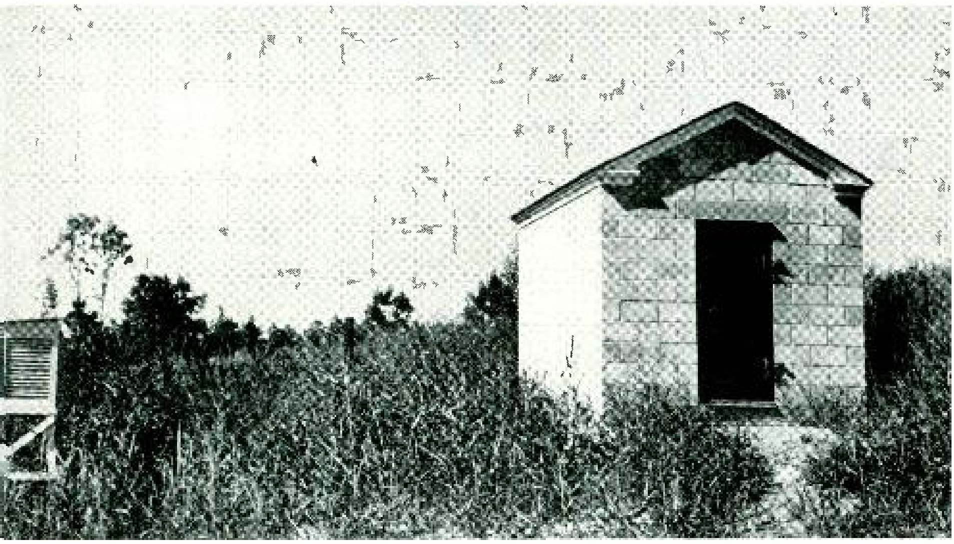
Auxiliary repeater equipment for coaxial cable systems is usually located at intervals of a few miles* along the route in unattended huts which are subjected to wide daily and seasonal temperature changes. The effects of the daily variations on the transmission characteristics of the system can be regulated automatically, provided they are held within certain limits, and the larger seasonal changes are cared for by periodic adjustments. To keep the short-range temperature conditions within the limits of automatic control, huts of special construction have been developed.

In designing these huts, the principal objectives were to limit the daily variations within to only a few degrees and the maximum temperature to a value which would not injure the equipment. No attempt was made to control the larger seasonal variations. The heat released by the equipment in operation, which is about 45 watts per repeater, and the design of the hut prevents extremely low temperatures under most operating conditions.

Factors affecting the temperature inside the huts are principally the heat passing through the walls, ceiling and floor and that released by the equipment. Insulation comes to mind as the first approach to the problem and considerable work was done in studying the effects of various amounts in an experimental hut built at Chester, New Jersey. These studies showed that the heat released by the equipment accumulated in the hut in sufficient amount to cause dangerously high temperatures, if enough insulating material were used in the walls and ceiling to maintain very small daily temperature variations.

*These huts are placed at approximately five-mile intervals for the 0.270-in. diameter coaxial and at eight miles for the 0.375-in.

Hut for unattended coaxial auxiliary repeater equipment built with massive walls of concrete blocks to decrease the daily range of the inside temperature



Prefabricated metal hut for coaxial auxiliary repeater equipment with double cellular wall panels. The outer walls are filled with insulating material and the inner ones with dry sand

Studies were then undertaken to use a principle applied for ages, in the "root cellar." Almost everyone has experienced the cooling effect, on a hot day, of entering a vault or building that has massive walls or walls partly covered by earth. In such structures the temperature lags considerably behind that of the outside air because time is required for the large mass of material of which they are built to absorb heat from or to release it to the surrounding atmosphere.

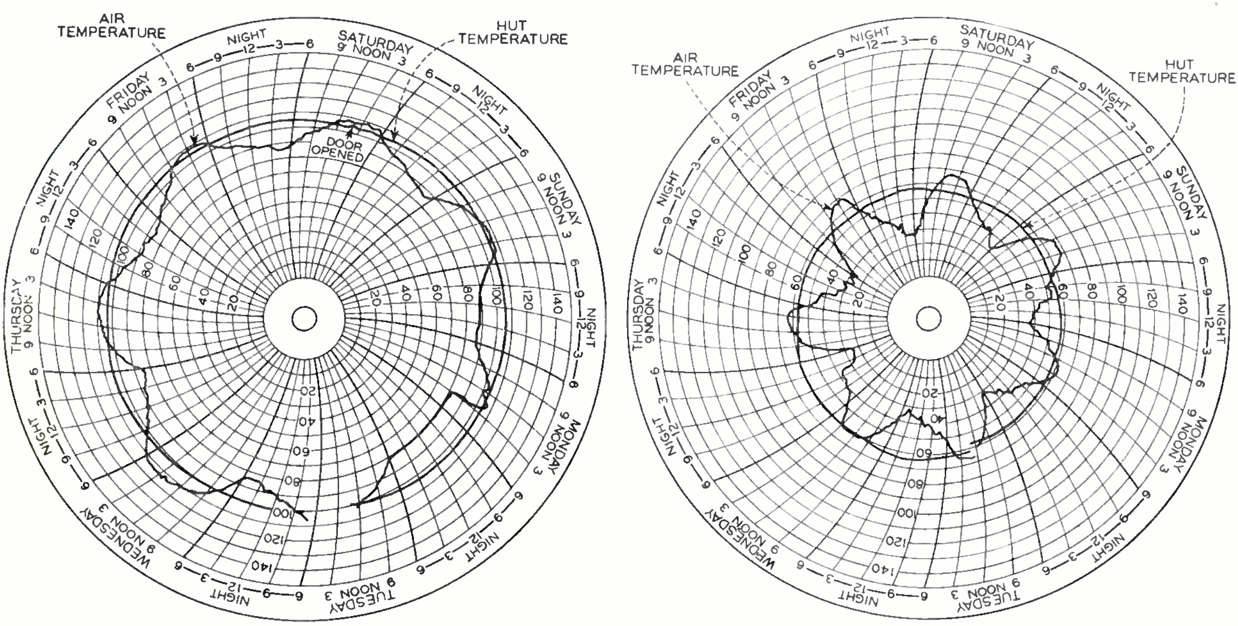
To explore this possibility, a hut with concrete block walls eight inches thick, but with only a moderate amount of insulation, was built at Chester. The mass of material in the walls of this hut acted as a reservoir which accumulated heat when the outside temperature was high and released it when that temperature was low. The results obtained were promising.

In another design the "root cellar" idea was carried still further and a hut with double concrete block walls 16 inches thick was constructed. The only insulation used in its walls was that provided by the air spaces in the blocks. Temperature measurements made inside showed very satisfactory results and after a series of tests it was concluded that this design met most of the conditions required for satisfactory operation of the type-L1 coaxial system.

After the heat-mass idea was found to be promising, arrangements were made by the Long Lines Department of the American Telephone and Telegraph Company with a manufacturer to make some sheet steel huts embodying this principle and of prefabricated construction. The general design provided wall panels, which had the outer part filled at the factory with insulating material, such as fiber glass, and inner cells arranged so that they could be filled with dry sand after erection to satisfy the requirement for mass. The roof, ceiling and floor pieces were also in sections. These huts were shipped knocked down and could be handled in the field with standard telephone construction equipment. Two thicknesses of sand walls, 1½ in. and 4½ in., were studied in sample huts erected at Chester. Temperature measurements made inside these huts indicated that the thicker-walled steel hut was almost as good as the double-walled concrete block hut. The steel hut with thinner walls was less satisfactory.

The design of the ceiling and roof of all the huts is important from the standpoint of temperature control because the roof is exposed to more intense solar radiation for a longer time during the day than are the other surfaces of the building. It was found, however, that a large amount of insulation placed in the ceiling prevented the overheating frequently seen in small closed level of the apparatus cases and the capillary tubing was carried through ducts in the floor to the recording mechanism outside. With this arrangement the charts could be examined at any time and changed without having to open the door of the huts.

To simulate the effect of the heat released by the repeater equipment under



Charts from the concrete block hut in Arizona taken in summer and winter. They show small temperature variation inside compared with that outside

buildings. The floors in both the concrete block and prefabricated steel designs are of concrete placed in direct contact with the earth.

During the development work on the various designs of huts at Chester, continuous measurements of temperature were made over an extended period with recording thermometers which gave records for a week at a time in each of the huts studied. The thermometers were equipped with remote bulbs which were connected to the recording mechanism with capillary tubing. The bulbs were placed inside the hut at the operating conditions, incandescent electric lamps were kept lighted continuously in standard apparatus cases that were installed in the huts.

The basis used in comparing the huts from the standpoint of daily temperature variation was the ratio of the average daily temperature change inside to that outside of the hut. A record of the outside temperature was obtained with a recording thermometer located in the vicinity. The bulb of this thermometer was housed in an instrument shelter of standard U. S. Weather Bureau design, shown at the left of the two photographs. The average temperature in the huts also allowed a comparison of the designs from the standpoint of the probable maximum temperatures which could be expected, since the more effective the insulation was in preventing the outflow of heat the higher the average inside temperature.

After the data had been collected at Chester and analyzed, it appeared worth while to try out the concrete and prefabricated steel huts with thick walls on some of the coaxial cable routes. Typical designs of these huts as built in the field and installed between Atlanta and Jacksonville are shown herewith. It was also thought advisable to verify the results by making measurements in huts located in the Southwest, where the effect of extremely high temperatures and that of radiation from the ground could be studied. A concrete block hut was therefore built about forty miles west of Yuma, Arizona.

For measuring the interior temperatures of huts in the field, specially constructed thermometers were used which recorded on the same chart with two pens both the hut temperature and that of the outside air. In these field installations the recorders were placed inside the hut instead of outside as at Chester. The bulb of the outside air temperature thermometer was brought out of the hut through a duct to a U. S. Weather Bureau instrument shelter nearby. Since the charts made continuous recordings for one week, it was necessary to enter the buildings only at that interval. Typical charts from Arizona show strikingly the small temperature variation inside the hut compared with that outside both in summer and winter; also, that the inside temperature in summer was always well below the outside maximum which was considerably over 100 degrees F. on consecutive days.

Several hundred huts of the types described will be constructed during the next few years in connection with the extensive program of buried coaxial cable which is under way.

THE AUTHOR: J. H. GRAY graduated from Cornell in 1917 with a C.E. degree. In 1921 he joined the D & R where he engaged in the development of materials used in the outside telephone plant; also in the design of the antenna structures for the first overseas telephone service. Since his transfer to the Laboratories in 1934, his work has been related to underground systems involving the burying of wires and cables in the ground by means of plows. Recently it has involved various outside plant features in connection with toll systems using coaxial cables.

INSULATION FOR HIGH-VOLTAGE PULSE NETWORKS

C. D. OWENS
Transmission
Apparatus
Development

During operation of a coil pulser network in radar systems, the insulation of the non-linear pulse generating coil* and other components must withstand lightning-like shocks several hundred times each second. Each voltage pulse builds up and decays rapidly, its over-all duration being only a few microseconds. In the SV radar transmitter, designed to deliver a peak power output of approximately one thousand kilowatts, a pulse potential of nearly 45,000 volts is developed in the network. To insure long operating life, several innovations were found necessary in the insulation design as compared with that employed in networks operating at lower voltages.

The behavior of dielectric materials subjected to impulse voltages differs considerably from their behavior under steady d-c or a-c voltages. Since the amount of readily applicable engineering data available was limited, a number of special tests was carried out during the development of the high voltage network for the SV radar system. These tests were not exhaustive, but served as a basis for selecting suitable materials. Most of the tests were conducted by C. T. Wyman and M. C. Wooley.

*Record, *December*, 1946, *page* 450.

Insulation failure under pulse potentials depends upon such things as steepness of wave front, recurrence frequency, pulse duration, temperature of the dielectric, and length of application, as well as on the peak voltage gradient. Dielectric materials will withstand much higher voltages of short duration than of long duration or of continuous application, since a certain amount of energy is required to produce puncture. On solid insulations, however, each such transient overvoltage, although brief, may produce some deterioration, and these small deteriorations are accumulated and lead to ultimate breakdown. At continuous high frequencies, moreover, insulations may develop excessive internal heating due to dielectric losses, which result in failure at lower voltages or after shorter periods than for low-frequency applications. Under a steady state d-c voltage, on the other hand, polarization effects or migration of conducting ions may build up a "leaky" path and produce failure sooner than for continuous a-c.

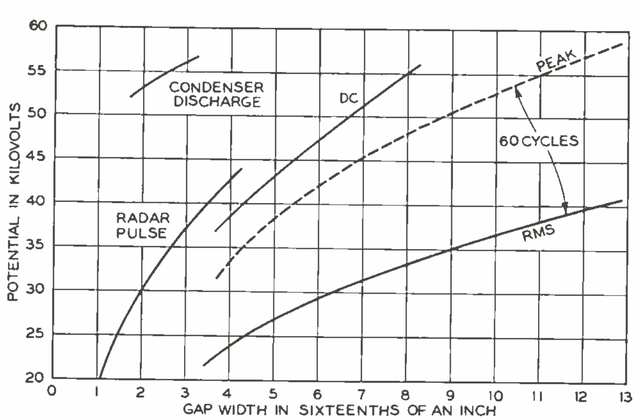


Fig. 1—Breakdown of insulating oil under a-c, d-c, and pulse-voltage conditions

The effects of the type of voltage on the instantaneous dielectric breakdown of cable oil for different gap widths between a point $\frac{1}{32}$ inch in diameter and a plate 2 inches in diameter are illustrated in Figure 1. The voltages employed were 60-cycle a-c, steady d-c, a condenser discharge through an air gap, and a voltage pulse actually generated across the coil in a radar coil pulser network. As shown in Figure 2, the potential for this latter pulse builds up approximately as the initial quarter cycle of a sine wave, and is then suddenly collapsed. This is repeated at a rate called the recurrence frequency, which is usually of the order of 1,000 cycles per second. The curves of Figure 1 show that a given gap under oil will withstand voltages of higher peak magnitude in pulses than in steady d-c or low-frequency a-c.

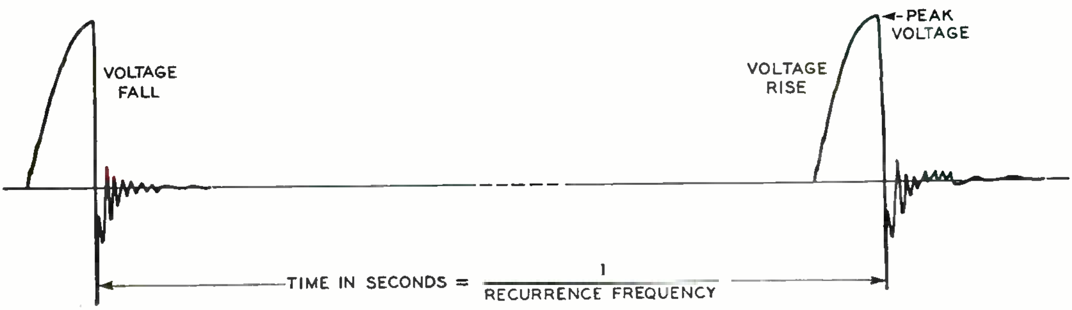


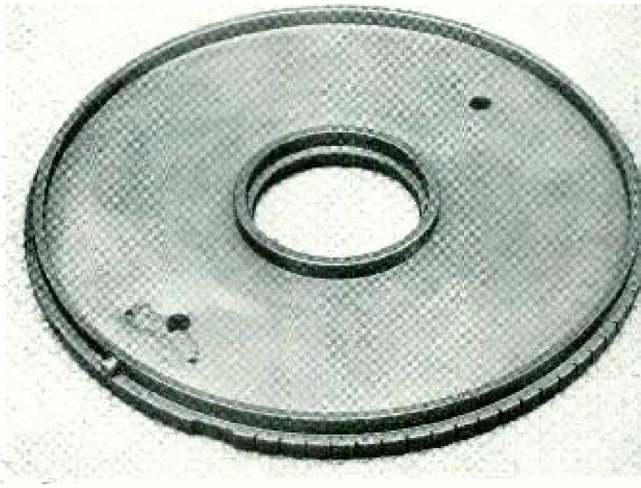
Fig. 2—Build-up and decay of voltage in non-linear coil pulser network

One of the most critical properties of a solid dielectric material for high voltage pulse networks was found to be its "arc resistance." This is a measure of ability to withstand exposure to arcs or corona discharge without deterioration, and is usually expressed as the number of seconds required to form a permanent conductive path over the surface when subjected to a standardized arcing test. Corona in air occurs whenever the voltage gradient becomes great enough to produce ionization. When the voltage gradient is increased sufficiently, spark-over takes place.

Corona is accompanied by the formation of ozone, and oxides of nitrogen that combine with moisture to form nitric acid. Such products are corrosive, and may attack the insulation over a long period of time. The most immediate and pronounced effect of corona, however, results from direct ionic bombardment which causes localized heating and, with organic materials, may produce carbonization. Once carbonization is started, it tends to travel progressively along the general lines of potential gradient until breakdown develops over the burned path. The distance traversed by this type of breakdown often is several times that considered safe against ordinary dielectric breakdown or flashover.

A typical carbonized path that develops over the surface of phenolic insulators exposed to corona is shown in Figure 3. Slotting, or corrugating, the insulators to interrupt or increase the length of the surface path is helpful. Because of the high voltage employed in the SV network, and the necessity of confining the network to restricted dimensions, it was not possible to insure complete freedom from corona or

Fig. 3—Corona failure of a phenolic insulator



sulations, thin slabs of the material were placed between point and plate electrodes and subjected to the potential for extended periods of time. The samples were then examined for signs of burning or deterioration. The results, in general, showed correlation with arc resistance properties, those materials having the lowest arc resistance also showing the most deterioration on this test. The mica types of insulation were not appreciably affected.

Some of the insulators used in the high-voltage SV network are shown in Figure 4. The four cylindrical parts in the center and lower center of the picture are of resin-bonded mica and the others are glass-bonded mica. As the latter is brittle, assemblies using it must be designed with care to insure against breakage in service. The resin-bonded mica becomes soft at high temperatures and cannot be used to support a load. The non-linear coil for this network is shown in Figure 6. The end plates are machined from glass-bonded mica, and a brass tube inside the coil struc-

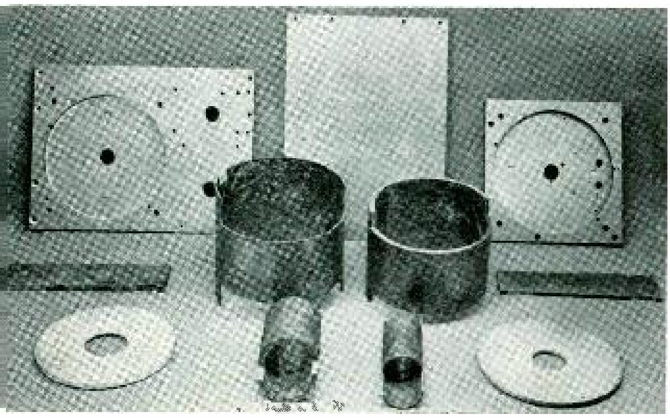


Fig. 4—Mica-type insulators for high voltage are either of resin-bonded mica flakes or glass-bonded mica

occasional sparkovers in trapped gas bubbles or around accidental points on solder or wire ends. It was desirable, therefore, to use insulation that was as inert as possible to corona. Mica and insulations containing mica powder or flakes, such as glass-bonded mica, were found best for resisting arcing. Melamine plastic has a considerably greater arc resistance than phenolic, and was found to have long life where phenolics proved unreliable.

To obtain data indicative of operating life with radar pulse voltages on solid in-

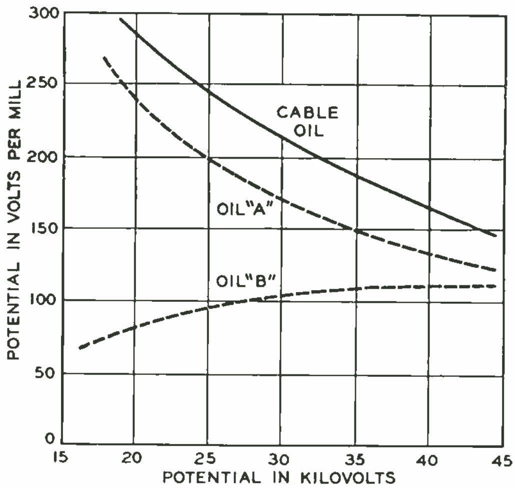


Fig. 5—Breakdown of insulating oils under pulse voltage

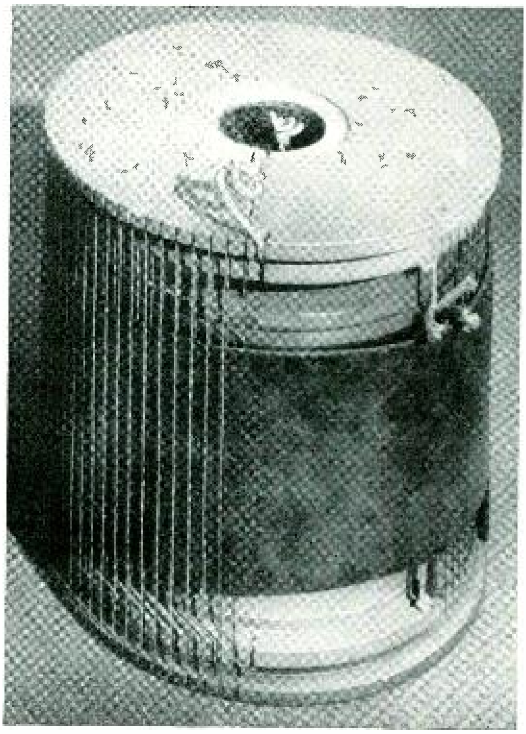


Fig. 6—Non-linear coil for the SV radar

ture supports them, thus relieving the resin-bonded mica cylinders of strain. Shock and vibrations studies and life tests on networks indicate that this design will give many thousand hours of operating life under service conditions.

To provide higher dielectric breakdown than air and to provide a cooling medium to dissipate generated heat, the network assemblies are filled with cable oil. Tests with radar pulse voltages on several oils, plotted in Figure 5, showed appreciable differences in dielectric strength at the lower voltages, but at higher voltages all the oils appear to approach a common value.

During breakdown tests on oils, it was observed that intermittent discharges would occur at a voltage somewhat below that necessary to produce continuous arcing. The time between discharges for a given gap width depended upon the voltage, ranging up to several minutes. It was found that if no breakdown occurred within one hour after application of the voltage, usually none would occur over a much longer period. The curves in Figure 5 are based upon the maximum voltages withstood for periods of one hour. Moisture content and contamination of the oil are, of course, important factors in its dielectric behavior.

Breakdown tests on oil with point-to-point and point-to-plate electrodes showed that the latter arrangement resulted in breakdown at the lower voltages as shown in Figure 7. One explanation is that breakdown in a liquid dielectric probably occurs as the result of the formation of a chain of ions between the electrodes. Circulation of the liquid tends to break up such conducting paths. The chances of forming a completed path are better between a point and plate than between two points. When two flat plates are used, the intensity at any given point is reduced so that the overall voltage necessary to produce breakdown is increased. The point-to-plate condition is one likely to be duplicated in practice between sharp points on soldered joints or conductors and the shell of the network. The importance of avoiding sharp points and corners on conductors has therefore been especially emphasized in designing and manufacturing high-voltage pulse networks.

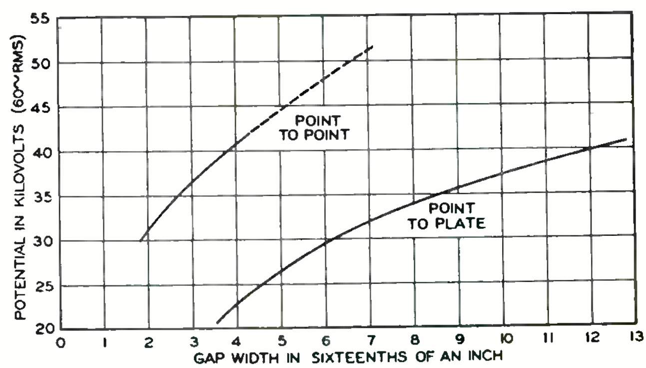
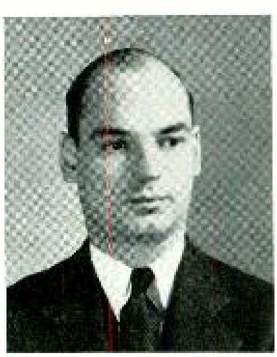
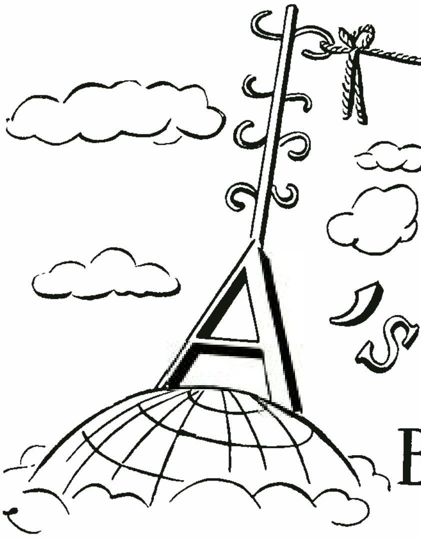


Fig. 7—Breakdown of insulators under oil



THE AUTHOR: C. D. Owens received the degree of A.B. in Physics from Indiana University in June 1928, and immediately joined the technical staff of Bell Telephone Laboratories. He took part-time graduate work at Columbia University and received an M.A. degree in Physics from this university in 1936. With the Transmission Apparatus Department he has engaged in the development of condensers, loading coils, retardation coils, and compressed magnetic powder cores. During the war he applied this experience to the design of similar apparatus for various projects—particularly radar equipment. He is now concerned with the development and application of magnetic materials.

The ABC of the COMMUNICATIONS ENGINEER



A's for Antenna, the jumping-off place
For waves to go into, or issue from, space.

B stands for Bridge, born of Wheatstone and Wien,
But Culbertson's kind is the one that's most see

C is for Coax, a short word and harsh,
Discussed by the bullfrogs at night in the marsh

D is for DB, that unit ubiquitous,
So often employed in a manner iniquitous.

E's for Electronic particles wee,
Just let them sniff volts, and they scamper with gle

F is for Feedback; by chasing its tail
The signal improves on a marvelous scale.

G is for Gain, and it's not hard to guess,
It means the securing of more out of less.

H is for Henry; his first name of Joe
Was changed into "milli" a long time ago.

I's for Impedor, a most scientific
Appellative, if just a bit dolorific.

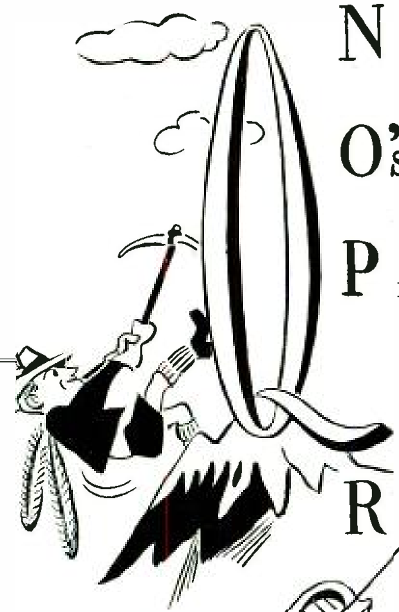
J is a symbol, in this journalese,
Denoting rotation of 90 degrees.

K is for K band, a big wartime mystery,
But now the great secret has passed into history.

L's for Lacuna, a word so abstruse
That only "hiatus" exceeds it in use.

M is for Maxwell; how firm the foundations
He laid for all time with his basic equations.

N stands for Noise; though this be absurd,
It still is called noise when it's seen and not heard.



O's for Oscilloscope, visual nexus
In many a problem that baffles and vexes.

P is for Pentode, the triode's first cousin;
No circuit's complete if it lacks a few dozen.

stands for something without any name,
But making it high is a praiseworthy aim.

R is for Relay; you couldn't count all
That operate just for one telephone call.

stands for Sine wave, or sawtooth, or square;
And other things likewise, but who gives a care.

T's for Telephony, all-hallowed art,
Bewildering maze owning no counterpart.

U is for Ultra; in scientists' lingo
It means just the same as in school kids', by jingo.

V is for Vodas, a strange sort of word;
And odder ones still are quite frequently heard.

for wave guide; what happens inside
Takes many a brash engineer for a ride.

X means unknown, but for him who knows not
The way to find X, then X marks the spot.

Y is an axis, with "j's" at the ends
Instead of two vanished and unbemoaned friends.

is for Zero, the rhyme comes to naught,
And so let us leave it with never a thought.

—E. I. Green

NEWS AND PICTURES OF THE MONTH

ARMY SIGNAL ASSOCIATION

A new link has been established between the Signal Corps of the Army, the communications services of the Ground and Air Forces, former members of these services and that part of American industry concerned with communications, electronics and photography. This link is known as the Army Signal Association; its activities are educational and scientific in character.

The purposes of the Army Signal Association as stated in its interim constitution are:

a. To maintain closer relations than ever before between civilian scientists, engineers, manufacturers and operating companies and those concerned with similar activities in military communications and photography.

b. To preserve and foster the spirit of fellowship among former, present and future communications personnel of the Armed Forces, commissioned, enlisted, and civilians.

c. To maintain as a contribution to industrial preparedness the splendid liaison and coöperation that existed between the Army, the Army Air Forces, and the communications, electronics, motion picture, and photographic industries during the war.

d. To educate the public at large and keep its members informed of requirements in the field of military communications and photography.

e. To promote mutual understanding and to effect coöperation between American scientists, inventors, engineers and manufacturers in civil life and the Regular Army, National Guard, Reserve personnel, and units and teams of the Army and Army Air Forces concerned with communications preparedness.

f. To assist in developing and maintaining an efficient personnel; commissioned, enlisted, and civilian, for the supply (including design and development), installation, maintenance, and operation of communications, electronic, motion picture, and photographic equipment in the field in an emergency.

The Association issues a monthly *Signal Bulletin* as a news letter to keep members informed of news and views and to make announcements; and a bi-monthly magazine, *Signals*, of a more technical nature.

Acting as president until the national convention in April is David Sarnoff, president of RCA. Among the directors are C. O. Bickelhaupt of A T & T, F. R. Lack of Western Electric, H. W. Hitchcock of Southern California Telephone and Dr. F. B. Jewett.

National in scope, the Association is composed of local Chapters now or to be formed throughout the nation. New York Chapter No. 1 and Fort Monmouth Chapter No. 2 were the first organized. Brigadier General Bickelhaupt is president of the New York Chapter; Lieutenant Colonel Frank H. Fay of Long Lines is secretary; and the directorate includes Col. F. E. Brooks of New York Telephone and Lee L. Glezen of the Laboratories.

At Whippany, Santa's assistants were Helen Benz at his side, Joan Thomas in his sleigh and Dorothy Clothier

Nichols Marino as Santa prepares to put finishing touches on a wheelbarrow in his Murray Hill workshop, where Grace Murphy and Lois Burford were in charge of the committee

Ida Wiberg, New York chairman of the Doll and Toy Committee, with Isabel Relay (left) and Claire Deerin (right), displays some of the prize dolls dressed for needy children

Membership in the Army Signal Association is open to all men and women interested in the communications and photographic fields who are American citizens, and to all firms, companies, associations and groups controlled by American citizens that are engaged in the communications, electronic, motion picture or photographic fields.

Membership application blanks can be secured from Lee L. Glezen, Room 946, West Street, or from the Association's headquarters, 804 17th Street, N. W., Washington 6, D. C.

Commonwealth Fellows

Under the Rhodes scholarship plan, as many people know, certain selected students from the United States, Germany and the British Dominions matriculate at Oxford for post-graduate work. Not so generally known, perhaps, are the twenty-eight Commonwealth Fund Fellowships offered annually to British graduate students and men in the various civil services for courses of study in the United States. One of the current group of Commonwealth Fellows in this country is assigned as a resident visitor for a year at Murray Hill Laboratories.

The incumbent is David H. Whiffen, 1943 graduate with B.A. degree from St. Johns College, Oxford, who is engaged in further studies on absorption of microwaves, having majored in that field and infra-red spectrometry.

The Commonwealth Fund was established by the Harkness family in 1918 to be applicable, broadly, to "the welfare of mankind." Although mainly devoted to medical education and research, the division of education also administers fellowships in other subjects.

We See by the Papers that—

Bell System companies in eleven states are seeking increases in telephone rates.

The latest to take such action was the Wisconsin Telephone Company, which filed application for an increase of 25 per cent. New Jersey Bell announced that it was planning to file for a rise in rates.

Applications for higher rates were filed with state commissions last week by Illinois Bell and by New England Telephone and Telegraph. The latter filed in Maine, New Hampshire and Vermont.

Applications previously had been filed by Southern Bell in Georgia, Kentucky, North Carolina and South Carolina. Mountain States and Pacific Companies have filed in Idaho.

The rate increases currently sought are based solely on today's operating costs. Additional rate increases will have to be sought in the event system-wide wage increases should be put into effect.—*The Wall Street Journal, December* 13, 1946.

Ship-to-Shore Service on the "America"

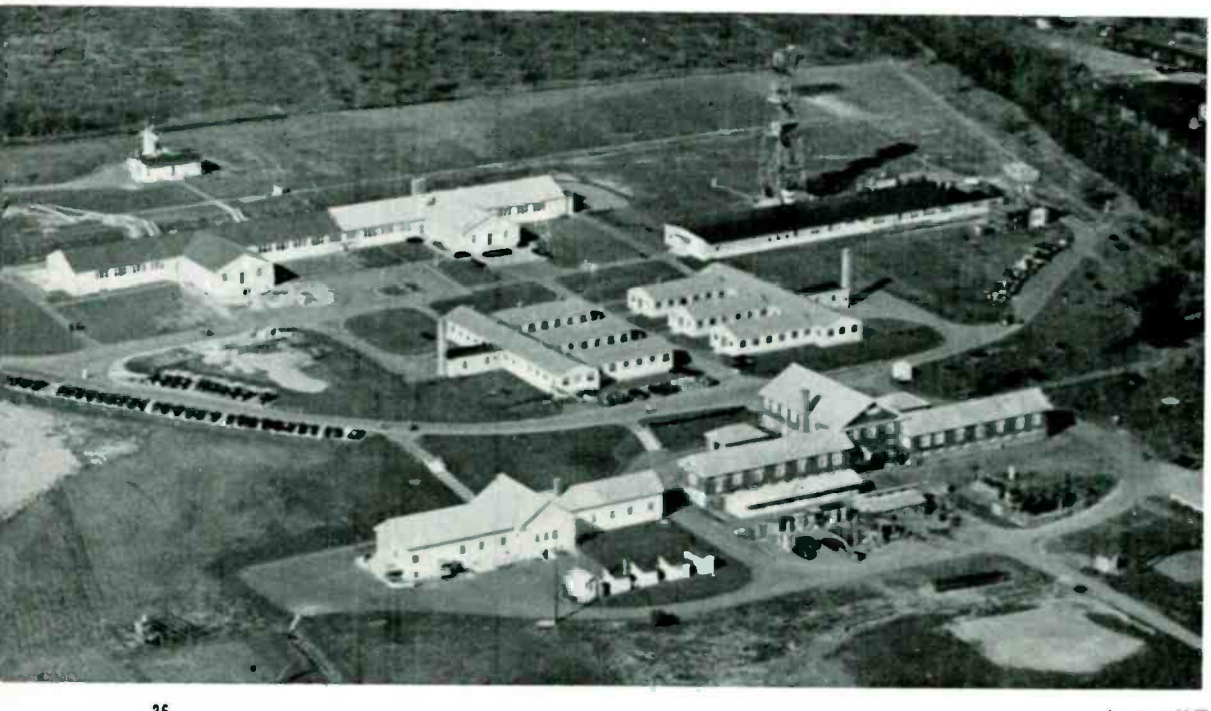
Ship-to-shore telephone service again became available to passengers of the S.S. *America* when she sailed from New York November 14 on her first post-war commercial transatlantic run between New York and Europe. This was the first time service had been available to the public since the ship was taken over for Government use early in World War II.

Rates vary with the location of the ship. From New York, 3-minute calls start at $4.50.

Whippany, 1926-1946

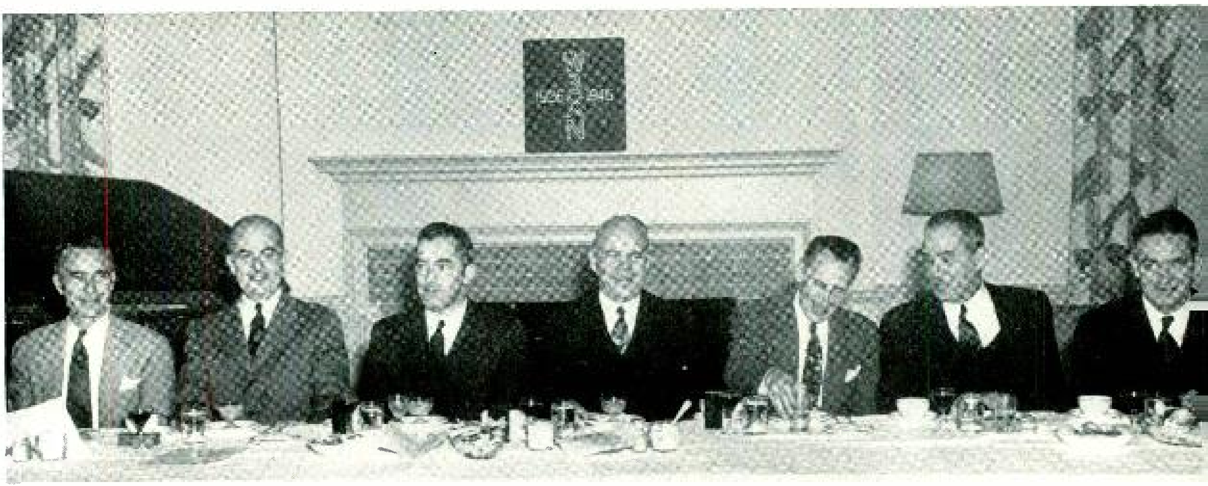
Last year was the 20th Anniversary of the establishment of the Whippany Radio Laboratory. The original property of 44 acres was made up of two tracts; the larger one of 37 acres, including the buildings, was purchased from Hannah H. and Richard Herbert McEwan on July 10, 1926, an adjoining tract of 7 acres having been purchased the day previously from Anthony Snyder. On June 10, 1931, two adjoining tracts of 77 acres were added to the property. Those most directly interested in the selection and purchase of the original property were E. P. Clifford, E. B. Craft, J. W. Farrell, O. M. Glunt, A. W. Kishpaugh, J. J. Lyng, J. E. Moravec, E. L. Nelson and N. H. Slaughter. The buildings on the original tract of 37 acres, shown above, were constructed during World War I.

The purchase of this property in the beginning was motivated by the need for a reasonably well isolated place where radio-telephone broadcasting transmitters could be developed with adequate space for the development of their associated antennas without electrical interference to or from others. The site has proven to be especially well adaptable to this and to all of the work which has subsequently been carried on out there. The photograph below shows the same 37-acre plot as it is today, 20 years later.



R. R. Williams Receives Perkin Medal for Research in Thiamin

R. R. Williams, who retired from the Laboratories last March, has been awarded the 1946 Perkin Medal of the American section of the Society of Chemical Industry. The medal will be presented on January 10 at a joint meeting of the Society of Chemical Industry, the American Chemical Society, the American Institute of Chemical Engineers and the Electrochemical Society. Since his retirement from the Laboratories, Dr. Williams has become Director of Research of the Research Corporation of New York.



Members of Whippany Laboratories who had spent ten years of service there before 1936 *gathered at a dinner to celebrate the event. Shown at the head table, left to right, are W. C. Tinus, R. E. Poole, W. H. Doherty, E. L. Nelson, R. E. Coram, M. H. Cook, and J. W. Smith*

News Notes

WILLIAM FONDILLER has been elected an honorary member of the Engineering Alumni of City College, New York.

HARVEY FLETCHER, F. M. WIENER, G. W. WILLARD, M. B. GARDNER, J. P. MAXFIELD and W. J. ALBERSHEIM presented papers before the Acoustical Society of America meeting on November 14-16 in Chicago. Dr. Fletcher spoke on *A Modern Version of the Old Theory of Telephone Quality;* Mr. Wiener *On the Diffraction of a Progressive Sound Wave by the Human Head;* Mr. Willard on *Temperature Coefficient of Ultra Sonic Velocity in Solutions;* Mr. Gardner on *Short Duration Auditory Fatigue as a Method of Classifying Hearing Impairment;* and Messrs. Maxfield and Albersheim on *An Acoustic Constant of Enclosed Spaces Correlatable With Their Apparent Liveness.* Others who attended were L. J. SIVIAN, E. C. WENTE, L. VIETH, H. K. DUNN, P. B. ONCLEY, R. H. GALT, W. P. MASON, D. M. CHAPIN, C. M. HARRIS, R. BIDDULPH and J. E. KARLIN. Mr. Karlin also visited the University of Chicago, where he discussed problems in psycho-physics.

W. SHOCKLEY is giving a series of ten weekly lectures on solid state physics to Princeton University graduate students.

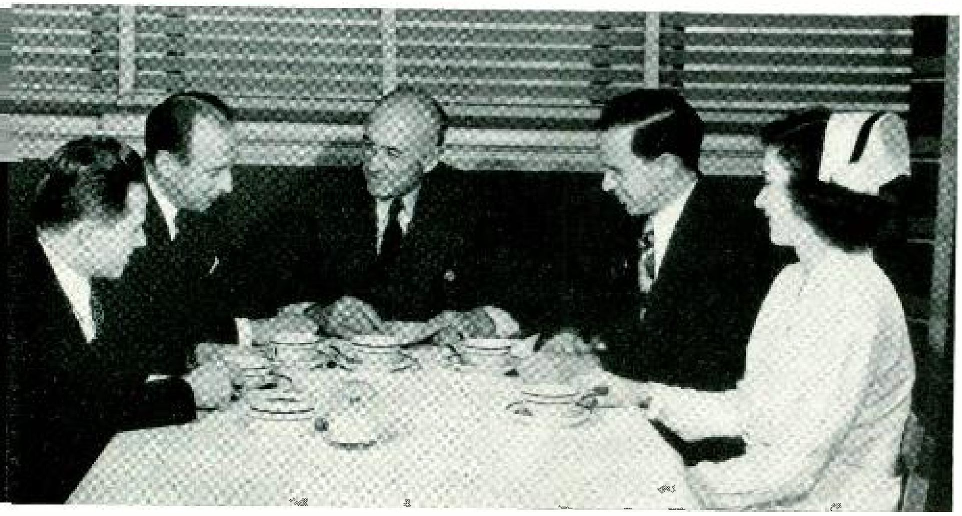
J. A. BURTON, L. A. WOOTEN and J. D. STRUTHERS visited the Lancaster plant of RCA to discuss luminescent materials.

G. L. PEARSON attended the American Physical Society meetings in Minneapolis on November 29 and 30, where he presented a paper which was entitled *Measurements of Hall Effect and Resistivity of Germanium and Silicon From* 10- *to* 600-*degrees K.*

D. H. WHIFFEN, G. G. DANIELSON, W. A. YAGER, W. H. HEWITT, C. H. TOWNES, E. J. MURPHY and S. O. MORGAN attended the meetings of the Conference on Electrical Insulation on November 7 and 8 at Baltimore. Mr. Yager presented a paper on *Dielectric Measurements at Microwave Frequencies;* Mr. Murphy, *Electrical Breakdown of Solid Insulation;* and Mr. Morgan, *Developments in Microwave Cables.*

C. A. WEBBER conferred with engineers at Point Breeze on cord manufacturing problems.

W. J. KING called on H. H. Buggie and Company, Toledo, regarding cables and connectors.



The PBX switchboard at West Street →

O. M. Glunt (center), Director of Whippany Staff, with R. R. Cordell, F. Cowan, R. H. Kendall and Miss A. G. Connell

O. M. Glunt Director of Whippany Staff

To centralize staff services at Whippany under a single head, O. M. Glunt has been given charge of all these functions as Director of Whippany Staff. On his staff are R. H. Kendall, Plant Operation Manager, and F. Cowan, Service Operation Manager. As head of the General Staff Department for the Whippany Laboratory, Mr. Glunt will have also the local supervision of R. R. Cordell, Cashier; N. A. Hall, Buyer; and Miss A. G. Connell, Nurse, although they will continue to report to their present general departments, which are headquartered elsewhere, for direction as to personnel, facilities and technical procedures.

The employees in the new department include the former staff group of Department 2700 and all of the service groups which have been reporting in the General Staff Department but assigned to Whippany, except the Development Shop. The administration under this new department will thus be simplified as compared with the previous arrangement. This coördination of services will give opportunity for the trial of new organization practices which may have application elsewhere.

Telephone Service

Our West Street switchboard has 51 trunks in a hunting series answering CHelsea 3-1000. These must carry the load of inward-bound calls. We have in addition 36 trunks, many in other series, which are used in preference by operators for outward calls. In addition, there are 77 tie lines to A T & T, Western Electric, and other Bell System boards, and 62 tie lines to the Laboratories' locations at the Davis Building and in New Jersey.

Last October, a "normal" month, the 2,218 extension telephones at West Street originated 23,000 calls a day. Incoming calls over trunks and tie lines were 6,300. Wartime peak of originating calls was 37,000 calls early in 1945. In the "busy" hour there are 38 operators and supervisors on duty.

Connected to West Street by 32 tie lines is the board at Murray Hill with 627 stations. At Whippany there are 238 extension telephones, with 15 tie lines to West Street and two tie lines to Murray Hill.

The Telephone Company's service observations on incoming calls at West Street pictured good service by our operators; only fair service by ourselves. We can improve by more prompt answering, which at present in ten per cent of the observations made took us over 30 seconds, the "passing grade," and by having somebody answer our calls when we are not present.

News Notes

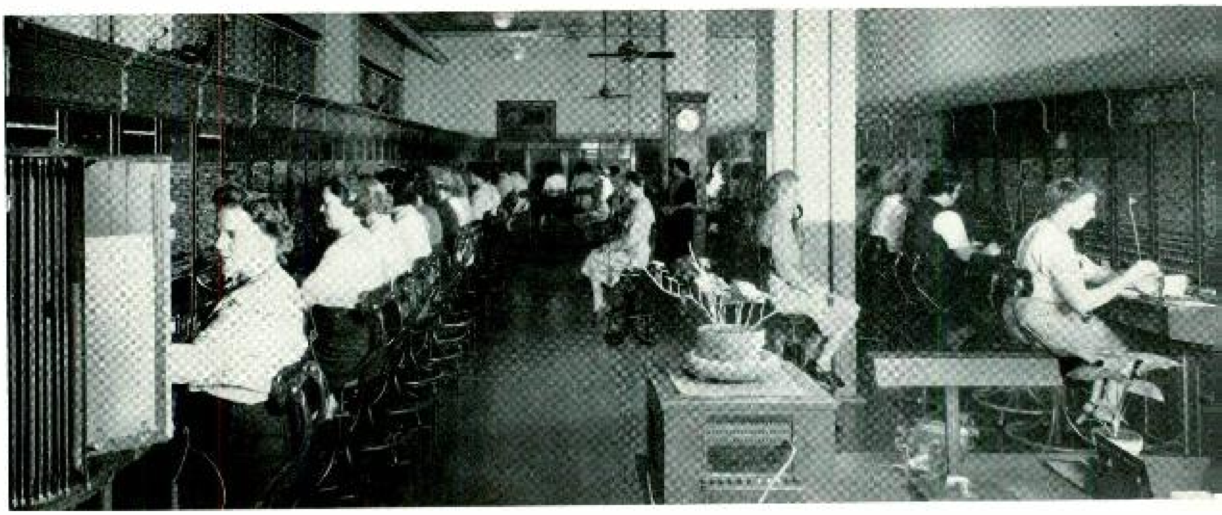
P. W. Bridgman, recent Nobel medalist and Hollis Professor of Mathematics and Natural Philosophy at Harvard, spoke to members of Physical Research and the Chemical Laboratories on *Recent Work on Plastic Flow and Fracture Under High Hydrostatic Pressure.*

C. H. Townes spoke on *Absorption of Microwaves by Gases* before the M.I.T. Colloquium.

A. N. Holden spoke to the New Jersey Mineralogical Society in Plainfield on *Growing Crystals From Solution.*

W. P. Mason and G. W. Willard, at the Western Electric plant in Allentown, Pa., gave talks on piezo-electric crystals.

D. H. Whiffen, at Harvard University and M.I.T., discussed microwave measurements.



C. H. Townes addressed the New England Section of the Physical Society on *Molecular Line Spectra in the Microwave Region.*

K. K. Darrow visited the University of Chicago while en route to the American Physical Society meeting in Minneapolis.

R. M. Burns, J. R. Townsend, D. A. McLean, R. G. McCurdy, W. J. Leveridge, F. J. Given and J. R. Weeks, at Hawthorne, discussed vapor deposited capacitors, plastic coatings on wire, enameled wire, material substitutions and the production of metallized paper condensers for new station sets.

G. K. Teal presented a paper on *Photoelectric Emission From Liquid Ammonia Solutions of the Alkali Metals* before the American Physical Society meeting at the University of Minnesota.

U. B. Thomas, Jr., and G. S. Phipps made several trips to the storage battery division of the Philco Corporation, Trenton, regarding the manufacture of storage batteries.

D. A. McLean, G. T. Kohman, H. A. Sauer and W. McMahon attended the Baltimore meeting of the National Research Committee on Electrical Insulation.

H. G. Wehe and W. J. Leveridge conferred with engineers of the Distillation Products Company in Rochester on the construction of vacuum apparatus for metallizing paper.

H. W. Hermance is engaged in a survey of central office switching problems in Chicago, Denver, Reno, Seattle and San Francisco.

H. T. Budenbom visited the National Research Laboratories in Washington on November 20.

W. H. C. Higgins and R. R. Hough conferred with the Office of Chief of Ordnance in Washington during November. Mr. Higgins, H. G. Och, E. R. Morton, R. H. Ross and R. F. Armeit visited the Knollsman Instrument Company, Elmhurst, N. Y., on current engineering problems.

W. H. Doherty addressed the directors of Associated Companies on *Radar* at the Arnold Auditorium, Murray Hill.

R. E. Poole and A. K. Bohren were at Burlington recently; Mr. Poole also went to Winston-Salem in connection with the production of commercial products equipment.

J. F. Morrison participated in a symposium on *FM Antennas* sponsored by the Washington Section of the Institute of Radio Engineers.

R. O. Wise attended a conference at Wright Field, where the procurement of radar units was discussed.

J. W. Smith and F. E. Nimmcke attended a conference that was devoted to radar equipment at Winston-Salem.

H. A. Baxter talked about solenoids for waveguide switches at the National Acme Company in Cleveland.

V. I. Cruser visited Harris-Seybold Company, Cleveland, on radar equipment.

E. F. Krommer consulted the DeLuxe Metal Furniture Company, Warren, Pa., regarding model cabinets for radar equipment.

F. Mohr appeared before the Board of Appeals and H. S. Wertz before the Primary Examiner at the Patent Office in Washington.

The Laboratories were represented in interference proceedings at the Patent Office during November by G. T. Morris.

Retirements

Recent retirements from the Laboratories include C. G. Spencer, with 47 years of service; H. W. Ulrich, 44 years; F. H. Berger, 41 years; Claude Deyo, 40 years; C. E. Boman, 39 years; J. T. Butterfield, 36 years; A. G. Jeffery, 30 years; and Joseph Kelly, 27 years.

Joseph T. Butterfield

Mr. Butterfield received the B.S. degree from the Worcester Polytechnic Institute in 1907 and the E.E. degree from Purdue University in 1910. Coming immediately to the Laboratories, his first work involved the development of an improved insulator for open-wire lines. This was followed by the development of the magnetic structure of the 54-type retardation coil. He then became engaged in the early research work on magnetic materials and in this connection produced the first loading coil cores made from finely divided electrolytic iron dust by the electrolytic cell process. He designed the molds for the production of annular iron dust cores.

During World War I, Mr. Butterfield was in charge of the development of switchboard lamps, vacuum thermocouples and vacuum fuses and also made important contributions to range-finding apparatus developed for the Government. He then supervised the development of electrolytic condensers and later contributed to the study made of bearings and lubrication. More recently he was concerned with the development of improved methods of maintenance for base metal contacts used in the panel system. Mr. Butterfield is responsible for the invention and development of the flexible multiple brush which is now standard on panel dial equipment and which has been successful as a means to alleviate contact noise in panel systems.

Carl E. Boman

Mr. Boman's service had its inception in the student training course of the New York Telephone Company. He had received the E.E. degree from the University of Minnesota in 1905, and had spent the first two years after graduation with the Stromberg Carlson Company. Following two years of central office maintenance work with the New York Company, he transferred to the Western Electric Company at Hawthorne, engaging in various phases of the work of the Equipment Engineering Branch. In 1919 he came to New York for dial systems development and a year later went to London and Antwerp in connection with the proposed introduction of dial equipment in London, returning to what is now the Equipment Development Department in 1921.

During the past twenty-five years Mr. Boman has been intimately associated in the development of the panel and No. 1 crossbar switching equipment. In close coöperation with the apparatus engineers he had a great deal to do with the development of the apparatus so that it would better fit into the equipment arrangement of both the panel and crossbar systems. In addition, he has been concerned with special switching system projects that have been considered from time to time. During World War II, Mr. Boman was active in the development of a number of projects for the Armed Forces, including radar equipments, special secrecy communications systems, and the general purpose relay computer.

J. T. Butterfield

C. E. Boman

Claude Deyo

F. H. Berger

Claude Deyo

Mr. Deyo entered the Western Electric Company in the New York assembly group in 1903. A year later he was in charge of the stockroom for finished apparatus and then was successively with the output and material ordering group. When, the manufacturing work moved to Hawthorne in 1913, he went to the Western Union Telegraph Company as an outside cable foreman.

Mr. Deyo returned to the Western Electric Company in 1916 and was engaged on shipping and receiving service on customers' orders and then assumed charge of case assignments and classifications in the Commercial Relations Department. He later was occupied with special duties and had a prominent part in purchasing, scheduling, shipping and billing materials for the transoceanic radio-telephone equipment at Buenos Aires. Since 1930, Mr. Deyo has been concerned with purchasing inquiries and other commercial services in the Purchasing Department.

A. G. Jeffery

C. G. Spencer

H. W. Ulrich

Joseph Kelly

Frederick H. Berger

Starting as a tool and die maker for the Western Electric Company, Mr. Berger, after a period of two years, transferred to the old Model Shop as an instrument maker. Eight years later he was made assistant foreman in charge of this work and in 1928 was placed in charge of the manufacture of short-wave radio equipment for transoceanic service in the Model Shop.

Following this work, Mr. Berger had charge of the coil and cabinet shops, sheet metal workers, and a group of mechanics on tube shop parts. During World War II he was responsible for all of the shops in the Graybar-Varick building which were operated in conjunction with the development of apparatus for the Armed Forces. For the past four months he has been at West Street handling Development Shop activities in connection with the New York-to-Boston microwave radio-relay project.

Albion G. Jeffery

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 and later to the group engineering the panel offices.

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 Equipment 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.

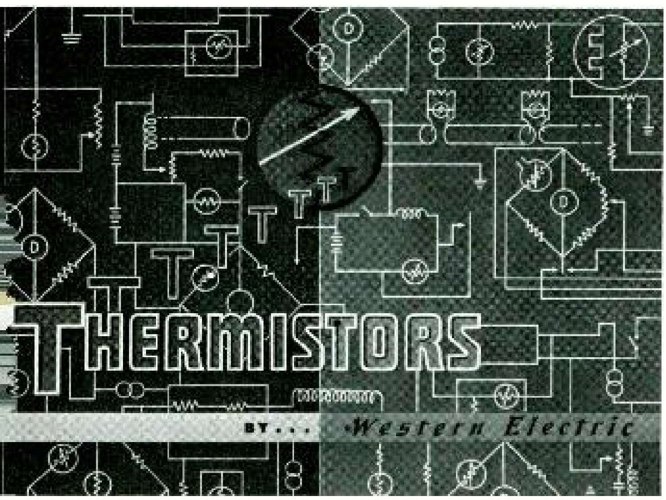
Charles G. Spencer

Mr. Spencer's long and varied telephone career began in 1899, when he joined the manufacturing organization of the Western Electric Company. Six years later he transferred to the inspection group of the Engineering Department and then, in 1911, entered upon apparatus design work at Hawthorne. Mr. Spencer came to New York shortly after the outbreak of World War I, joining the Systems Development Department. He became concerned with developments which took him to Sweden in 1921 in connection with the installation of the cable connecting Stockholm with Goteberg. Two years later he returned to West Street, where, in the Switching Development Department, he has since been engaged in developing all types of systems for manual central offices.

Horace W. Ulrich

Mr. Ulrich joined The Bell Telephone Company of Pennsylvania as a telephone inspector, and after eleven years in the operating field, during which he became special inspector on complaints, he transferred to the circuit laboratory at West Street. He has participated in many general developments, such as those of the circuits for manual central offices, PBX's, telephone repeaters, and toll lines.

Notable among the special projects which have claimed his attention was the design and construction of the equipment with which the Western Electric European engineering department demonstrated the value of telephone repeaters. As a direct result of the demonstration, repeaters were commercially introduced in Europe. He was also concerned with the early development of repeaters and their application to commercial service in this country, and with pilot-wire regulation for automatic control of transmission with four-wire repeaters. More recently, in the manual circuit design group of the Switching Development Department, he was concerned with the circuit development of the No. 12 manual switchboard.



Cover for Western Electric booklet describing the development, characteristics, and applications of thermistors

Joseph Kelly

Mr. Kelly joined the Engineering Department of the Western Electric Company in 1919 as a machinist in the Power Room. In 1923 he was transferred to the Building Shop, and in 1932 to the Development Shop, where he operated a lathe until 1937. Since that time he has been engaged on the operation of band saws.

News Notes

J. R. Townsend attended meetings of A.S.A. Standards Council in New York and American Society for Metals in Atlantic City.

J. C. Osters and L. M. Towsley attended the National Paint and Varnish Production Club convention in Atlantic City.

H. Peters visited E. I. duPont de Nemours & Company at Wilmington on neoprene latex and cements for coatings on coin chutes.

E. K. Jaycox and L. A. Wooten discussed spectrographic equipment at the National Bureau of Standards. Mr. Jaycox gave a paper, *Spectro-chemical Analysis of Ceramics Materials*, at a Conference on Applied Spectroscopy at the Mellon Institute in Pittsburgh. He has also been appointed to the executive committee of the Society of Applied Spectroscopy.

C. J. Calbick spoke on *Electron Microscopy* at a meeting of the Norwegian Engineering Society in New York.

W. O. Baker and J. H. Heiss, Jr., attended the E. C. Bingham Memorial Symposium of the Society of Rheology in New York City on November 1 at which Mr. Baker spoke on *Rheological Properties of Polymers and Plastics.*

G. N. Vacca attended meetings of the Wire and Cable Technical Advisory Committee at Civilian Production Administration and Rubber Reserve offices in Washington.

R. K. Potter selected *Visible Speech* for his subject when he spoke at the Deal-Holmdel Colloquium held on December 6 at Deal.

H. H. Lowry, R. L. Lunsford, A. J. Busch, R. C. Davis and J. G. Ferguson conferred at Hawthorne on crossbar systems developments.

G. E. Dustin and A. S. King were at Trenton on step-by-step development problems.

When Peggy Parsons, formerly of the D & R and of Systems Development, returned to New York, she was honored with a luncheon (see the facing page) by a group of associates who sent her a little remembrance each month when her health forced her to leave the city. Among those present were, back row: Betty Williams, Mildred Lammers, Betty Lemmerz, Eunice Kiefer, Alice Bell, Louise Jentschke, Jo Heermans, Virginia Niemeyer and Fay Hoffman; center row: Mary Corr, Kathleen Thompson, Nannette Meade, Peggy Parsons, guest of honor; Edith Nolan, Ruth Leonard and Estelle Potter; and, front row: Hazel Long, Margaret Wardlaw, Helen Racz and Elsie Hoffman

January Service Anniversaries of Members of the Laboratories

40 years			10 years
L. T. Cox	James Cameron	Mary Brainard	C. B. Brown
35 years	J. S. Clark	Margaret Gray	George Bukur, Jr.
A. O. Shann	Heloise Giles	E. H. Johnson	G. E. Campbell
30 years	Joseph Haverl	James Kelly	Frank Caroselli
Helen Ryan	Patrick Higgins	J. H. Kronmeyer	R. F. Heinrich
A. J. Snyder	F. S. Kammerer	Rose Rovegno	J. W. Hoell
25 years	Florence Metz	F. W. Steele	E. T. Lundgren
R. B. Bauer	D. W. Pitkin	Reinhold Weihs	J. R. May
	A. J. Zerbarini	15 years	J. W. McRae
	20 years	A. J. Kizelevich	G. E. Oram
	Walter Arelt	W. A. Waechtler	W. L. Rohr
	M. A. Basedow		C. J. Schnoor

A. D. KNOWLTON, A. A. OSWALD, N. F. SCHLAACK and R. G. KOONTZ, at Burlington and Winston-Salem, discussed manufacturing problems in connection with power-line carrier and radio equipment.

G. A. ROBERTS discussed the New York City No. 1 tandem crossbar office during a recent visit to Hawthorne.

H. A. AFFEL gave a talk entitled *Microwave Relay System* before the Communications Section of the Association of American Railroads in Detroit on December 19.

E. T. BALL studied the No. 5 crossbar framework at the Dahlstrom Metal Works at Jamestown, N. Y.

R. R. GAY visited the Superior Electric Company at Bristol, Conn., in connection with a-c line regulators for radio relay systems.

R. W. PRINCE witnessed the testing of rectifiers for radio systems at the Power Equipment Company in Detroit.

H. H. SPENCE was at Dallas, concerning a reserve power plant for type-L carrier.

C. H. ACHENBACH made studies of type-L carrier reserve power supplies at Atlanta and Jacksonville.

J. M. DUGUID visited the Hercules Motor Company at Canton, Ohio, regarding engine alternators for the New York-to-Boston radio relay.

N. F. SCHLAACK and H. L. HOLLEY conferred at Jamestown, N. Y., on cabinet designs.

P. T. HAURY and R. I. GAME of the Laboratories with B. V. Miller of Western Electric and J. G. Todd of Northern Electric Company visited the K2 carrier, main and auxiliary stations, in the Springfield and Albany areas. Mr. Game, in Indianapolis, Terre Haute, St. Louis and Dayton, supervised the trial installation of new crystal filters on K2 carrier.

O. CESAREO and E. JACOBITTI spent a month at Langley Field, Va., in connection with the installation of the X66744 computer.

H. M. PRUDEN and F. S. ENTZ inspected the receiver selection system in Philadelphia used on urban mobile radio-telephone systems.

S. KING, D. MITCHELL, L. A. DORFF and W. R. YOUNG were at St. Louis testing receiver selection arrangements of the urban mobile system.

R. A. HAISLIP, S. C. MILLER and J. J. HARLEY witnessed a field trial in the New York Telephone plant, Schenectady, of the new lightweight cable lashing machine and the block method of temporarily supporting aerial cable.

V. J. ALBANO, J. H. HARDESTY and J. H. GRAY conferred on transite conduit questions at Manville, N. J. Mr. Gray also witnessed cable plowing tests in Maryland.

C. S. GORDON and C. C. LAWSON discussed insulated wire problems at Point Breeze.

A. J. Nelson Dies

Arthur J. Nelson of Equipment Drafting died suddenly on December 4. Born in Norway in 1902, Mr. Nelson came to this country in 1928 after graduation from Hortens Technical Institute. The following year he entered the Department of Development and Research of the A T & T as a draftsman and came to the Laboratories in the 1934 consolidation as a design draftsman in the Systems Development Department. During World War II he worked on various Army and Navy projects and for the past year had been concerned with the mechanical development of special machine switching equipment.

L. L. GLEZEN was elected to the Board of Directors and appointed chairman of the Membership Committee of the Army Signal Association, New York Chapter No. 1.

O. B. COOK and B. A. MERRICK recently witnessed trials of the new lightweight lasher designed for lashing small cables during visits to several of the associated companies.

DO YOU KNOW THAT

payroll deductions can be used for

1 U. S. Government and National Service Life Insurance premiums—ask the Secretary, Employees' Benefit Committee, extension 109, West St.
2 Equitable Life Assurance premiums on your own life—ask the Insurance Counselor, extension 264 or 1426, West St.; extension 347, Murray Hill.
3 U. S. Savings Bonds—ask Payroll, extension 1434, West St.
4 Regular deposits in a savings bank—ask Payroll, extension 1461, West St.
5 Hospital and Surgical Service—ask Payroll, extension 1461, West St.

T. A. DURKIN observed the installation in Philadelphia of new designs of wire for use in block distribution.

R. P. ASHBAUGH was engaged with general cable problems at Point Breeze.

A. H. HEARN made studies at commercial wood preserving plants at Brownville, Ala., and Orrville, O., on the treatment of southern pine and Douglas fir poles.

A. J. CHRISTOPHER attended a committee meeting in Rochester for the purpose of drafting RMA capacitor standards proposals.

N. BOTSFORD, W. R. NEISSER and E. T. HOCH discussed new subset components at Hawthorne recently.

G. F. J. TYNE was at the Western Electric plant at Winston-Salem in connection with the manufacture of coils for the rural power-line carrier system.

A. C. EKVALL conferred with Western engineers at Haverhill on transformer problems.

F. W. CLAYDEN inspected the trial of No. 1 metal-tipped wipers at Scranton and Richmond step-by-step offices.

"The Telephone Hour"

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

January 13	*Josef Hofmann*
January 20	*Jascha Heifetz*
January 27	*Lauritz Melchior*
February 3	*Ezio Pinza*

E. F. Smith is chairman of the road committee and a member of the finance committee of the New Providence (New Jersey) Township Civic Association.

A. H. Inglis, A. F. Bennett, W. H. Edwards, H. I. Beardsley and J. M. Haywood visited the Archer Avenue plant of Western Electric to study apparatus codes and their problems.

E. L. Fisher visited the Western Electric Company at St. Paul regarding a quality survey on protection equipment, and their plant at Hawthorne on protection apparatus.

E. C. Erickson went to Washington to confer on gauging problems with the Bureau of Standards and to attend a meeting of the American gauge design committee.

Laboratories men transferred to North Carolina include K. O. Thorp, H. C. James, R. V. Lohmuller, A. Reckenzann, H. C. Hardaway, A. F. Jacobson, R. C. Smith, J. J. Butler, W. E. Bearl, C. B. McKenney, J. J. Martiner, W. E. Vierling, M. M. Toms, A. J. Irwin and H. A. Doll. Speaking of Mr. Doll's transfer, the *Denville Herald* in an editorial stated, "The community of Denville has sustained a considerable loss . . . those who have seen what his interest, intelligence and energy meant to his church, the organizations of which he was a member, and through them the community in general, know that his going leaves a gap which cannot quickly be filled."

E. P. Felch and F. G. Merrill were at the U. S. Naval Air Station, Quonset Point, R. I., in connection with the installation, by the Naval Ordnance Laboratory, of airborne magnetometer equipment in planes of the U. S. Navy's Operation "High Jump" which will be used in geophysical exploration for national resources in the Antarctic this winter.

C. N. Hickman spoke on *Rocket Developments of World War II* at a "Rocket Dinner" jointly sponsored by the American Rocket Society and the A.S.M.E.

During August, September and October, the United States Patent Office Issued Patents on Applications Previously Filed by the Following Members of the Laboratories:

L. G. Abraham
A. E. Anderson (3)
W. M. Bacon
C. C. Barber
H. M. Bascom
A. C. Beck (3)
F. R. Bies
R. Black, Jr.
D. G. Blattner
J. H. Bollman
A. E. Bowen
E. Bruce
H. T. Budenbom
F. G. Buhrendorf (3)
J. T. Butterfield
H. D. Cahill
H. Christensen
J. W. Clark
F. W. Clayden
H. L. Coyne
G. W. Davis
J. W. Dehn (2)
A. C. Dickieson (2)
S. Doba, Jr.
S. J. Elliott
W. B. Ellwood (2)
L. A. Elmer
K. E. Fitch (2)
N. R. French
H. T. Friis
W. W. Fritschi
M. C. Goddard
H. W. Goff
W. D. Goodale, Jr.
W. M. Goodall
H. C. Harrison
W. R. Harry (2)
R. V. L. Hartley (3)
R. A. Heising
H. E. Hill
B. D. Holbrook
W. H. T. Holden
O. M. Hovgaard
J. B. Howard
A. H. Inglis
K. S. Johnson (2)
W. M. Kellogg (2)
W. J. Kindermann
R. W. King
R. J. Kircher
J. J. Kleimack
H. M. Knapp
P. V. Koos
J. J. Kuhn
W. Y. Lang
J. B. Little (2)
G. A. Locke (4)
M. A. Logan
C. A. Lovell (2)
W. A. MacNair
R. F. Mallina (2)
M. E. Maloney
W. A. Malthaner
W. P. Mason (9)
A. L. Matte
T. A. McCann
J. W. McRae
L. A. Meacham (2)
L. E. Melhuish
O. R. Miller (2)
D. Mitchell
M. E. Mohr
J. A. Morton
A. H. Muller
W. A. Munson
O. Myers (3)
R. C. Newhouse
R. S. Ohl
C. V. Parker
R. D. Parker (3)
D. B. Parkinson (3)
G. L. Pearson
W. A. Phelps
J. R. Pierce (2)
C. E. Pollard, Jr.
T. J. Pope
W. T. Rea
V. C. Rideout
D. H. Ring
L. C. Roberts
F. F. Romanow (2)
J. E. Rose
B. F. Runyon
A. L. Samuel (3)
S. A. Schelkunoff
J. C. Schelleng
R. B. Shanck
W. G. Shepherd
F. F. Shipley
W. Shockley (2)
F. J. Singer (3)
E. M. Smith (2)
G. C. Southworth (2)
B. E. Stevens
K. D. Swartzel, Jr.
B. S. Swezey
G. K. Teal
F. M. Thomas
W. A. Tyrrell
E. F. Watson (2)
B. T. Weber
G. W. Willard
R. O. Wise
P. L. Wright






LIEUT. LINDBERG LIEUT. LOBISSER M. KRISCHIK MARJORIE URBAN R. I. FORREST R. G. EN

RECENTLY RETURNED VETERANS

LIEUT. FRANK W. LINDBERG trained for the Maritime Service at Fort Schuyler, New York, where he received his commission in 1944. Transferring to the Navy, he was assigned to a converted cruiser mine layer and spent two years in the Pacific theater of operation.

LIEUT. ALOIS H. LOBISSER engaged in cable and radio construction and in outside plant work during forty-one months of service in the Philippines and Japan. His assignments were with the 442nd and the 46th Signal Heavy Construction Battalions. Lieut. Lobisser is now in the wiring group.

MANFRED KRISCHIK'S naval service was at Quonset Point and Martha's Vineyard where he was a mechanic on all types of naval aircraft.

MARJORIE C. URBAN'S naval career was spent for the most part at Patuxent River, Maryland, where she was an Aerographer's Mate 3/c.

RICHARD I. FORREST shipped to Italy as a rifleman replacement, but during his year and a half overseas duty was engaged for the most part in communications drafting in the Signal Section of the United States Forces Headquarters in Austria.

RAYMOND G. ENGEL trained in San Diego as a hospital apprentice and was assigned to a dispensary on a naval ammunition depot in Hawaii during his overseas service.

CHARLES F. WEISS, after training at the Yeomen School, Great Lakes, was assigned as a yeoman at the Lido Beach, New York, separation center for the rest of his naval duty.

The Laboratories has employed 1,214 veterans of World War II

LOUIS W. TELFER, an electrician's mate on *LST 589*, participated in the Philippine invasion. He also served aboard the 589, carrying prisoners to Japan from Korea and China and food to the interior of China on the Yangtze River.

ELLIS GILLIAM of the Marine Corps has returned to the Laboratories at Deal as a Technical Assistant after having served for over three years with the 4th Marine Air Wing.

WILLIAM F. JAPPE, a coxswain during twenty-two months of naval duty, served with the Armed Guard between this country and Europe.

WILLIAM O. ZVONIK, after extensive AAF training, was assigned to the Air Command and Staff School, New Development Section, where he accumulated for the School data on new developments forwarded by laboratories and research groups.

HERBERT J. FISCHER was a storekeeper technician for a year at Pearl Harbor. A member of the Photocopy Department before entering service, he is now a junior draftsman.

WILLIAM SPRINGER'S two years of sea duty were spent with the Armed Guard in European waters and later aboard a flattop in the Pacific.

JOHN V. MOYNIHAN served on an attack personnel destroyer carrying underwater demolition troops in Pacific waters. His tour of duty took him to Guam, Hawaii and Japan.

LIEUT. FREDERICK W. WHITESIDE, in forty-two months of Army duty, served with Quartermaster supply groups in various air fields in

C. F. WEISS L. W. TELFER ELLIS GILLIAM W. F. JAPPE W. O. ZVONIK H. J. FISCH






. Springer J. V. Moynihan Lieut. Whiteside W. E. Howard A. C. Luebke C. W. Bachmann

this country before being assigned to the Pacific. He became Post Quartermaster for Fort William McKinley in Manila and subsequently for Pacusa Headquarters in Tokyo.

WILLIAM E. HOWARD, an aviation ordnance machinist, did ground work with a bomber squadron at Quonset Point and maintained aircraft on the *Bennington* in Atlantic waters.

ARTHUR C. LUEBKE was assigned at Newport to a tanker awaiting to be commissioned and served aboard her in Caribbean waters.

CARL W. BACHMANN fought in two major engagements with the 42nd Rainbow Division before signing up with the Counter-Intelligence Corps to help bring Nazi leaders to justice. Because he speaks both English and German accent-free, his services were valuable abroad to the United States and he transferred to the Military Government at Darmstadt where he served ten months after he had been released from the Army. Winkelmann, one of the men he arrested, was recently on trial at Nuremberg.

CLIFFORD E. UNDERHILL served two and one-half years in the Navy as a Pharmacist's Mate. His last assignment was as assistant to the doctor in the first aid room on the U.S.S. *Pitt*.

EDWARD J. DUGAN completed boot training and then attended service school before being land-based for a year on the Marshall Islands, where he was a signalman on yard oilers at Kwajalein, Eniwetok and Majuro.

RICHARD M. GAMBON and **ROBERT L. PRITCHARD** have been granted a personal leave of absence to attend college under the GI Bill of Rights.

News Notes

A. J. Snyder has been appointed Assistant Patent Service Manager, reporting to H. P. Franz. The office of OSRD Contract Supervisor, previously held by Mr. Snyder, has been discontinued.

Elizabeth Ink attended the Nutrition Foundation Symposium on Current Progress in the Science of Nutrition.

W. E. Kahl and S. Bobis visited the Western Electric shop at Winston-Salem in connection with development work on filters for the power-line carrier-telephone system.

G. H. Lovell and R. I. Game attended a Laboratories field trial of new crystal filters at Long Lines repeater stations in Indianapolis, Terre Haute and Dayton.

G. M. Thurston and F. Caroselli discussed the CR-9 oscillator with the Bureau of Ships.

Morton Sultzer has been appointed chairman of the Meetings and Program Committee of Army Signal Association, New York Chapter No. 1.

D. R. Brobst discussed with engineers of the United States Rubber Company at Bristol, R. I., distributing frame wire which they are manufacturing for Western Electric Co.

D. G. Blattner, V. F. Miller and B. B. Mann observed the test of covers for lubricated panel banks at Philadelphia.

M. O'Connell attended a meeting of the RMA vacuum tube socket committee which was held in Rochester.

W. L. Tuffnell and G. F. Schmidt studied handset transmitter problems at the Archer Avenue plant of Western Electric.

M. S. Richardson and C. F. Wiebusch spent November 12 and 16 at Chicago conferring with Western Electric engineers; they also attended the American Standards Association conferences devoted to acoustics and a meeting of the Acoustical Society of America.

E. Dietze attended the November meeting in Chicago of the subcommittee on underwater sound measurement of the A.S.A. committee on acoustical measurement and terminology.

H. C. Curl and W. L. Black went to Burlington, where they discussed problems related to the manufacture of several items of speech input equipment.

T. H. Crabtree conferred with the Raytheon engineers at Newton, Mass., on the use of subminiature type vacuum tubes employed in hearing aid amplifiers.

F. E. Engelke and G. J. V. Faley took up current engineering problems associated with hearing aid production at Burlington.

R. C. Newhouse, R. F. Lane, J. G. Matthews, F. C. Ward visited the Bendix Radio Corporation in Baltimore.

D. K. Martin attended the first session of the Special Radio Technical Division of Provisional International Civil Aviation Organization (PICAO) in Montreal, which made recommendations for standard radio aids to air navigation on international airways and airports.

J. H. Cook represented the Commercial Products Development Department on November 18 and 19 at the Navy-sponsored symposium held at the Massachusetts Institute of Technology in Boston.

Laboratories Advertising in 1947

The Laboratories technical advertising series now enters its third year with twelve single-page advertisements scheduled to appear in the thirty-six magazines listed below. Object is to inform people interested in science and engineering of Laboratories' contributions to the Bell System and the communication art. These advertisements supplement another series on the Laboratories published by the A T & T in general magazines.

To inform Western Electric's customers in the radio and television fields, the joint Laboratories-Western series, started in 1945, will be continued with six double-page spreads.

The effectiveness of Laboratories single-page advertisements is periodically measured through surveys conducted by Daniel Starch and Staff among male readers of *Popular Science Monthly*. Each advertisement is compared with all other single-page advertisements in the same issue. Three questions are asked: Did you see it? Do you recall the name of the advertiser? Did you read half or more? With three questions asked about each, seventeen Laboratories advertisements were scored on 51 questions. On thirty-six they ranked in the top 30 per cent; three in first place; four in second place; seven in third place; and four in fourth place.

Birch Laboratory

Birches, which grow like weeds on erstwhile farm land, are a bright spot of color in fall and winter landscapes. At Chester, six birch thickets are a functional part of our Outside Plant Laboratory. Here, more than 150 spans of drop wire are exposed to the abrasion of swaying trees at some 3,000 points of contact for damage to drop wires comes mostly from friction against small branches.

A wire may be tested for one year, or as long as ten years, depending on the performance of its covering and the severity of the abrasion. When an old specimen is removed, the new one is threaded through the trees so as to duplicate the tree limb exposures of the preceding test. The fast-growing birch has proved itself an excellent testing medium.

The photograph was taken by S. O. Jorgensen, staff photographer at Murray Hill.

Magazines Carrying Laboratories Technical Advertisements

Aeronautical Engineering Review
American Scientist
Army Ordnance
Bulletin of the American Ceramic Society
Chemical Engineering
Civil Engineering
Communications
Electrical Engineering
Electrical World
Electronics
F-M & Television
India Rubber World
Industrial & Engineering Chemistry
Instruments
Journal of Applied Physics
Journal of Chemical Education
Journal of Engineering Education
Journal of the Franklin Institute
Mechanical Engineering
Modern Plastics
National Safety News
Popular Mechanics
Popular Science Monthly
Proceedings of I.R.E.
Radio Craft
Radio News
Review of Scientific Instruments
S.A.E. Journal
Science
Science News Letter
Science Teacher
Scientific American
Scientific Monthly
Tele-Tech
Telegraph and Telephone Age
U. S. Naval Institute Proceedings

Joint Laboratories-Western Advertisements

Broadcasting
Communications
Electrical World
Electronics
F-M & Television
Proceedings of I.R.E.
Signals
Tele-Tech