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A Crystal Test Set

By G. M. THURSTON
Radio Development

OF THE various useful characteristics of quartz plates, two are intimately associated with the dimensions of the plate and the parallelism of its faces, and thus can be used as criteria for the final lapping process already described.* These are frequency and activity. Their use is complicated, however, by the fact that both, and particularly the activity, are affected by the circuit with which the crystal is to be used as well as by the crystal dimensions and form. It has been necessary until recently, therefore, for crystal manufacturers to measure the frequency and activity of crystals in the circuits with which they are

actually to be used. This has meant that they have had to carry a large stock of radio apparatus always available for use in calibrating a crystal.

To improve this situation, the Laboratories has recently developed the D-151288 Crystal Oscillator Test Set, shown being operated by J. J. Cozine at the head of this article. This set permits the circuit with which the crystal is to be used to be accurately simulated in its essential respects so that frequency and activity may be measured under conditions equivalent to normal operation. Activity is measured by a circuit incorporated in the test set, but the frequency is measured by an external measuring

*RECORD, July, 1944, p. 452.

set such as may be seen at the right in the photograph at the head of this article.

The characteristic of the circuit with which the crystal is to be used that chiefly affects the activity and frequency is the capacitance it places in shunt with the crystal. One of the major features of the new test set, therefore, is an arrangement to permit the equivalent capacitance to be connected across the crystal. This is not as easy as it sounds—particularly for crystals of very high frequency. At such frequencies almost every element of a circuit—even switches, contacts, and leads—has capacitances associated with it, and only extreme care in preparing the design can provide a circuit that permits their precise control. Every element of the circuit must be carefully specified, and no element or part can be used that will have different characteristics under varying conditions. Since the test set is used as a shop standard reference circuit, all units must have similar characteristics within close limits, hence once the circuit has been designed and every element specified, no substitution can be allowed, since a change in characteristics would be bound to follow.

The activity of a crystal expresses the amplitude of the voltage appearing across

the faces of the crystal as it oscillates. It is measured by the amount of current in the grid circuit of the vacuum tube with which the crystal is directly associated. In the last analysis, of course, it affects the output of the tube, but the output is also affected by the tuning of the plate circuit. A circuit for measuring crystal activity must thus provide for placing a precisely known capacitance across the crystal, for measuring the grid current in the associated oscillator tube, and for tuning the plate circuit to the desired frequency. In addition, a connection to the output must be provided so that the frequency can be measured. The circuit by which this is accomplished in the new test set is shown in Figure 1.

Shunting capacitance for the crystal is provided by a fixed condenser C_2 and an adjustable condenser C_1 . A three-position switch, D_1 , permits connection to C_1 alone, to C_1 and C_2 in series, or to neither, in which case the shunting capacitance that is involved is merely that of the remaining elements of the input circuit.

Grid current is read on a milliammeter with an adjustable resistance in series with it, and with an adjustable shunting resistance that may be inserted by operating switch D_4 . Both of these resistances are ad-

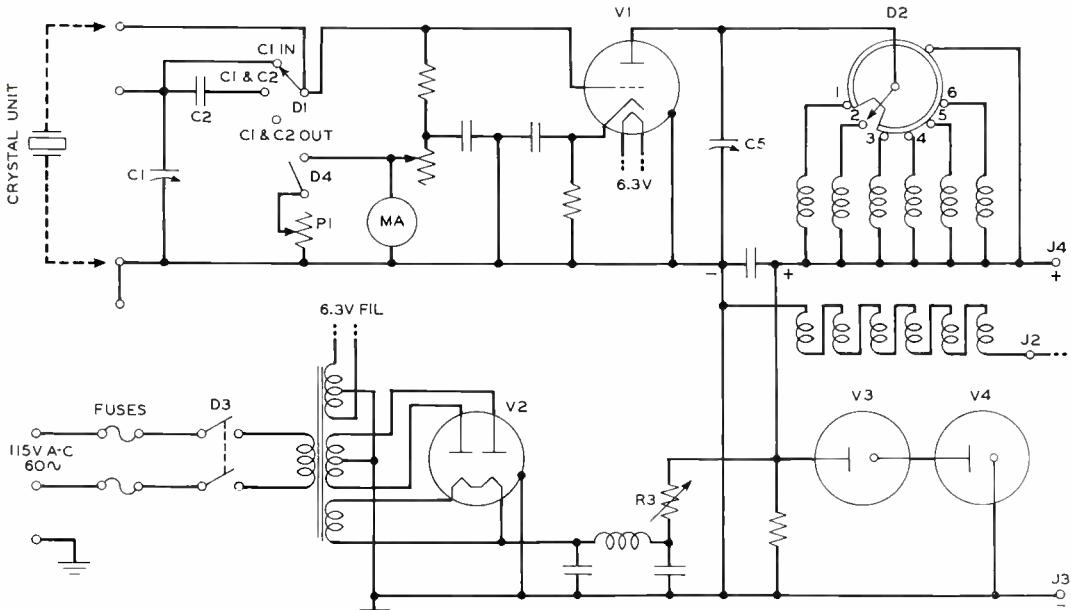


Fig. 1—Circuit schematic for the new crystal test set

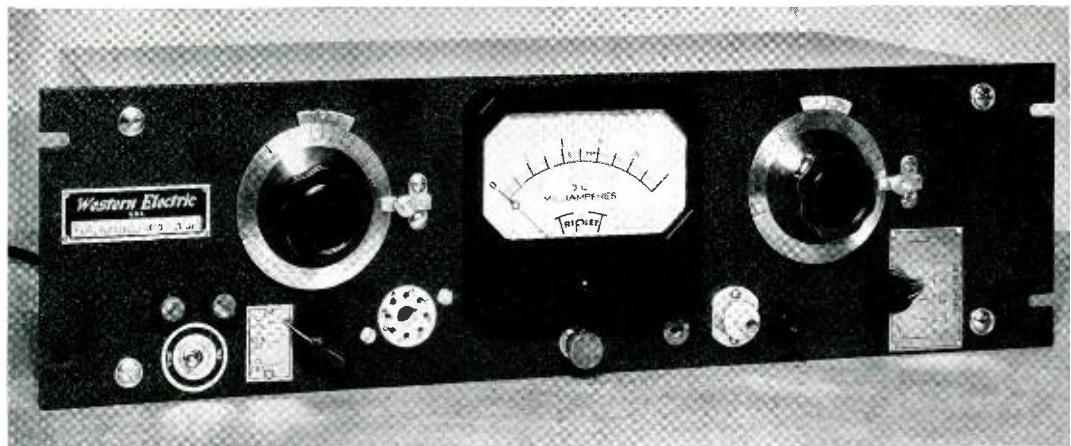


Fig. 2—Western Electric D-151288 crystal oscillator test set

justed when the set is calibrated. The value of the shunting resistance is made to equal the resistances of the meter itself so that when the switch D_4 is closed, the meter will read just half the current it read before. The operation of D_4 thus has the effect of doubling the range of the meter.

For tuning the plate circuit of the vacuum tube, two controls are provided. One is a six-point switch that selects one of six

THE AUTHOR: G. M. THURSTON of the Commercial Products Development Department entered the student course of the Engineering Department of the Western Electric Company in 1919. He then joined the radio research group where he was concerned with circuit development. He was associated with the development of transatlantic radio and in this connection made a field survey of the transatlantic short-wave project. He was also closely associated with the development of ship-to-shore radio, particularly the initial installation on the *Leviathan*. From 1922 to 1926 he studied at Columbia University and in 1927 at the Polytechnic Institute of Brooklyn. Since 1930 most of Mr. Thurston's work has been concerned with investigations of quartz crystals. This has covered dimensioning and lapping techniques and the development of testing equipment.



tuning coils, each used for one frequency band in the range from 0.43 to 31 megacycles. The other controls the adjustable condenser C_5 .

A regulated plate power supply unit, shown in the lower part of Figure 1, is included in the test set. It consists of a full-wave rectifier employing the tube V_2 , and two regulator tubes V_3 and V_4 . Before the set is put in operation, R_3 is adjusted to give a specified current through V_3 and V_4 . At this current, the potential across J_3 and J_4 is regulated to limits of ± 2 per cent. Tubes V_3 and V_4 will then hold the voltage within these limits by drawing more or less current through R_3 as the rectifier voltage varies.

Before using the test set for the first time, and periodically thereafter, it should be checked to make sure the resistance in series with the milliammeter is of the correct value, and that the characteristics of the tube V_1 are those required for proper operation. For this purpose an alignment coil, provided with the set, is plugged into the crystal socket, and a reading made on the milliammeter. Only tubes giving a grid current within a specified range are usable.

The meter and all the controls are mounted on the front panel of the test set as shown in Figure 2. At the lower left is the main power switch, D_3 , with the fuses immediately above it. To the right of these is switch D_1 , and to the right of it is the receptacle in which the crystal unit to be tested is plugged. Above these is the dial controlling C_1 . Immediately below the meter is the switch D_4 , and just

to the right and below the meter are jack terminals j_3 and j_4 with a connection for terminal j_2 between them. This terminal is used for connecting to the frequency-measuring equipment. To the right of the meter is the dial for controlling c_5 , and at the lower right of the panel is the switch D_2 that selects the desired tuning coil.

To make a test, the crystal is plugged into the set, and switch D_1 and the dial for c_1 are adjusted to give the shunting capacitance with which the crystal is designed to operate. The capacitance value for various positions of D_1 and settings of c_1 are shown on a chart accompanying the test set. Switch D_2 is then operated to select the proper tuning coil for the crystal frequency, and then c_5 is turned to give a maximum reading on the meter. Should the reading be off scale, D_4 is pressed to halve the current

through the meter. With this button pressed, the actual grid current is twice the reading of the meter. The reading of activity thus obtained may then be compared with the required value.

To measure the frequency of the crystal, the dial for c_5 is turned to the left to reduce the reading of M_1 to half its maximum value. A reading is then made on a frequency-measuring set using a connection from j_2 . The six small coils shown in this lead in Figure 1 are each coupled to one of the tuning coils, and supply sufficient voltage for measuring the frequency.

This set has proven so satisfactory that it has been made an American Standard, and is being specified for use on Army and Navy contracts. It is employed by most plants making crystals for apparatus designed for any of the Armed Services.



TELEPHONE SETS FOR PIPE LINES

Telephone service is a vital part of the control system of the "Big Inch" Pipe Line. Telephone sets are located in all pump rooms as close as practicable to the pumps, gauges, switches, and valves so that any abnormal condition may be quickly communicated to other stations to avoid delaying the movement of oil, so important for war purposes. Since the atmosphere in the pump rooms is considered explosive, the telephone sets have been specially designed and installed to insure that the telephone installation will in no way cause ignition of the explosive atmosphere.

The picture shows a typical installation of handset, switch box on which the handset is supported, and a foot switch. In the pump rooms there is a high noise level. To reduce the effect of this on the telephone conversation, the transmitter is normally disconnected. This necessitates connecting the transmitter to talk, which is accomplished by operating the foot switch.



Loop Assignment and Selecting Order for Crossbar Toll Switching

By F. A. PARSONS

Switching Engineering

IN THE crossbar toll switching system, operators are required to handle calls coming in over manual trunks. Such calls are distributed automatically by crossbar link frames and controllers as already described.* The arrangements will accommodate a maximum of either forty or eighty operator positions, depending on the amount of manual traffic. Besides the provisions described in the earlier article, it is necessary to assign the operator loops to levels on the link frames, and to arrange the order in which idle loops are selected by the controller, so that during light-load periods, when only a few positions are occupied, all trunks will be able to reach those particular positions regardless of where they are; and so that calls do not tend to select some positions more frequently than others.

Another condition placed on the assignment of loops arises from the division of the frames into A and B halves. One of the reasons for this division was to permit half of a frame or a half of all the frames to be removed from service for maintenance. Since all trunks are multiplied to both A and B primary switches, no trunks are denied access to loops when half of every frame is removed from service. The assignment of loops to the frame must take this possibility into consideration, however, so that when half of each frame is removed from service, all the calls will still be distributed uniformly among the positions.

Since each position has three loops, each of which is connected to a different one of the three key-frames, the major part of the problem can be

solved by devising a satisfactory distribution of the forty loops on one key-frame. This arrangement can then be permuted on the other key-frames to insure that the three loops to one position do not appear on the A or B switches of all three frames, and so that the order of selecting loops on the three frames will be different. The problem is thus narrowed down to that of arranging the locations of the loops on the frame and to the method of selecting idle positions.

The many factors that must be considered in the solution of these problems may be divided into two groups; one is concerned with arranging the loops so that all occupied positions are equally available to all trunks, even when the A or B halves of the frames are not in service; the other is concerned with arranging a selecting procedure that will not tend to select some loops oftener than others, and that will not require ap-

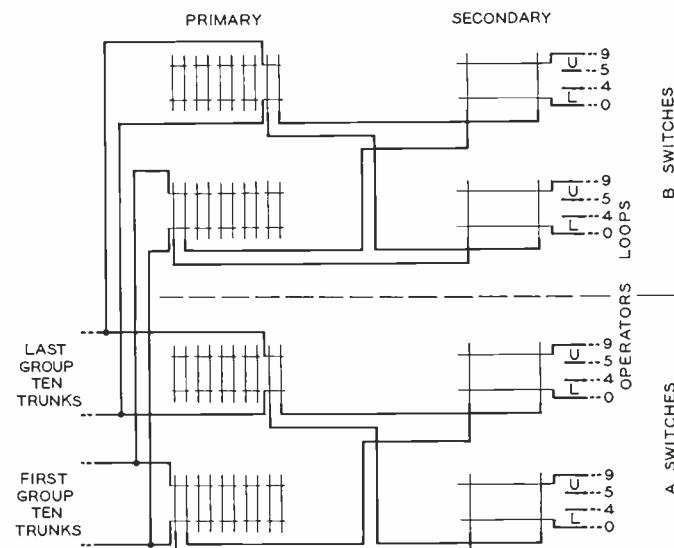


Fig. 1—Single-line diagram of operator link frame where each line represents sixteen wires and each switch element represents three on the actual frame

*RECORD, July, 1944, p. 454.

preciable longer time in finding idle loops under some conditions than under others. These two problems, although different, are interrelated, and cannot be considered entirely independently.

In considering the loop selection, it will be simpler to refer to the single-line diagram of Figure 1, where each line represents sixteen wires, and where each switch element represents three elements on the actual frame. The one hundred incoming trunks are connected to the four primary switches, and the forty loops are distributed among the four secondary switches. At the A primary to which it is connected, each trunk has access over two links to the twenty loops connected to the A secondaries, and at the B primary it has access over two links to the twenty loops connected to the B secondaries. Each trunk thus has access over four links to all the loops. The four links available to any one trunk, however, are also available to nine others, and thus one or more of them may be busy when a particular call comes in. The selecting circuit thus must locate the idle loops and select some one of them that is

TABLE I—SWITCH HORIZONTALS INCLUDED IN UPPER AND LOWER TESTS

<i>Test</i>	<i>Lower Test</i>	<i>Upper Test</i>
A	A1-0	A1-5
	A1-1	A1-6
	A1-2	A1-7
	A1-3	A1-8
	A1-4	A1-9
B	A2-0	A2-5
	A2-1	A2-6
	A2-2	A2-7
	A2-3	A2-8
	A2-4	A2-9
C	B1-0	B1-5
	B1-1	B1-6
	B1-2	B1-7
	B1-3	B1-8
	B1-4	B1-9
D	B2-0	B2-5
	B2-1	B2-6
	B2-2	B2-7
	B2-3	B2-8
	B2-4	B2-9

accessible to one of the idle links to which the calling trunk has access.

In testing loops, the controller circuit tests half of the loops at one time, and if all of these that can be reached with a suitable idle link are busy, it then tests the other half. To distribute each half of the loops tested evenly over all the switches, one-half

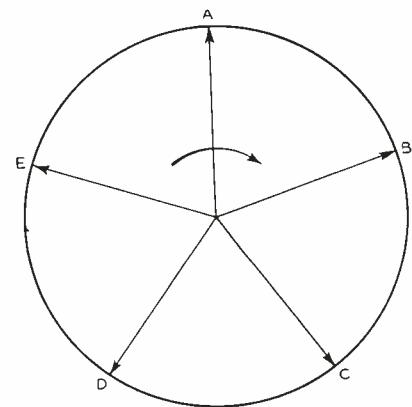


Fig. 2—By letting equally spaced radii of a circle represent the five testing groups, the possible variations in testing sequence may be determined by beginning at different radii and providing in either a clockwise or counter-clockwise solution

of them are connected to the horizontals 0-4 inclusive of all the four secondary switches, and the other half are connected to the horizontals 5-9 of all the switches. The former is called the lower half and the latter, the upper. They are indicated by the letters L and U on the horizontals of the secondary switches of Figure 1.

In a single operation the controller determines all the loops of the half tested that are idle, and by matching these against the links, it also knows which of them are accessible to the calling trunk. In the general case, however, there will be more than one available idle loop, and in the extreme case there may be twenty. It is desirable, therefore, to establish some order in which the controller makes its selection.

For this purpose, five test groups are established and they are designated groups A-E, inclusive. Since there are twenty loops tested at a time, each test group includes four. The horizontals included in these five

groups for both uppers and lowers are given in Table I. Here, A1-O, for example, represents the O level of the No. 1 switch of the A half frame while B2-6 represents the No. 6 level of the No. 2 switch of the B half frame. The controller is arranged to select the first idle loop beginning with the first level of some one of the five test groups. If it begins testing in a lower half, and finds no idle combination of loop and link, it releases its lower test relay, operates its upper test relay, and proceeds to select in the same order in the upper half. If no loop is found, it continues testing upper and lower halves alternately until it times out. This disconnects the controller, and the link frame will seize another controller. As a result a new testing cycle will be begun.

The order or arrangement of the five groups could be that listed in Table I, beginning at the top and running down, or it could begin with group C (A2-3), and proceed down through groups e, d, e and then back to A and b, or it could be made any other order of the five groups. Each time it is seized by a link frame, the controller makes a double shift in the testing order: it shifts from lower to upper or vice versa, and moves ahead one test group. If it started testing for one call in group c, for example, it would start for the next call with group d, and if the loop it found for the first call were in a lower half, it would begin testing for the next call in an upper half. Thus if it started testing for one call in group c and found a loop in a lower half, it would start testing for the next call in upper d. Since it is the first idle level following the beginning point that is selected, this rotation of the starting point destroys any systematic tendency to select certain levels so far as the levels of different groups are concerned. Within each group, of course, there is a tendency to select levels at the beginning of the group, but this is avoided partly by assigning the three loops of each position to different levels on their respective key frames, as described later, and partly by having half of the controllers test in one direction and half in the other.

The variations in selection brought about by five different beginning points for the selection, and by arranging half of the controllers to select in one direction and the other half in the other, are made more evi-

dent by indicating the five groups as five points equally spaced around the circumference of a circle as shown in Figure 2. The controllers that make their selections in one direction, say clockwise rotation in Figure 2, will—depending on the starting point—select levels from groups in the five orders ABCDE, BCDEA, CDEAB, DEABC, and EABCD. The other half of the controllers will select in the counterclockwise rotation, and thus will use the five orders EDCBA, DCBAE, CBAED, BAEDC, and AEBCD.

Altogether there are twelve different circular orders in which five objects may be arranged. These are shown in Figure 3. By assigning the loops in different orders on the three key-frames, the three loops for each

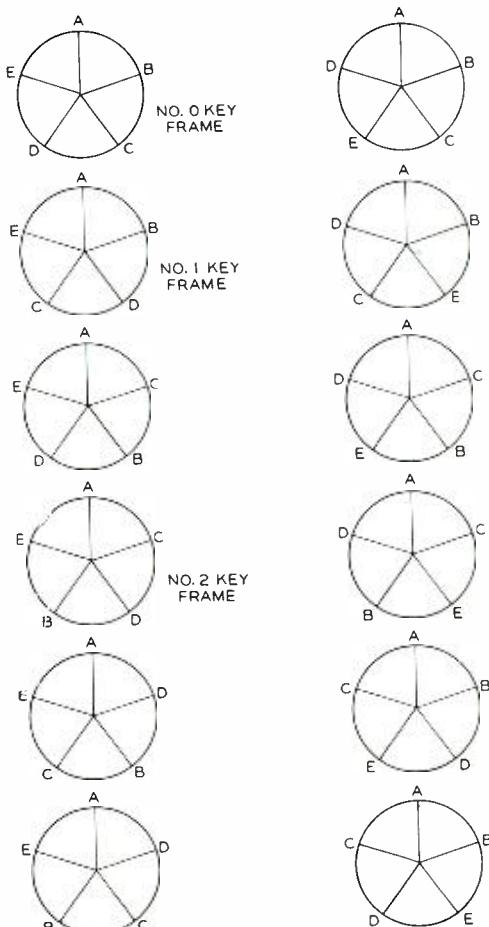


Fig. 3—Five objects may be arranged in twelve different circular orders. These are shown above, where the order at the upper left is that given in Figure 2

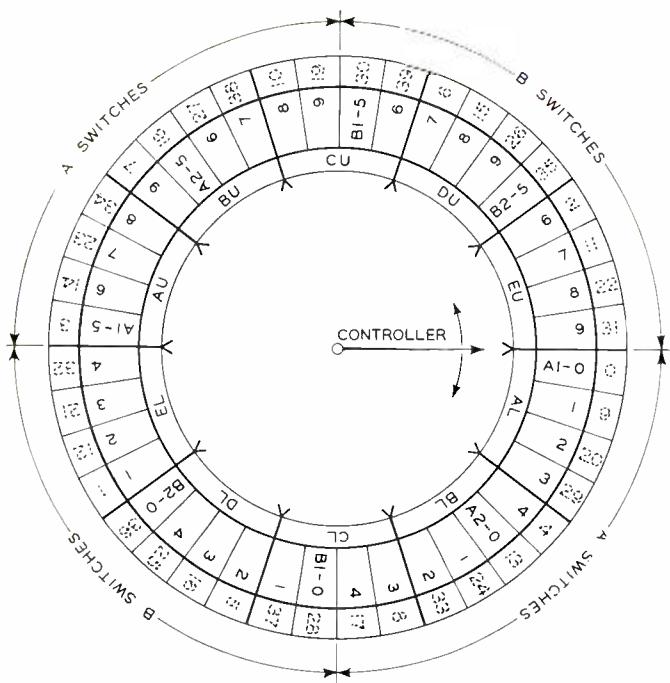


Fig. 4.—Distribution employed for the zero key-frame

position are selected according to different circular orders of the five testing groups. Since for each circular order, there are in turn ten actual orders of test—one each for the five different starting points in two directions of rotation—loops are selected in thirty different orders altogether.

These provisions for variations in loop selection at various frames and with various controllers avoid any systematic tendency to select some loops oftener than others. It is still necessary, however, to connect the loops to the switches in such a way that with the A or B halves of all frames out of service, all positions will be accessible, and when only a few positions of the board are occupied, these positions will still be accessible to all trunks without abnormal delays in locating an idle position because of too frequent switching from uppers to lowers or vice versa, which would happen if all occupied positions were on either the upper or lower levels.

The position circuits of the switchboard are arranged so that the operator at any position can "group" with her position, the positions on each side of her. When she does this, she automatically receives calls incoming to three adjacent posi-

tions. This is taken into consideration in assigning loops to various positions on the switches, since as long as no three adjacent positions are all on the A or B halves, no position can be inaccessible because either the A or B halves are out of service. It is necessary also to consider possible systematic groupings of the operators when the board is only partly occupied, so that no such distribution of the operators will result in their all being reached through A or B switches or all through upper or lower levels. Because of these various conditions, no completely systematic distribution of the loops will serve.

The distribution actually employed for the zero key-frame is shown by the outer circle of numbers of Figure 4, which shows the complete selecting possibilities for the zero key-frame. The central arrow represents the action of the various controllers, which can start the test at any of the ten points indicated, and can proceed in either clockwise or counter-clockwise rotation. Letters in the circle just beyond the arrow represent the various test groups, thus AU stands for the

THE AUTHOR: F. A. PARSONS received the E.E. degree from Cornell University in 1937, and at once joined the Technical Staff of the Laboratories. After spending some time on relay design, and in the toll laboratories group, he transferred to the toll facilities. Here he worked on the requirements for crossbar toll switching systems, and was intimately associated with the design and development of the No. 4 system that was recently installed in Philadelphia. In February, 1941, Mr. Parsons left the Laboratories on a military leave of absence and is now a major with the Bomb Disposal Group.



upper level of the A test group, while CL represents the lower levels of the C test group. Designations in the next circle represent the switch levels. The dotted numbers in the outer circle indicate the operators' positions connected to these levels.

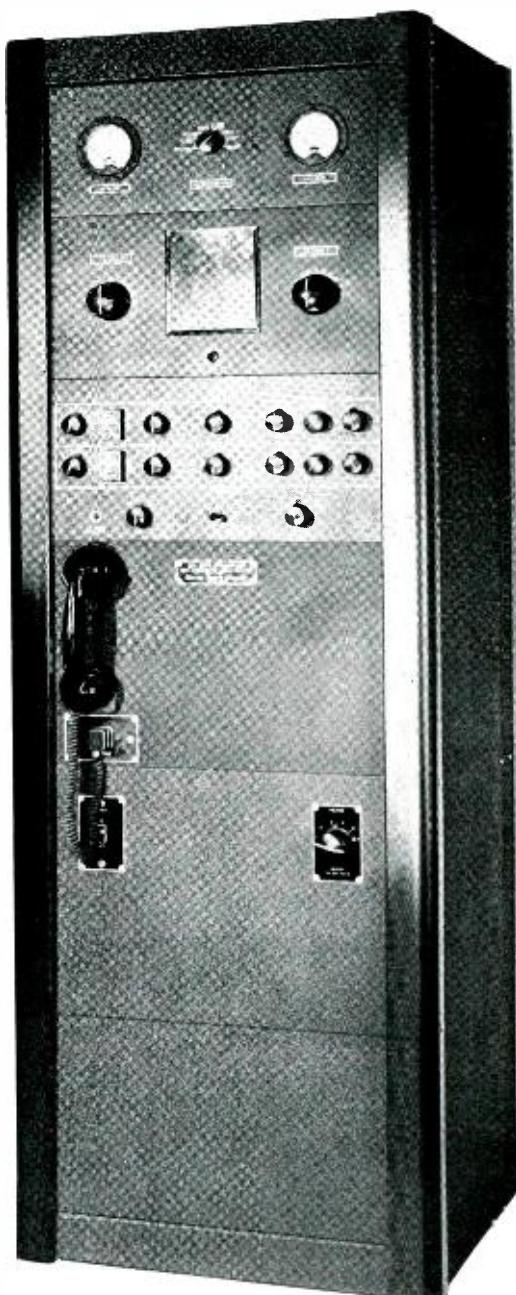
Equivalent wheels for the other two key-frames would be similar, but would differ in

the assignment of loops to switch levels. By these means calls are uniformly distributed over the occupied positions regardless of which ones they are. Hunting time is equalized for all normal conditions, and the removal of the A or B switches in this system has no effect except to reduce the number of loops that are available.

RADIO TRANSMITTERS FOR THE SIGNAL CORPS

In 1939 the Laboratories developed a short-wave radio transmitter for the Pan-American Airways. These provided both telephone and continuous-wave telegraph transmission, and were to be used at ground stations throughout Latin America and also at more remote foreign stations. Over 500 of these transmitters were installed during the last few years, and proved very satisfactory. Some of them, which were installed in North Africa, were taken over and used by the Army following the American invasion. They were found so effective that the Army wanted to employ them generally for ground station service. The Laboratories was asked to modify the design to provide two-tone telegraph as well as telephone and continuous-wave telegraph transmission. The 33A and 34A Radio Transmitters are the result of this request. The former provides telephone and both forms of telegraph transmission, while the latter provides both forms of telegraph transmission only.

These transmitters deliver 350 watts of carrier power, and operate in the frequency range from three to thirteen megacycles. They are used by the Army as ground stations for airplane communication and also for various point-to-point applications. Each transmitter provides for operation on two pre-tuned channels either of which may be selected from a remote operating point. Some 150 of each type have already been delivered to the Signal Corps.





Low-Temperature Properties of Rubbers

By G. G. WINSPEAR
Chemical Laboratories

NATURAL rubber and some synthetics change in two ways when their temperature is lowered; they may crystallize and they may become brittle. Crystallization may develop well above the minimum temperature to be expected in many current applications. Its progress is slow, and depends on temperature. In advanced stages crystallization impairs efficiency in such mechanical applications as flexible seals, diaphragms, and power belts but it does not make rubber break when flexed. Embrittlement has no relation to crystallization; it occurs immediately when the material passes through a critical temperature which is characteristic of each natural or synthetic rubber. The brittle point must be known, when rubbers are specified for low-temperature applica-

tions, because a severe and sudden impact or bend at or below this temperature breaks the rubber and renders it useless.

Studies recently completed on the brittleness of rubbers show that varying the rate of deformation and the severity of bending stresses at low temperatures may change the breaking point by as much as 40 degrees F. The apparatus used for this investigation, shown above being operated by W. H. Lockwood, is an improved design of a testing device previously developed by these Laboratories.* The specimen *F*, Figure 1, is mounted on a motor-driven quadrant *A* and is bent around an arbor *B* as it passes the rigid breaking arm *D*. Interchangeable arbors of different sizes control the bending stress applied to the specimen and worm

*RECORD, March, 1942, p. 175.

gears c of different pitches vary the rate of deformation. A strip of spring steel g is inserted in the slot e in front of the specimen to make it conform to the profile of the arbor. The samples can also be bent at right angles by mounting a block on the periphery of the quadrant in place of the arbor and thin spring, as shown in the headpiece, and setting the breaking arm one-quarter inch beyond the arc described by the block. The cold bath in which the sample is immersed for conditioning and testing must have no solvent action on the test material. Acetone or alcohol, refrigerated by dry ice, were used in these experiments. Uniform temperature was insured by circulating the mixture. The specimens were $1\frac{1}{2}$ in. x $\frac{1}{2}$ in. x 0.075 in. and were conditioned for three minutes at the test temperatures. The tank which holds the cold bath is heat insulated by a double wrapping of aluminum foil and a layer of fiber glass and is enclosed in a transite box h. This brittleness test was proposed by the Laboratories and has been adopted by a number of industrial rubber concerns and Federal agencies. The American Society for Testing Materials specifies a right angle bend and a velocity of impact of $6\frac{1}{2}$ feet per second as its brittleness test for flexible plastics as well as rubber.

When bent at right angles or over an arbor of one-inch radius, vulcanized pure-

gum rubber specimens broke at temperatures from -70 to -79 degrees F., depending on the velocity of impact, which was varied in these experiments from $1\frac{3}{4}$ to $6\frac{1}{2}$ feet per second. At the highest speed none of the gum-rubber samples failed, at -108 degrees F., however, when bent over an arbor of $1\frac{1}{2}$ inches radius. The corresponding values for vulcanized rubber, reinforced with carbon black, were -73 to -85 degrees F. but all of the specimens broke within this temperature range, even with the $1\frac{1}{2}$ -inch arbor.

Differences in the low temperature behavior of natural and some of the synthetic rubbers may be attributed to their chemical structure. Natural rubber consists of long carbon chains with a methyl group attached repeatedly to each fourth carbon atom. Some of the neoprenes have the same chain structure with chlorine instead of methyl groups. Materials exhibiting these fixed structures crystallize and lose their resilience at temperatures well above their brittle points. Synthetics of the copolymer type, including Buna s and Buna n, have structures which consist of two molecular configurations that occur at random in their long carbon chains. Natural rubber crystallizes most rapidly at -5 degrees F. as compared with $+32$ degrees F. for neoprene gn. The synthetic rubbers that are in the copolymer class do not crystallize on cooling.

In un compounded form, the brittle points of synthetic rubbers may vary from $+45$ to -85 degrees F. Knowledge of their low temperature properties has led to studies which have improved the brittleness characteristics of commercial compounds of these synthetics. Chemical plasticizers, such as dibutyl sebacate, lower the brittle point appreciably when used in amounts known to be compatible at the minimum temperature that is anticipated.

Low temperature tests were made on a number of synthetic rubbers which were compounded to obtain

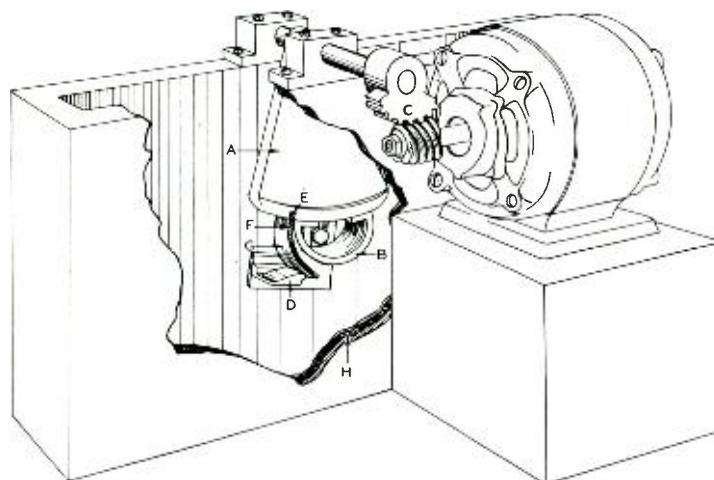


Fig. 1.—As the rotating sector A passed the projecting arm D, the test specimen F bent around an arbor B. By using arbors of different diameters the bending stress was varied, and interchangeable gears C changed the speed

the maximum depression of their brittle points. Some of the samples were conditioned for three minutes in a methanol cooling bath and others for 360 hours in air at -40 degrees F. Those subjected to long conditioning in air were tested in a cold room at temperatures which started at -50 degrees F. and the exact brittle point was thus determined for those specimens which broke at or above this temperature. The immersion bath was used in the cold room to find the brittle points of samples which broke at lower temperatures. Although some of the samples cooled for 360 hours in air were stiff from crystallization, their brittle points were not affected by this long exposure. Breaking temperatures, under all the conditions investigated, checked within close limits with one exception, Thiokol FA, which is an organic polysulfide containing both carbon and sulfur atoms in its long molecular chains.

Among the synthetics tested were compounds of Buna S, Neoprene FR, Neoprene GN, Paracon, Perbunan, Butyl, Hycar OS-10, Neoprene IIS, Hycar OR-15 and Thiokol FA. They exhibited brittle points which varied from -81 to -25 degrees F. in the order mentioned. A Buna S gasket material of special composition refused to break at -108 degrees F. after cooling in air at -40 degrees F. for 360 hours.

This investigation establishes the lowest temperature at which a number of rubber-like materials can be used without danger of fracture in service. It also confirms the fact that the property of brittleness can be accurately detected by the rapid procedure

THE AUTHOR: G. G. WINSPEAR was graduated from Pratt Institute School of Industrial Chemical Engineering in 1929. After working eight months as chemist with the duPont Rayon Company, he joined the Laboratories in 1930 as a Technical Assistant to engage in the experimental compounding and testing of soft rubber insulation. Five years later Mr. Winspear was made a member of the Technical Staff and has since worked on general rubber problems and their application for telephone use. At present this program is confined entirely to synthetic rubber investigations.



described and that it is independent of the state of crystallization of the synthetic. With the information gained it has been possible to provide suitable materials for applications requiring the maintenance of specific functional characteristics over a wider temperature range than has previously been achieved.

The apparatus and the test methods described here for determining the critical temperature of fracture on bending of rubber and synthetic elastomers should be of considerable value to the rubber industry in the fundamental study and development of compounds to be used under working conditions of low temperature.

ARMY'S SALVAGE PAPER PROGRAM

Under the Army's salvage program, the soldier in today's camp is learning not only to save small bits of paper, but also to keep cigarette butts and sticky candy wrappers from spoiling good paper scrap. Used cartons must be flattened, spent letters and envelopes saved and baled, and every other chance of wasting anything useful stopped by careful salvage precautions. The cartons used over and the tons of salvaged paper, which increased from 16,000 in January to 22,000 in March, take the place of tons of new paper. Every pound of paper, or anything else reused, the program emphasizes, not only saves the cost but the manpower needed to make new paper or other new items needed in the war supply program.



U. S. Navy Photo

A. B. Clark and A. Tradup Visit the European War Zones

EARLY in March, the War Department asked A. B. Clark and A. Tradup of Bell Telephone Laboratories, and H. H. Beverage, Associate Research Director of RCA Laboratories, to visit the Mediterranean and European theaters of operation to study problems connected with mobile and fixed communication facilities. Within two weeks of the original request, Messrs. Clark, Tradup, and Beverage went to Washington, where they were sworn in as expert consultants, and given travel orders and letters of introduction to the Theater Commanders and to the Air Force Commanders to be visited.

They took off from Washington on March 22 in one of the large transport planes of the Air Transport Command, landed briefly at LaGuardia Field, and about midnight stepped out into the snow of a Newfoundland airport. After a short sleep in its Officers' Club, they were up early, and spent the day inspecting various communication facilities. At 8:30 that night they

were away again in a big C-54 plane. The plane was cold, and fur-lined foot bags and oxygen masks were required. Sleep was intermittent, and at 6:30 next morning, they landed at a Scottish airport.

Here again the day was spent in inspecting radio and wire communication facilities, and at 9:00 P.M. they left in a plane for Algiers. Landing first at Marrakech, they then made a short flight to Casablanca, and thence took a plane to Algiers, where they landed shortly after noon on Sunday. Here they were introduced to General Devers, Commanding General of the North African theater, and to his Signal Corps staff at headquarters. Each day through Friday was fully occupied with inspection trips to various communication centers, consultations with Signal Corps personnel, writing reports to guide the development work at home, and giving information and advice requested.

Saturday afternoon they took off for Tunis, flying over snow-capped mountains,



Signal Corps Photo

Artillery fire control crew receives directional data from observers and pass it on to the gun crew nearby during the shelling of Mt. Trocchio in the Cassino area, Italy

over desert, and over farmlands. With them was a young soldier of Italian ancestry who was looking forward to a reunion with his father in Sicily. He pointed out scars of combat on the ground, and identified some of the places where he had fought. En route to their hotel in Tunis, they saw the ruins of Carthage in the distance.

They were up the next morning at 6:30, and after a quick breakfast were off in a plane for Italy. Flying across the Mediterranean, the plane kept just north of Sicily, and permitted a good view of that rugged island and of Vesuvius. At the airport at Naples they were met by a Lieutenant Colonel, formerly of the New York Telephone Company, who drove them to the Air Force headquarters camp, where they were introduced to General Eaker. Nearly two weeks was spent in conferences, in visiting radio and other communication centers, in studying conditions, and making recommendations. There was no time for more than casual sight-seeing, but later Mr. Clark did make a short visit to Vesuvius, driving up the greater part of the distance to where the road had been blocked by lava from a recent eruption, and then climbing the rest of the steep acclivity through lava dust and rock. Reaching the top, he was able to look over the rim into the crater with

its floor of hot, black lava. It was smoking in places but for the most part was quiet.

Their next stop was with the Fifth Army, where they conferred with the chief signal officer and members of his staff, and inspected communication facilities in Army, Corps, and Division Headquarters to get first-hand knowledge of the operation of communication facilities under war conditions. Mr. Clark arranged for permission to go to Anzio, at that time a real "hot spot." Wearing a Mae West, he set out in a light two-place plane of the kind used for artillery spotting. The route was several miles offshore, then up the coast at about 200 feet above the water. He spent most of the day inspecting radio and communications facilities, some of which are in a series of deep caves said to have been built during wars with the Saracens, but more recently used as wine cellars. By request, he was taken to a battery of 90-mm anti-aircraft guns equipped with the Laboratories M-9 Director. Officers and men were enthusiastic about its performance. The battery was frequently under fire, and some days before his visit a couple of 177-mm shells had landed twenty feet from the computer. They broke all of the windows in the trailer housing the Director, but did not interrupt the functioning of the Director. The beachhead

was under intermittent shell fire while he was there, and as required of all on the beachhead, he had to wear a steel helmet. Late in the afternoon, he returned to Fifth Army Headquarters, by the same plane and without any enemy action.

The party was not always together, since their individual interests were somewhat different, but the general nature of their duties was similar: inspecting installations, making notes of things needed, and discussing problems with the signal officers. Occasional air raids or exploding shells never let them forget that the enemy was not far away.

On the morning of April 29, they left by plane for Algiers, where several days were spent in further conferences and inspection trips, and then Mr. Clark left for Casablanca, en route for England. Priority and passport troubles delayed Messrs. Tradup and Beverage in Africa for two weeks.

Until June 21, they were in England and Scotland. The days and part of the nights were spent in visits to flying fields, radio installations, and communications headquarters of all sorts. Interspersed through

all this period were conferences and the continual writing of reports and recommendations. They were in England on D-Day, and during the following tense weeks they followed from a distance the progress in establishing communication facilities to the Normandy Beachhead. It was while Mr. Clark was in England that the Buzz Bombs started coming over. He saw a number of them in flight, and examined the still hot remnants of one that had landed in a nearby field. He also was within 300 yards of the Guard's Chapel when the damage pictured in the July 24 issue of *Life* occurred. Although not hurt, his ears rang for hours after.

They were all greatly impressed with the tremendous amount of communications plant which had been built both in Africa and Italy, and with the ability and versatility of the Signal Corps personnel in adapting it to varied conditions. Everywhere the necessity was obvious for quick and reliable communications.

They returned home on June 21, after three months of intense study. During the trip they had flown some 15,000 miles.

WAR DEVELOPMENTS OF THE LABORATORIES EXHIBITED

THAT the work of the Laboratories has been almost entirely concentrated for the past two and one-half years on the development of war equipment is well known to all members of the staff, but each person has been so much engrossed in his own special projects that many have not realized the magnitude of the program as a whole.

The extent of this effort was strikingly disclosed by a partial display of the Laboratories' war developments at Murray Hill and Whippany during the last week of June. Arranged at the request of the Western Electric Company for the information of a War Contract Price Adjustment Board, most of the exhibits were housed in tents.



There were also exhibits in the building at Murray Hill and, at both places, several large equipments out of doors.

Communication apparatus developed for the special needs of our Armed Forces and facilities for the detection and location of the enemy on land and sea, in the air, and under water were displayed. The showing of radar equipment was very extensive and indicated the remarkable progress which has been made in this particular field during the last two years.

Members of the Board who attended the demonstration were J. M. Dodge, Chairman; W. R. Biggs, A. Clapham, W. L. Goodwyn, Dr. R. B. Mitchell, and Lieut. Col. G. Walters. With the exception of Mr. Dodge, who came later, they visited Murray Hill on Wednesday morning, June 28, and Whippany that afternoon. R. L. Jones and M. J. Kelly were hosts for the Laboratories. R. A. Haislip had charge of the arrangements at Murray Hill and O. M. Glunt at Whippany.

Thursday and Friday the exhibits were shown to the major executives of the American Telephone and Telegraph Company and of the Western Electric Company.

On Saturday, July 1, members of the War

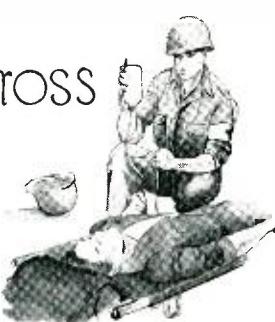
and Navy Departments were guests of the Laboratories at Murray Hill and Whippany. Those of this group who witnessed the demonstrations were Major Generals H. C. Ingles, W. H. Harrison, and R. B. Colton; Rear Admirals W. A. Kitts, III, and E. L. Cochrane; Brigadier Generals J. H. Gardner and H. M. McClelland; Colonels J. H. Rothrock and Maurice Hirsh; Captains, U.S.N., J. F. Crowe, Jr., J. B. Dow, F. C. Layne, Frank Akers, and Royal MacLaren.

A T & T Honored by Signal Corps

A certificate of appreciation was presented to the American Telephone and Telegraph Company on June 23 by Major General Harry C. Ingles, Chief Signal Officer of the Army, at ceremonies held in the main hall of the 195 Broadway building. Accepted by President Gifford, the certificate acknowledged the company's "loyal and patriotic services rendered the Signal Corps of the Army of the United States in the accomplishment of its vital mission during a period of national emergency. This acknowledgment of your distinguished contribution in furtherance of a future world at peace will be inscribed forever in the annals of the Signal Corps."

W. J. Albersheim
Charles Arnold
Miss J. G. Asbury
V. C. Belt
A. P. Besier
G. Bittrich
W. A. Buchwald
Miss L. E. Burford
Miss M. E. Christensen
M. Corry
F. E. Dorlon
L. Dorrance
R. H. Erickson
Walter Fewer
J. R. Fisher
Miss E. A. Foster
L. O. Frey
Miss C. J. Gauthier
Harry Goedeke
G. Goodman
C. B. Green
J. B. Hays
W. F. Hoover
Mrs. F. A. Hummer

Red Cross Blood Donors



Charles Humphrey
Miss E. J. Hyde
H. Jackman
Miss R. Jaffe
Michael Konash
C. A. Landslide
Miss M. E. Lavery
G. W. Lees
A. F. Leyden
Miss H. E. Liter
V. E. Lowden

F. J. Morin
Miss Phyllis E. Nimmo
Miss L. H. Norkin
Miss M. R. Northup
Miss J. M. O'Riordan
J. J. Oestreicher
Miss J. A. Otto
N. R. Pape
J. F. Potter
Miss M. M. Ralph
R. V. Roller
Miss D. Y. Shaw
Miss D. Shultz
M. Sparks
Mrs. M. R. Stites
Harry Thomas
Andrew Toth
R. G. Treuting
C. Van Benschoten
P. Venneman
L. Vieth
Mrs. J. M. Vreeland

News Notes

A NEW EDITION of the booklet *Pictures from Bell Telephone Laboratories* has been prepared recently by the Bureau of Publication. It is the latest of a series which began in 1928 as a souvenir for visitors. During the war, the booklet has been given to graduates of the School for War Training, as a memento of the Laboratories. The new edition contains, in addition to text and pictures concerning the Laboratories as a whole, similar material about the School.

O. B. BLACKWELL, on June 29, was the guest speaker at the Commencement Exercises of the Brooklyn Technical High School.

R. CLARK JONES has been awarded the Adolph Lomb Medal of the Optical Society of America for his development of a new calculus for optical systems involving polarizing, double-refracting and optical active elements. The medal will be presented at the October meeting of the society. It is given not oftener than once in two years to a person under thirty years of age who has made a noteworthy contribution to optics.

THE NATIONAL ACADEMY OF SCIENCES has announced two Charles L. Mayer awards, each of \$2,000, for contributions on the nature of light. A special advisory committee, of which K. K. DARROW is a member, has been appointed to assist the National Science Fund of the Academy to make these awards.

HARVEY FLETCHER spoke on *Ideal Systems for High Fidelity Transmission of Speech and Music* before the Utah Section of the A.I.F.E.

W. A. SHEWHART has been appointed a member of the National Research Council, on the Division of Physical Sciences, for two years dating from July 1, 1944.

J. B. KELLY delivered three lectures during the first week of July at the *Symposium in Hearing Aids and Residual Hearing* held at Northwestern University.

AMONG MEMBERS of the Laboratories attending the convention of the A.S.T.M. in New York were W. O. BAKER, A. R. KEMP, G. T. KOHMAN, F. C. LARSON, F. S. MALM, C. H. SAMPLE and V. T. WALLER.

"THE TELEPHONE HOUR"

(NBC, Monday Nights, 9:00 P.M., Eastern War Time)

AUGUST 7, 1944

Make Believe from "Show Boat"	Kern
James Melton	
Pastorale from "L'Arlesienne Suite No. 2"	Bizet
Orchestra	
In the Silence of the Night	Rachmaninoff
Mexican Serenade	Sacco
James Melton	
Bacchanale from "Samson and Delilah"	Saint-Saëns
Orchestra	
Recondita Armonia from "Tosca"	Puccini
James Melton	

AUGUST 14, 1944

Drums in My Heart from "Smilin' Thru"	Youmans
Nelson Eddy	
Speak to Me of Love	Lenoir
Orchestra	
Cargoes	Dobson
Trade Winds	Keel
Captain Stratton's Fancy	Taylor
Nelson Eddy	
Introduction to "Khovantchina"	Moussorgsky
Orchestra	
Credo from "Otello"	Verdi
Nelson Eddy	

All August programs will be broadcast from Hollywood

AUGUST 21, 1944

Torch Dance from "Henry VIII"	German
Orchestra	
Concerto No. 4 in D Major—Second Movement (Andante Cantabile)	Mozart
Jascha Heifetz and Orchestra	
Prelude in C Sharp Minor	Rachmaninoff
Orchestra	
Nana (Berceuse) from "Suite Populaire Espagnole"	DeFalla-Kohansky
Figaro from "The Barber of Seville"	Rossini-Castelnuevo-Tedesco
Jascha Heifetz and Orchestra	

AUGUST 28, 1944

I Love Thee Ecstasy	Grieg
Helen Traubel	Rummel
Waltz from "The Swan Lake"	Tschaikowsky
Orchestra	
Elsa's Dream from "Lohengrin"	Wagner
Helen Traubel	
Czardas Rhapsody	Zador
Orchestra	
In the Gloaming	Harrison
Helen Traubel	

★ ★ ★ ★ ★ ★ ★ ★ ★

In Our Nation's SERVICE

Lieut. John C. Applegate

LIEUT. JOHN C. APPLEGATE of the Marine Corps paints a vivid word picture of life in Panama where he is now stationed. He writes, "This is good duty here. I probably live more comfortably than I would in the States, with good food including plenty of Argentine beef. My room has only two walls, the other two sides are just screened and look right out over the bay. Winter is the best season because then there is practically no rain for about four months. May is the beginning of the rainy season, and it will rain most of the time from now until November.

"At present I am at a Naval Air Station where the Marines do guard duty. For quite a while I was in a company which did some real jungle training and I kept busy with hikes and marches which were really rugged in this climate.

"In ten months of garrison soldiering I have done all sorts of jobs that go with this duty. I have signed payrolls and muster rolls, change sheets and morning reports. I have sold life insurance and War Bonds. Incidentally, if you know anyone who is not buying War Bonds, tell them that 99 per cent of all Marines in Panama have payroll deductions for War Bonds out of their very meager salaries!"

David Webster

Under the title of "G.I. Joe" in the *Fighter*, the weekly paper published at the Abilene Air Base in Texas, appeared the following:

"PFC. DAVID (P.W.) WEBSTER, clerk in the Distribution Center at Headquarters,



is the fellow you'd like to meet this week.

"Dave has seen quite a bit of this old world, starting life some 29 years ago in Glasgow, Scotland. His early schooling was had in the British Isles and for a while he attended a grammar school right by those 'White Cliffs of Dover.' He readily agreed that this region was indeed beautiful country. Private First Class Webster, called P.W. up Headquarters way, remembers trips into the famous highlands, which has been the subject of much classical literature.

"In 1925 Dave and his mother came to America, settling just off the shoreline in Brooklyn.

"After high school, Dave saw some more of the world while working on a passenger steamer to South America.

"Webster's next job was in the photostatic department of Bell Laboratories in New York City. In that office was the world's largest photostatic camera, he said, used to photograph blueprints. Entering the Army in January, 1943, he served at Fort Dix and at St. Petersburg, Florida, before coming to Abilene."

Robert F. Rennick

"On this side of the ocean in New Guinea a Signal Corps man has to be a jack of all trades. My case is a typical example. I started off as a trained radio TTY man and wound up doing pole lineman's work, drafting, electrician's work, and now TTY maintenance. All our TTY and TWX equipment was originally Bell Lab equipment.

"The roster of our Signal Service Company reads like a Bell System Directory: Dunford, Olsson, Welding, and I represent the Labs,



one fellow from each—Long Lines, Wisconsin, Michigan, Illinois, Northwestern, and New England Bell, and numerous men from Western and the Teletype Corporation."

Lieut. Ralph D. Horne, Jr., a Prisoner of War

Word has been received from the mother of LIEUT. RALPH D. HORNE, JR., that he was shot down over Germany on May 19, and is a prisoner of war within Germany. He had previously been awarded the Air Medal and two Oak Leaf Clusters. Lieut. Horne, who joined the Laboratories in 1934, was a Technical Assistant in the Outside Plant Development Department. He was granted a military leave of absence in January, 1941, at the time of the National Guard Mobilization. Until September, 1942, he was with the Headquarters Troop of the H-Mecz. Cavalry at Fort Devens. He then became an Aviation Cadet and trained successively at Nashville, Tenn.; Santa Ana, Calif.; Phoenix, Ariz.; Pecos, Tex., and received his Second Lieutenant's commission at the Roswell Army Flying School, New Mexico, in June, 1943. Advanced training took him to Ephrata, Wash., and Ardmore, Okla. Lieut. Horne went to England early this year as the pilot of a Flying Fortress and was soon promoted to rank of First Lieutenant.

Lieut. Col. William W. Sturdy

Recently promoted, LIEUT. COLONEL STURDY is Executive to a Chief of (Staff) Division at the Army War College in Washington. In addition he is in charge of the issuing of Signal Corps equipment, and the organization and equipment of all Army Ground Force Signal Units. Last fall Colonel Sturdy received a citation for developing methods for applying machine accounting to equipment tables.



Lieut. Ralph D. Horne, Jr.

Ensign Philip H. Thayer

"My work at the present time in the Radio Material Office at the Boston Navy Yard is on installation, maintenance and repair of * * * gear. After many months of schooling, I find it interesting to get back into doing active work again. There is plenty of work to be done on all types of ships, and the opportunity to actually work on the gear is most welcome. A good deal of the equipment is, of course, Laboratories' designed and Western built, so that my background in Laboratories drawings and design methods is often a help. Actually, except for the types of equipment, the job is not too much different from that of my former work in field engineering with the Laboratories."

Herbert J. Brown

"A good many months have passed since I last visited West Street on furlough. How I'd like to swap this hot, dust-laden wind for the cool breezes of Bethune Street. The picture of the cafeteria in the May issue of the RECORD brought back Lab meals in sharp contrast to the 'out of the can' diet here in Australia. We get occasional shipments of fresh meat and, rarely, fresh eggs. We sometimes get hold of cocoanuts and

have even broiled a wallaby for variety. At present I have put aside my work in the gun shop to repair and service bomber turrets. I am sporting numerous bumps, bruises and scratches, showing that my long legs weren't meant for the confined spaces of a turret."

Robert T. Lynch

From somewhere in the Pacific ROBERT T. LYNCH informs us, "I have finally been assigned to the job I was trained for and wanted. It is in communications, supposedly the newest type. We are quite busy here now, besides working our regular shift we



David F. Greenhagen informs us of a change of rank as well as a change of address. He has been commissioned an Ensign in the U.S.N.R. and is designated a Naval Aviator. He is taking fighter operational training at Melbourne, Florida, before going to the Fleet

are in the process of building ourselves a livable hut. In spite of the heat we work all day in the sun and have become accustomed to it by now. Our food is about the best and along with our weekly cokes and ice cream, life here isn't bad."

Lieut. Col. Robert W. Harper

Enclosed with COLONEL HARPER's letter from overseas was a page from the *South Pacific Daily News*. It announced that a variety of Scottish bagpipe music would be broadcast over the radio from records received by him from his sister, Miss Elizabeth Harper of Edinburgh. The music was recorded by the 2nd Bn., Scots Guards, and the Queen's Own Cameron Highlanders Pipe Band of the British Army.

"When our Yellow Enemies in Tokyo hear the 'Skirl' of Scotland's martial music arising from the Cocoanut Islands of the South Pacific," said Colonel Harper, "they will surely think the famous 'Ladies From Hell' are just 'O'er the Border.' This music, it is hoped, may be to them just a prelude of the real thing that they will hear and fear."

492D

Sons of Laboratories Man Meet on a Pacific Island

Sons of H. D. PECKHAM, Commercial Relations, pictured during their unexpected sojourn together "somewhere in the Pacific" where Duncan is stationed as Radar Material Officer. Kenneth (right) at the time was on his way back to the States, and is now in New River, N. C., at Officer-Candidate School.

The meeting of the two boys was one of the many coincidences of the war. Duncan, a Lieutenant in the Navy, received his training at Columbia University, Bowdoin College and M. I. T., then went to the West Coast for embarkation. Kenneth was successively at Parris Island; New River, N. C., and finally Oceanside, California.

On their way out, in a matter of a two-hour stopover at Los Angeles, the boys also met without previous planning, had dinner together and went their separate ways. Duncan went to his present station and Kenneth landed on another of the "Islands."

Military News

MEMBERS of the Laboratories who have been promoted: SECOND LIEUT. ARTHUR J. NOLAN; S/SGT. HAROLD H. GEORGENS; SGT. WILLIAM R. GRANT.

JOHN J. LANTZ, JR., has been given a personal leave of absence to work for the Naval Research Laboratory.

From an air base in England, LIEUT. WILLIAM VON GLAHN writes, "A word about 'Merry Old England.' We live in a 'fox hole'



Lieut. Duncan Peckham (left) and Sergeant Kenneth Peckham, sons of H. D. Peckham of Commercial Relations, met in the Pacific

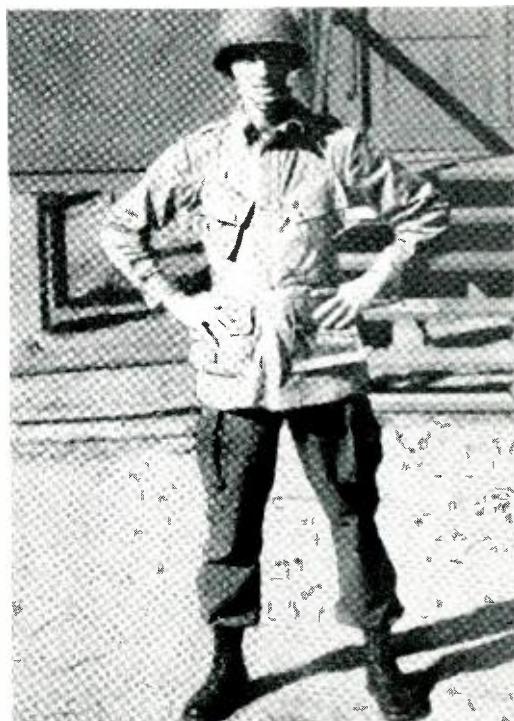
August 1944



made of red brick. It is three stories high, and is almost covered with ivy. We have all the comforts of home, including colored tile baths, steam heat, and hot and cold water. It was a bit difficult, and, I might add, expensive, learning the money system over here. Our food is good, and generally speaking, the morale is very good."

CAPTAIN WALTER W. MAAS is the Assistant Executive at AWUTC in Florida. "We use much of the aircraft detection equipment developed by the Laboratories. You might give them my best, and tell them to keep up the fine work. Some day when the war is won the entire world will hear of the marvels they have given us."

LIEUT. COLONEL JOHN M. HAYWARD writes, "On temporary duty recently in the Southwest Pacific area I had an opportunity to observe combat operations in New



Wilbur G. Sauer in England

Leaves of Absence
As of June 30, there were 869 members of the Laboratories on military leaves of absence. Of these 33 leaves have been completed. The 836 active leaves were divided as follows:

Army 496 Navy 251 Marines 30

Women's Services 59

There were also 18 members on merchant marine leaves and 27 members on personal leaves for war work.

Recent Leaves

United States Army

Helen A. Di Stefano	Boyd R. McDonald
Gilbert Goodman	Elizabeth McIlravey
Lawrence B. Jones	William A. Myles
Ira S. Markowitz	Francis C. Roeckl
Albert B. Watrous	

United States Navy

John J. Barrett	Lieut. Harvey W. King
Paul R. Brookman	Ruth E. Lowe
Vincent Decker	Richard E. Strelbel
Monroe W. Dring	Eric G. Strubing
Aristides Gouzoulis	Thomas J. Walsh
Joseph H. Hill	Millicent M. Whitlock
Margaret M. Kenny	Ensign Robert E. Yaeger

Merchant Marine
Van Dyke Wippermann

Guinea and to visit various engineering activities throughout Australia. During the 25,000-mile trip, traveled almost entirely by air, I frequently ran across Bell System people. They are truly all over the world."

On active duty in the Pacific, EDWARD GEMPLER says, "One of the most important pieces of gear that I am in charge of is a product of Western Electric, and I recall having built some of its internal parts in the Model Shop at the Labs."

A recent letter from JOHN J. O'SHEA indicates that he is now in Italy after spending several months in England.

ROBERT J. KOECHLIN, now at Camp Wolters, Texas, recently received his First Lieutenant's commission.

JOSEPH U. MEATS is now overseas, somewhere in the Central Pacific Area, with the Seabees; and EDWIN F. BIRGER is training now in Decatur, Illinois.

F. R. MISIEWICZ sends "Sunny Greetings to all the Labs, especially to the Research Drafting Department. I have been transferred to a different company, but I am still in school on Treasure Island (California)."

ENSIGN GEORGE E. ORAM has been as-



W. J. GOLDSTEIN

HENRY BENTLE

signed to a Merchant Ship as Naval Communications Liaison Officer. He has already made a trip to the United Kingdom.

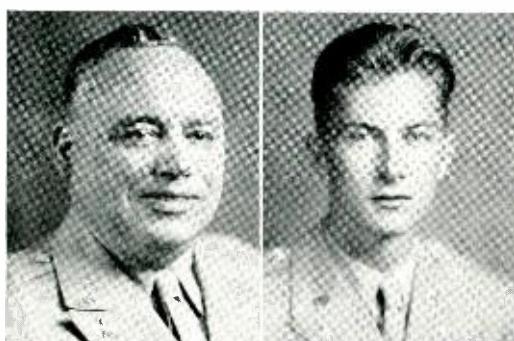
WARREN J. GOLDSTEIN, MM3/c, visited West Street recently, after having completed "boot camp" training in the U. S. Naval Training Center at Sampson, N. Y.

HENRY BENTLE of the Navy visited West Street after the completion of his preliminary training at Sampson Naval Training Station.

LIEUT. RALPH A. BENSON was commissioned upon completion of training as a pilot at Spruce Field, Georgia. He is now taking advanced training at Randolph Field.

LIEUT. A. R. PARKER, of the Division of Aviation in the Marine Corps, visited the Laboratories recently while on leave. He had finished a rigorous training at the Marine base at Quantico, Virginia. Lieut. Parker now leaves for Corpus Christi, Texas, where he will take a seven-month Communications Course on airborne radio and * * *.

H. L. SMITH is now located at the United States Naval Training Station at Sampson, New York.



LT. COL. W. SMITH, JR. LT. R. A. BENSON

After quite some time spent in the Mediterranean war theater, and "Arab Heaven," as he called it, WILLIAM J. CONNOR is back in the States taking the Navy's V-12 course. Although the program is extremely regulated, he finds it a great deal more pleasant than dodging the bombs, mines, and shore batteries he encountered in his Beach Jumper Unit.

LIEUT. FREDERICK J. HURT is with an Engineering Company overseas and GEORGE J. THIERGARTNER is now overseas, somewhere in the Pacific area.

WILBUR INSULL has returned to Camp Gruber, Oklahoma, after completing a three-month course in surgical techniques. He is now a surgical technician attached to the Medical Battalion supporting the new Rainbow Division.



LT. COMDR. UNNEVEHR LT. A. R. PARKER

ALOIS H. LOBISSE is with the Signal Corps at Fort Monmouth.

WILLIAM J. MEEHAN is "somewhere in the jungles of New Guinea."

JOAN SCHUBERT is taking her basic instruction at the Third Wac Training Center at Fort Oglethorpe, Georgia.

LIEUT. EVERETT T. URBANSKI is stationed at an Army Air Field in Florida. "I'm in the Third Fighter Command, starting the last phase of fighter training in P-40's prior to the long-awaited overseas assignment. It's been a long grind but I've enjoyed every minute of it. Best regards to all in the 4C Development Shop."

MAXWELL C. ANDREWS is taking the Navy V-12 course at Purdue University in Indiana and ENSIGN JOHN R. BOYLE of the Navy Air Corps is an instructor at Glenview, Illinois.



RITA RAY of the Women's Army Corps visited West Street before reporting to Camp Crowder, Missouri. She hopes to be sent overseas shortly.

T/Sgt. CHARLES D. BRIGGS writes from Hawaii that he is enjoying the sights on the Islands, but above all, he is impressed by the excellent food served there—even good steaks! Since he has been there he has visited Honolulu, Waikiki Beach and several other places of interest.

WILLIAM L. WILDLIGG is a maintenance man in one of the largest army exchanges in the Southwest Pacific. ROBERT H. MEUSER is now in Italy.

A. A. HAUTH is now stationed at the Frankford Arsenal in Philadelphia after completing his training at the Rossford (Ohio) Ordnance Depot.



Lt. A. J. NOLAN Lt. R. C. BENKERT

LIEUT. ARTHUR J. NOLAN of the Air Forces was at West Street recently while on leave. He had just received his "wings" and expects to return to George Field, Illinois, as an instructor there.

LIEUT. RICHARD C. BENKERT spent a day at the Laboratories visiting friends with his fiancée, MISS MARJORIE FLYNN, who is in the Accounting Department at 14th Street. Lieut. Benkert received his Air Corps wings at Victorville, California, on May 20. When his leave is over, he expects to report to a base in Lincoln, Nebraska.

CAPTAIN ARNOLD R. BERTELS is now with the Fort Monmouth Signal Corps Publications Agency handling moisture-proofing of Signal Corps equipment and maintenance at Red Bank, New Jersey.

COAST GUARDSMAN WILLIAM J. DOUGLAS called on the Receiving and Shipping De-



CAPT. A. R. BERTELS

A. A. HAUGH

partment when he was on leave after having completed his boot training. Mr. Douglas was the receiving clerk for the Restaurant before going into service.

AVIATION CADET WILLIAM V. HOSHOWSKY is taking further training at Greenwood, Mississippi.

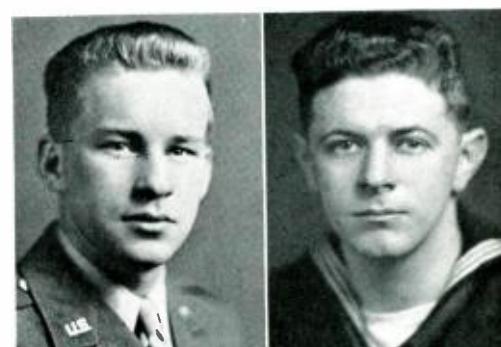
GEORGE N. ELTZ is in an Operational Training Unit flying P-40's, after five months as an instructor in a Basic Flying School. "There is a group of French Cadets and Flying Officers here, and did they go crazy when the Invasion news came through!"

WARREN M. PRALL has been transferred to Pensacola for advanced training in the Air Force.

ELIZABETH FITZSIMMONS of the Waves is in Rhode Island taking a course in the latest training equipment for aviators.

JOHN P. FRASER is an Air Cadet at Turner Field, Georgia.

ROBERT A. DRYDEN is with a depot company in England. CAPTAIN WALTER S. GUNNARSON is now overseas with a New York post office address.



W. V. HOSHOWSKY

W. J. DOUGLAS



E. M. KENNAUGH

N. J. FLYNN

LIEUT. FRED J. SCHWETJE of the Marine Air Corps visited West Street while on leave recently. He had just finished operational training at Jacksonville, Florida, and now will report to San Diego.

EDWARD H. BUEB describes his South Pacific outpost: "A coral rock covered with a steaming jungle, crawling with lizards, and assorted bugs including centipedes whose bite sends one to the hospital for a few days. It could be worse, at least it cools off enough at night so that we can sleep fairly comfortably. What I miss most is reading matter. Most of the time our thoughts turn to food. Some of the complainers at home should be put on K rations for a week!"

EDWARD M. KENNAUGH visited West Street on a recent furlough from Columbus, Ohio, where he is studying electrical engineering in the Army.

AVIATION CADET WILLIAM F. LYNCH of the Navy Air Corps stopped to see friends at the Laboratories after completing his pre-flight training at Chapel Hill, North Carolina. He now expects to report to a primary base in Illinois for further training.



ENS. J. R. BOYLE

W. F. LYNCH

CADET MIDSHIPMAN BERTRAND H. SOMMER is now at the Merchant Marine Academy on Long Island.

EDWARD O'HARA and NICHOLAS J. FLYNN visited their friends at the Laboratories recently while on leave.



EDWARD O'HARA

B. H. SOMMER

LAWRENCE B. JONES returned to West Street for the day recently while on furlough. He had just completed three months' training at Cornell in the Army Specialized Training Reserve, and is now awaiting further orders.

JOSEPHINE T. GALLO in June completed a two-month course in the Officers' Training School for Waves at Smith College. Commissioned as an Ensign, she was assigned to the Headquarters of the Commander-in-Chief of the U. S. Fleet.

LIEUT. WILLIAM H. BURGESS is flying P-38 fighter planes in Italy.



W. A. ANDERSON

L. B. JONES

WILLIAM R. GRANT writes from New Guinea, "I have been here two months installing and maintaining equipment. My last assignment was in Australia where I was stationed for six months. I have met a lot of fellows from the Bell System and they are



doing a swell job. The climate here is rather hard on our equipment, and speaking of equipment, it sure is a credit to the Bell System. Please say hello to the boys in the downtown development shop."

THOMAS P. GANNON is in a Navy Armed Guard School in Virginia.

NICHOLAS SFOUGRAS has been transferred from the Military Police to the Army Service Forces, and is "at a swell camp situated in the shadow of Mount Rainier."

JOSEPH P. REDDINGTON and JOHN C. PRACEK are both stationed at Camp Le Jeune, North Carolina.

ROGER W. WALTER, after completing a year course in Basic Pre-Meteorology at



Spencer N. Foster had just finished a long voyage in the Aleutians when he wrote. He told us, "The life jacket I am wearing in the picture is silly because the water was so cold that no one could have lasted more than twenty minutes in it"



John H. Anderson says, "My present job is administration of payrolls, court martial cases, etc. I work eight hours a day and my principal weapon is the typewriter." He is in Camp Hood, Texas

Bowdoin College, is now at Olmstead Field in Middletown, Pennsylvania, studying to be a weather observer.

EUGENE E. FRANCOIS is an Air Cadet at Blytheville, Arkansas. "My duties here consist of working 'on the line.' That means I service and check airplanes, for experience in ground crew training is an important part of study for the air cadet."

HANS W. MENZEL has finished training in airborne electronics and is now awaiting an



Walter J. Bittman is now in England. He likes the beautiful countryside and says the towns are nice too

OTHERS WHO have written to the RECORD include:

A. F. Bartinelli, Arthur Jackson, Lieut. G. S. Bishop, R. W. Search, Lieut. H. E. Manke, R. Klem, W. B. Bachmann, J. E. O'Keefe, G. G. Bailey, L. C. Brown, G. C. Barry, Carole M. Finch, J. P. Ahrens, W. F. Bodtmann, H. H. Sharpe, W. W. Grote, W. C. Brossok, R. C. Ryan, Richard Rafferty, Lieut. C. J. McDonald, H. J. Rohr, L. W. Telfer, John Merchant, A. E. Lawson, Peggy MacIlvaine, P. Craven, W. F. Lichte, H. H. Hoffman, M. J. Corley, Lieut. G. A. Bickard, J. J. Cozine, W. M. Prall.

News Notes

B. L. CLARKE and H. W. HERMANCE visited the Eastman Kodak Research Laboratories at Rochester and the Esso Laboratories of the Standard Oil Company at Linden, N. J., to discuss chemical analysis problems.

Dr. Clarke attended a meeting of the Editorial Advisory Board of *Industrial and Engineering Chemistry* at Woods Hole, Mass.; extended greetings of the New York Section of the A.C.S. at a Symposium on Analytical Colorimetry and Photometry sponsored by the A.S.T.M.; and has been appointed to the A.C.S. committee on Local Section Councilor Representation.

K. G. COMPTON has been elected Vice-Chairman of the New York Section of the Electrochemical Society and has been appointed Consultant to the N.D.R.C. Administration Committee on Tropical Deterioration as a representative of the electronic industry.

MR. COMPTON and C. H. SAMPLE observed corrosion specimens on a recent trip to Wilmington, N. C.

MR. COMPTON and J. LEUTRITZ, JR., were at Wright Field on corrosion and finish problems encountered by the Army Air Forces and the Aircraft Radio Laboratory.

B. STIRATELLI and B. S. BIGGS visited the General Electric Company at Schenectady to discuss special test methods for synthetic rubber products.

E. F. SCHUMACHER spent several days at Hawthorne discussing metallurgical problems with Western Electric engineers. Mr. Schumacher and J. H. SCAFF visited members of the staff of Purdue University at Lafayette, Ind., on rectifier and metallurgical problems.

W. J. KIERNAN, at the Radiation Laboratory of M.I.T., discussed moisture and fungus proofing of relays.

G. G. WINSPEAR was at Hawthorne for a week on problems concerning synthetic hard rubber.

C. J. CHRISTENSEN and M. D. RIGTERINK were at the Robertson Manufacturing Company and at Lenox, Inc., Trenton, on ceramic production problems.

G. N. VACCA has been appointed Chairman of the A.C.S. Finance Committee.

J. W. MULLEN, H. R. WALKER, J. H. HEISS, JR., and W. O. BAKER attended a research conference on synthetic rubber held in Akron.

DR. BAKER presented an invited paper, *Transition Phenomena in High Polymers*, before a meeting of the American Physical Society in Rochester.

C. J. FROSCH attended conferences in conjunction with the A.S.T.M. convention in New York.

C. S. FULLER was elected Vice-Chairman of the conference on *High Polymerics* which is held annually at Gibson Island, Md.

R. M. C. GREENIDGE and N. INSLEY, at the Pittsfield plant of the General Electric Company, investigated sealed terminals, and at the Usinite Corporation in Boston, formed metal parts.

R. T. STAPLES recently discussed cable manufacturing problems with engineers of the Boston Insulated Wire Company and of the Ansonia Electric Company.

DURING May and June, F. J. GIVEN and F. E. HANSON of the Western Electric Company acted as technical advisors of the War Production Board at several meetings with the visiting British Radio Material Mission. These meetings, held both in New York and Washington, were held for the purpose of exchanging information on methods of conserving mica by more efficient use of available supplies and by adoption of other dielectric materials.

Your Copy of the RECORD

Please put your RECORD in the "Correspondence-Out" box when you are through with it so that it can be sent to a Serviceman's family.

A. W. ZIEGLER, at the Hawthorne plant of the Western Electric Company, tested equipment for heading support wires for small crystal units.

W. C. SCHMIDT, also at Hawthorne, discussed testing problems involved in data-smoothing networks.

H. H. STAEBNER was at the Point Breeze plant of the Western Electric Company on cable development problems.

C. A. WEBBER went to Washington in connection with high-frequency cables.

A. D. HASLEY visited the M.I.T. Radiation Laboratory at Cambridge, Mass., in connection with operational tests on transformers. He was also at the Haverhill and Hawthorne plants of the Western Electric Company on matters pertaining to the manufacture of transformers.

J. F. NUNER, at the Bendix Aviation Corporation, Teterboro, N. J., and at the Camp Evans Signal Laboratory, Belmar, N. J., investigated power transformers.

H. A. STONE and J. E. RANGES spent a day in Pittsfield in connection with the investigation of high-voltage terminals.

A. J. CHRISTOPHER went to St. Louis to attend the A.I.E.E. convention. During the first part of June he was in Hawthorne to attend the meeting of the Radio Manufacturers' Association in connection with the drafting of specifications for ceramic capacitors. He also spent some time while there in discussing various problems in connection with the manufacture of capacitors.

C. A. McJOHNSTON visited the Magnetic Windings Company at Easton, Pa., on transformer problems.

C. D. HOCKER and J. B. DIXON, Chairman and Secretary, respectively, of Committee A-5 on Corrosion of Iron and Steel, attended several sessions at the Annual Convention of the American Society for Testing Materials recently held in New York. C. S. GORDON, W. H. S. YOURY, A. P. JAHN and J. A. CARR also were present at meetings of

July Service Anniversaries of Members of the Laboratories

10 Years

E. J. Dall
W. J. Fullerton, Jr.
G. A. Gawel
J. P. Griffin
Fenella Langenau
W. H. Lockwood
C. V. Lundberg
Anthony Majlinger
C. J. Norton
T. J. O'Rourke
J. P. Quinn
L. J. Smith
Estelle Talbert
W. H. Webber
C. F. Wollner
A. M. Zillian

15 Years

Edna Aamodt
S. C. Bates
R. W. Benfer
Grace Benner
Edith Betz
P. O. Boschan
F. R. Brereton
R. W. Bunttenbach
J. J. Burke, Jr.
S. O. Carleton
R. S. Caruthers
J. J. Cebak
H. E. Curtis
Sidney Darlington
G. W. Davis

K. H. Davis
W. H. De Zavala
B. A. Diggory
H. E. Ehrich
E. P. Felch
M. J. Frank
C. J. Frosch
E. P. Furst
H. R. Garing
P. A. Gartman
B. C. Gaughran
T. F. Gleichmann
G. R. Gohn
F. A. Goss, Jr.
Q. E. Greenwood
Warren Gronros
O. O. Gruenz, Jr.
C. H. Hamill
R. L. Hanson
E. K. Harvey
F. V. Haskell
E. E. Helin
G. J. Herbert
H. C. Hey
W. H. C. Higgins
C. P. Koch
H. H. Koehn
C. A. Lovell
L. B. Luckner
J. J. Lukacs
P. M. Maher, Jr.
R. F. Mallina
C. R. McIver
J. H. Mogler
A. R. Morris

C. M. Morris
Robert Mueller
C. A. Nickerson
K. M. Olsen
D. M. Osterholz
G. L. Pearson
R. B. Perkins
L. H. Peterson
W. S. Pratt
L. G. Rector
H. A. Reise
L. F. Sander
J. H. Scaff
H. P. Scheffer
H. F. Schreiber
W. C. Schumann
F. G. Shane
Ella Suda
U. B. Thomas, Jr.
E. R. Till
Elias Toy
F. C. Ward
Clement Winter
M. C. Wooley
L. R. Wrathall

20 Years

G. A. Benson
W. C. Buckland
A. F. Burns
T. J. Crowe
C. R. Eckberg
R. A. Ehrhardt
A. A. Elwood
A. G. Ganz

P. R. Gray
George Hecht
Elizabeth Humes
T. A. Jones
G. J. Knandel
J. J. McCormick
J. O. McNally
L. S. C. Neel
W. F. Ottemann
D. B. Penick
D. H. Pennoyer
J. W. Smith
W. P. Sohn
A. C. Thompson
W. L. Tuffnell
H. S. Winbigler
G. R. Yenzer

25 Years

John Baumfalk
J. W. Beyer
G. E. Dustin
E. L. Getz
Henry Giroud
G. I. Glaser
W. R. Goehner
L. G. Hoyt
L. A. MacColl
Cordelia Mattice
L. E. Melhuish
C. G. Miller
Franklin Mohr
S. E. Norton
L. A. O'Brien
H. M. Pruden

C. S. Rhoads
Henry Schucht, Jr.
May Schupp
J. E. Shafer
L. C. Swicker
C. V. Taplin

30 Years

A. F. Bennett
O. E. Buckley
Rodger Clifford
R. A. Heising
E. T. Hoch
A. H. Inglis
E. C. Matthews
R. M. Moody
J. G. Motley
G. B. Small
J. R. Weeks, Jr.

35 Years

George Dobson
William Fondiller
H. H. Glenn
L. H. Johnson
W. C. Jordan
C. W. Lowe
H. E. Marting
W. J. Shackleton
J. C. Wright

40 Years

E. W. Hancock
S. W. Shiley

some of the committees on which they serve as members.

C. H. AMADON visited Albany and Syracuse on pole line inspection procedure.

R. H. COLLEY conducted non-pressure treatment of full length lodgepole pine poles at St. Paul, Minn., using commercial equipment for the first time. He also visited the Forest Products Laboratory at Madison, Wisc., and Chicago.

DR. COLLEY was recently appointed a member of the OPA Eastern Pole and Piling Industry Advisory Committee.

Coördination of Electrical Graphical Symbols and New Graphical Symbols Depict Electronic Devices, two articles by W. L. HEARD, were published in the May issue of *Industrial Standardization*.

J. A. WATTERS attended a Quality Survey Conference at Hawthorne on channel bank equipment and other associated items.

A. F. BURNS and R. H. HUMER visited the Ground Maintenance Branch of the Signal Corps in Philadelphia where they discussed dynamotor repairs.

G. J. MAGGI made a trip to Richmond in connection with the trial of improved contacts and wipers on step-by-step switches.

H. H. SPENCER was present at the cutover of the rectifier inverter trial on the Type-L carrier system at Baldwin, Wisconsin.

J. F. POLHEMUS has been supervising the installation of new equalizers for trial on the Minneapolis-Stevens Point coaxial system. He also assisted in the tests.

R. E. POMEROY is a member of the *Papers, Symbols, and Circuit Committees* of the Institute of Radio Engineers.

G. T. MORRIS was at the Patent Office in Washington relative to patent matters.

H. W. WERTZ appeared before the Primary Examiner at the Patent Office in Richmond relative to applications for patent.

G. B. THOMAS attended the Bell System Personnel Conference held in New York from June 13 to 15.

LEAH SMITH gave a talk on Libraries in the Post-War World at the annual conference of the Special Libraries Association held in Philadelphia from June 19 to 21.



Mailing Department at Murray Hill. The girls are sorting the mail according to room numbers preparatory to going on their next delivery rounds. After training for advancements in other fields these girls will be promoted and there are openings for other girls like them at Murray Hill and at West Street

Distaff

The women of Bell Telephone Laboratories are substantial in number and important in its wartime operations

PHYLLIS JANE VIBBARD became interested in the Laboratories through her father, Mr. E. L. VIBBARD of the Systems Development Department. She began her career here in the Technical Assistants' School at Fourteenth Street. She took the fifteen-week course there and then came to West Street in the Apparatus Development Department where she is engaged in the testing of secret equipment to be used by the Armed Forces.



PHYLLIS JANE VIBBARD

August 1944



Even with a full-time war job Phyllis finds time to devote to outside wartime activities. With a small group of girls, she goes to St. Albans Hospital to entertain and dance with convalescing servicemen who have been wounded in action. Despite the fact that these men are just becoming accustomed to using artificial limbs, she finds their morale is excellent. Miss Vibbard is enthusiastic about these visits, for the appreciation expressed by the men is more than gratifying.

She has also been awarded golden wings for having spent over one hundred hours as an airplane spotter.

Phyllis completed her high school course at Virginia Intermont College in Bristol, Virginia, and then attended Ursinus College in Pennsylvania where she met her fiance who is now serving overseas with a Signal Corps outfit.

She is an accomplished swimmer and this sport occupies most of her week-ends which she spends at Lake Mohawk, New Jersey.

* * * * *

IT'S HER "yes" or "no" that goes. As a technical assistant in the condenser group, HELEN KUCHTA tests capacitors for their specific requirements. Her data obtained from these tests form the basis of the accepting or rejecting of the test lots.

She became interested in this type of work while doing clerical work at Haw-



HELEN KUCHTA

thorne in Chicago. The mysteries of the Shop so fascinated her that she asked to be trained for a job there.

Helen was transferred to the Laboratories several months ago. She expects to be married in the fall when her fiance completes his internship at the Kings County Hospital in Brooklyn.

She has lived most of her life in Kentucky where she attended school and also took up nurses' training. When she went to Chicago to work, her nursing experience enabled her to assist in teaching home nursing at the Red Cross there.



MARY ELLEN WERTZ

MARY ELLEN WERTZ became Women's Editor of the RECORD on May 15. Her work includes the writing and editing of the Women's and Military sections of the magazine and the illustrating and layouts for these pages. A native of Nebraska, Mary Ellen moved to Lebanon, Pa., where she finished high school. She then studied for two years at the University of Texas and a year at both Traphagen School of Fashion and Parsons School of Design in New York. She joined the Laboratories in 1943 as a member of the Commercial Relations Department at the Graybar-Varick building.



GEORGINE L. FREDERICKS

A LONDONER by birth, GEORGINE FREDERICKS of the Systems Development Department received her early schooling in Switzerland. At nine, and en route to America, she had command of English, French and German; she was able to ski and to swim with unusual skill; and she had travelled. After completing grammar school in New York she was sent back to the Moravian Institute in Switzerland.

Miss Fredericks—"Freddie" to her co-workers—returned to this country in 1929 and became a member of the General Service Department, a position which she held until 1936. Then she transferred to her present position where she is responsible for



"It's very convenient when I just have to sign my name!"

distributing *Bell System Practices* to the associated Bell System Companies. She has also done considerable war work.

Before the war she returned to visit Europe; her love of travel has also taken her on vacations to the British West Indies, Guatemala, California and to the National Parks. She belongs to a hiking club and has spent several vacations climbing various mountain ranges in the East. Her free evenings are now devoted to Red Cross work and to the care of patients at the Beekman Street Hospital. In the past she has had a Girl Scout troop and has done Settlement work. She is the sister-in-law of Remie Lohse, the well-known photographer.

Engagements

Joseph B. Gerard, U. S. Army—*Ruth Finn

*Robert G. Treuteng—*Mary-Elizabeth King

*Ens. H. A. Bennett, U. S. Navy—*Edith Pappin

*Robert A. Dryden, U. S. Army—Muriel Smith

*Samuel E. Hardaway—*Viola White

Lt. Alfred A. Lamor—*Dorothy Talcott

Weddings

*Alexander E. Lawson, U. S. Army—Nancy Baker

Robert W. Olmstead, U. S. Army—*Betty Coven

*Herbert E. Kern—*Joan Curtis

*Harold Aumond Sweet, Jr.—Carol Lois Henry

*Raymond W. Kosley—*Julia Lynch

*Members of the Laboratories. Notices of engagements and weddings should be given to Miss Mary Ellen Wertz, Room 1103, Extension 296.

EVERYONE who has waited in line for a cup of coffee or a dish of ice cream in the cafeteria at Whippany knows "Hanah." MRS. FAGAN came to the Laboratories late in 1942, shortly after the Whippany cafeteria was opened. Her work there keeps her busy dispensing milk, coffee, cold drinks, and ice cream to the hundreds who file past her counter every day.

Mrs. Fagan was born in County Cavan in North Ireland where her father was a farmer. When she was nineteen years old she, with her parents and a brother and sister, came to America. They made their home in



MRS. HANAH FAGAN

Morristown, New Jersey. Although she has always had a desire to visit her native County Cavan, she considers New Jersey her home and has no wish to live in Ireland again.

* * * * *

WITH a husband who has been in the Army for three years, one brother in the Navy, one in the Army, and another in the Seabees, ANN ROSLAN decided that the most effective way to keep from worrying and to make the slow days pass more quickly was to keep busy—with hands as well as mind. In her



MRS. ANN ROSLAN

work at the Whippany Shop she fulfills this ambition. Reading blueprints, making tools, operating the lathe and drilling machines, Ann handles a man-sized job. She was trained in this type of work for six weeks at Murray Hill before coming to Whippany.

Sewing for her two-year-old daughter takes up a great deal of her free time, although she does enjoy bowling in the winter-time, and during the summer she participates enthusiastically in the sports and other activities among the girls at Whippany.

Learn to Relax

The leaflet, *Fighting Fit in the Factory*, issued by the British Ministry of Labour, points out the fact that sufficient rest is one of the most important factors necessary for health and efficiency.

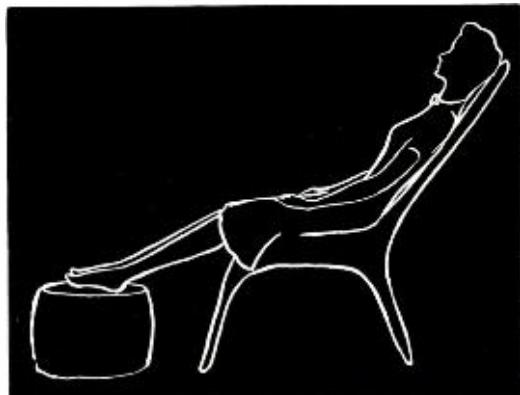
"Rest is of course most necessary. It makes all the difference if it is taken in a really comfortable position. All are soldiers now: all must learn, like them, to rest when the chance comes, even if it is only for a few minutes. All too should learn, like them, to make resting a pleasure: that gives it double value.

"If there are ten minutes free after a meal they should be used for rest in an easy, relaxed position. Lying flat on the back with the knees up is the best, and it does not take long to learn to like it. It is a help to take off

the shoes; this cools the feet and the shoe leather. Tight clothing should be avoided or loosened. Let all the muscles go limp. Breathe slowly, deeply and evenly. There should be no effort in this, the legs and arms should go particularly limp in breathing out. This induces a heavy drowsy feeling, and may even lead to sleep. Even if not it will at any rate secure getting a first-class rest. One should not worry if the night's rest is broken. Worrying about it does more harm than sleeplessness itself. It is well to make up for lost sleep if possible, but bad to think one can't get along with less than one is used to. Most people find they can get along with a good deal less sleep than they usually take.

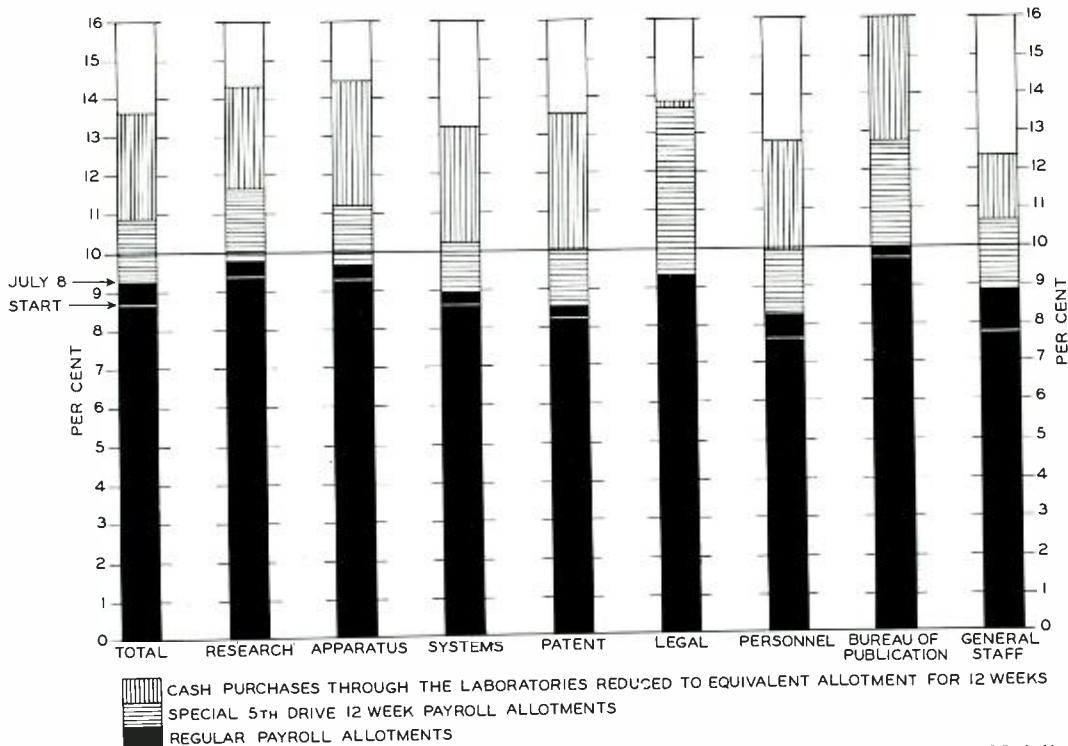
People who are up at night should take some food—hot milk is the best; it helps sleep when the chance comes.

"In sleeping as in resting, it makes a lot of difference, to lie easy. It's bad to be listening for things. It's bad to keep the muscles tight. It's good to learn how to relax: how to find the most comfortable position and let everything go."



With the strain and tension of wartime living, it is more necessary than ever before to be able to relax completely in order to insure proper rest. To relax:

- Loosen tight clothing*
- Breathe slowly and deeply*
- Allow each muscle to go limp*
- Forget your worries*



Fifth War Loan Campaign

The final report on the results of the Fifth War Loan Campaign in the Laboratories showed that, as of July 8, 13.61 per cent of the "takehome"—standard pay plus overtime—was being spent for War Bonds. This percentage consisted of 9.26 per cent regular payroll deductions (compared with 8.73 per cent at the beginning of the Campaign), 1.63 per cent in special payroll deductions effective from July to September, inclusive, and \$215,353 in over-the-counter cash purchases, which is equivalent to 2.72 per cent of "takehome" for three months. A total of 7,413 members of the Laboratories, or 96.9 per cent, are participating in Bond purchases.

The accompanying chart shows the results for the Laboratories as a whole and for the major departments.

Laboratories Telephone Pioneers Elect Officers

O. E. Buckley was elected President of Bell Laboratories Chapter of the Telephone Pioneers of America at the second annual meeting held on June 27. Other officers elected were M. B. Long, Vice-President; R. J. Heffner, Secretary; and A. O. Jehle,

Treasurer. W. A. Bollinger, R. A. Haislip and Leah Smith were reelected to the Executive Committee for one-year terms, and William Bodenstedt, C. A. Conrad and J. B. Kelly elected for two-year terms.

Membership in the chapter has increased 25 per cent during the past year. On September 24, 1943, 994 members of the Edward J. Hall Chapter were transferred to

Telephone Pioneers Enrolled During Second Quarter of 1944

E. H. Ackerson	H. Kords
T. J. Arkinson**	J. P. Larson
W. C. Babcock	L. M. Ludlam
H. H. Burrell*	P. Mertz
J. H. Connerty	A. Meyer
Janet Dein	N. D. Newby
W. J. Distler	H. Oldham
A. Ebinger	C. G. Pangburn
R. C. Ennis	W. A. Shewhart
H. M. Fee	T. Smith
T. C. Fry	N. R. Stryker
Ella Good	E. Van Horn
J. P. Greene	C. P. Wells
F. Holi	E. S. Wolek**
Gertrude Keiningham	

*Federal Telephone and Radio.

**Transferred from other Chapters.



Booth for use of wheel-chair patients (center background) in an attended service location

the newly organized Laboratories Chapter. Of this number there were 885 active members, 106 life members and 3 other members. As of June 30, 1944, there were 1,243 members composed of 1,107 active members, 122 life members and 14 other members.

Telephone Service Aids Soldiers' Recovery

Our servicemen all over the world find the telephone one of the strongest links with home, and therefore it has become an important factor in the welfare and morale of these men. Nowhere is the importance of the telephone more in evidence than in our Army and Navy hospitals for our returned wounded veterans.

At Crile General Hospital in suburban Cleveland, within thirty-six hours after the arrival of the first group of men, over half of them had placed long distance calls.

The problems the operators must cope with are varied and numerous. One soldier had only a post office box number as his wife's address, but the operator, with the help of the police and fire departments and the rationing board, completed the call.

The telephone company provides special

wheelchair booths for the patients' privacy and comfort, current magazines, cigarettes, comfortable chairs, and for the more inquisitive patient they offer a map of the United States, a world globe, an atlas, a dictionary, and even, on occasion, mail-order catalogues!

Although some of the patients are confined to their beds, they too have telephone service. Arrangements have been made to have plug-ending telephone sets available to all the men for both incoming and outgoing calls.

In the 69 larger hospitals, 33 attended locations are already installed and plans are reported for the installation of 31 more. In addition to this hospital service, as of May 1 there were 499 attended telephone centers located at or near military establishments. Of these 309 were in 239 camps and 120 installed at locations primarily for the use of the Armed Forces.

Fourth "E" Award

For the fourth time, the Laboratories has won the Army-Navy Production Award for high achievement in the development and design of military equipment. In notifying the Laboratories, Robert P. Patterson,

Under Secretary of War, said: "I am pleased to inform you that you have won for the fourth time the Army-Navy Production Award for outstanding achievement in producing materials essential to the war effort. By maintaining the distinguished record which previously brought you distinction, you are once again proving your leadership on the production front. This third White Star added to your Army-Navy Production Award flag carries with it the thanks and congratulations of our Armed Forces."

With this award, new lapel pins became available for all those who were connected with the Laboratories on June 30, 1944, and who had not received a pin for the previous award, which was "as of" December 31, 1943. In addition, contractors' employees who work under Laboratories supervision are eligible.

G. C. Crawford, 1875-1944

G. C. CRAWFORD formerly of the Systems Development Department, who retired from active service in 1940, died on June 28. Mr. Crawford held the degrees of A.B., A.M. and S.B. from Harvard. He taught at

the University of North Carolina for a year and then, in 1905, joined the Western Electric Company where he remained until 1908 when he left to join the staff of the College of the City of New York. He returned to West Street in 1911.

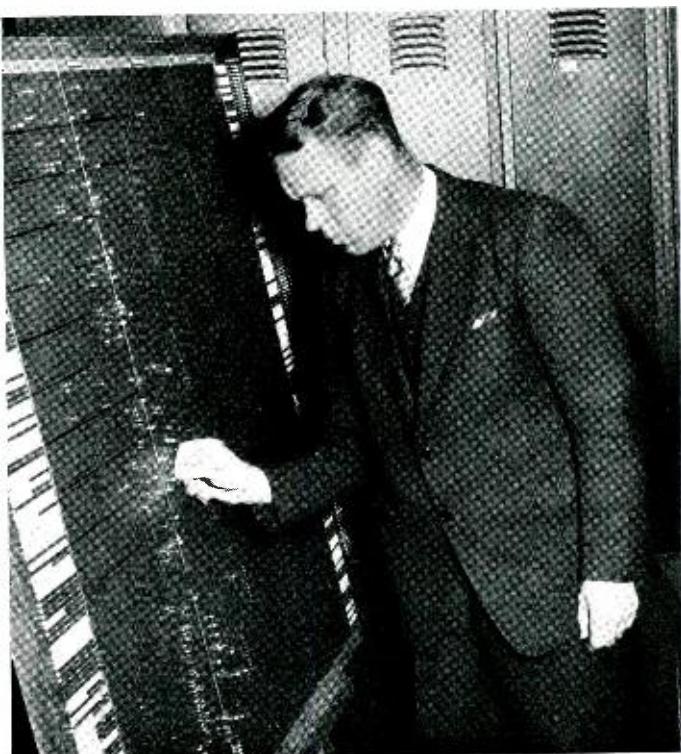
Mr. Crawford, from 1905 to 1908, made several important contributions to the application of probability to trunking problems. Later he engaged in the development of ringing systems, repeaters, and testing and maintenance switching methods for carrier and coaxial repeaters.

Telephone Call Saves Bomber Test Crew

How a telephone call saved the lives of a four-man test crew aboard a Flying Fortress was told recently by newspapers at Denver, Colorado, where the big bombers undergo changes to fit them for the various theaters of war. Everything went fine during the test until they were ready to land and discovered they couldn't—the landing gear would not lower. That was bad, because to make a belly landing with a Fortress you first must drop the ball turret on the under-

SHOP SCHEDULE BOARD AT MURRAY HILL

Progress of jobs in the Development Shop at Murray Hill is readily seen from this board. Each job has its horizontal line on which pins indicate projected or actual dates for completion of certain steps, such as "order received," "material received" and "completion." The current date is marked by the vertical cord. A. E. Emerson, who is in charge of Murray Hill shop-work, is shown with the schedule board which he designed



side, and neither the experienced test pilot nor the others aboard knew how this was done.

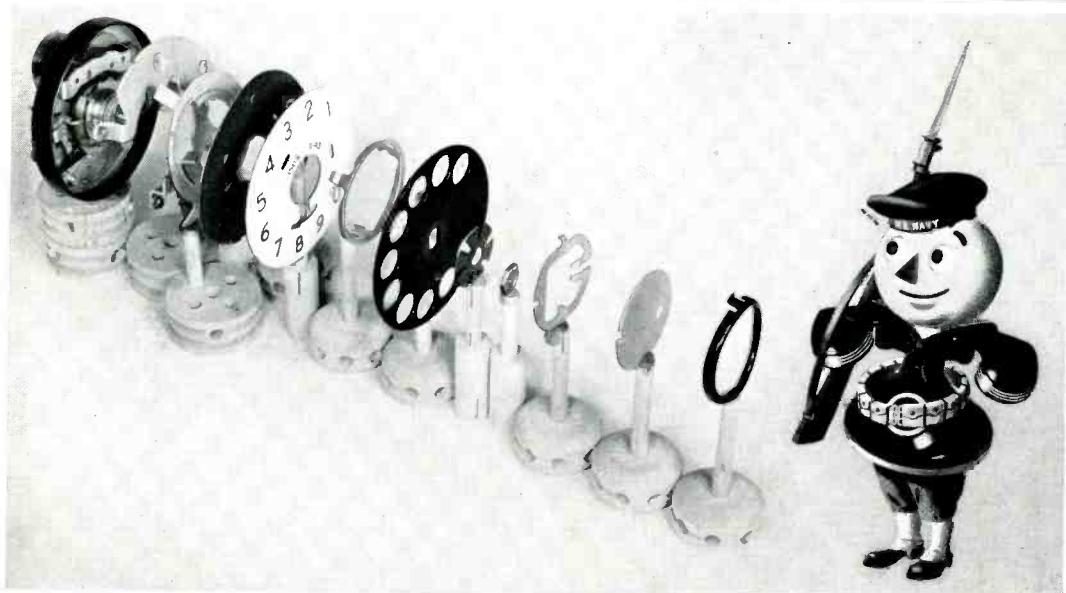
The pilot hadn't had a great deal of experience with bombers. He had been taking a course on how to make emergency landings in the big ships, but the part about dropping the turret wasn't due until his next lesson. Contacting the Fortress modification center by radio, he told of his predicament and suggested that the *Boeing Field Service News* advance the publication date on the particular lesson he needed.

While the Fortress circled the field according to instructions, Army authorities telephoned Boeing officials at Seattle, got the information in a hurry and related it by radio to the plane. From the information thus obtained, the crew was able to unfasten the proper bolts and the turret went sailing down. With that out of the way, the pilot negotiated what



The honorary degree of Doctor of Science was conferred on Harvey Fletcher (right) by the University of Utah on June 6, where he gave the commencement address. He is shown with Dr. W. H. Leary who also received an honorary degree

was termed a "remarkable" belly landing on Lowry Field. In the landing none of the plane's crew was injured.



SAILOR BELL TELEPHONE INSPECTS A SQUAD OF REPLACEMENTS

Reporting for duty in telephone dials are piece-parts of steel instead of the brass and aluminum which have gone to war

Battle of Transportation Critical

Decisive battles may appear at home or at the front. Battles at the front highlighted at critical stages by headlines get maximum support necessary to bring victory. Even for these thrilling events coöperation is hard to obtain during the dull stages of preparation.

Waves of optimism roll in about our present battles at the front but isn't it true either side could win the grand decisive battle much more easily and less costly if the opponent's transportation system would collapse? We read with glee each small bit of questionable news which indicates the German home transportation system is rolling on squeaky axles, but are we doing everything we can to maintain our own transportation system? Tire and gasoline shortages are still acute, and if we are not cutting our own use of these vital transportation elements to the minimum, we are not doing our part. With this object in view, we must continue to keep our car pools operating efficiently.

Dr. Jewett Appointed to Committee on Post-War Research

The Secretaries of the War and Navy Departments have organized a twelve-man Committee on Post-War Research as a



Charles G. Spencer of the Switching Development Department, with the longest service record of any present member of the Laboratories, receives his 45-year pin from Dr. Buckley

permanent institution to provide new ideas in warfare. The Chairman of the Committee is Charles E. Wilson, Vice-Chairman of WPB, and the members are:

CIVILIAN SCIENTISTS

Dr. K. T. Compton, President, Massachusetts Institute of Technology.

Dr. J. C. Hunsaker, Chairman, National Advisory Committee for Aeronautics.

Dr. Frank B. Jewett, President, National Academy of Sciences.

Dr. M. A. Tuve, Carnegie Institution of Washington (representing the Office of Scientific Research and Development).

WAR DEPARTMENT

Major Gen. O. P. Echols, Assistant Chief of Air Staff, AAF.

Major Gen. A. W. Waldron, Chief of Requirement Section, AGF.

Brig. Gen. W. F. Tompkins, Director, Special Planning Division, WDSS.

Brig. Gen. T. D. Weaver, Director, Industrial Mobilization, ASF.

NAVY DEPARTMENT

Rear Admiral J. A. Furer, Coördinator of Research and Development.

Rear Admiral E. L. Cochrane, Chief of the Bureau of Ships.

Rear Admiral G. F. Hussey, Jr., Chief of the Bureau of Ordnance.

Rear Admiral D. C. Ramsey, Chief of the Bureau of Aeronautics.



V. A. Douglas with Lieut. J. H. Willig of Wright Field discuss captured enemy communications equipment



ON JULY 11, members of the 1909 Western Electric student class held a 35-year anniversary luncheon at West Street. There were 65 in the original group which started at Hawthorne and there are 30 who are still active in the Bell System. In the photograph shown above are, left to right: H. L. Nash, W. E. Distributing House Manager at Newark; W. J. Shackelton, B.T.L.; "Doc" (E. M.) Williams, W. E. General Installation Engineer, New York; H. E.

Marting, B.T.L.; and A. W. Bates, W. E. Telephone Sales Division, New York. Others attending were George Dobson, H. H. Glenn, C. W. Lowe, H. H. Lowry, D. D. Miller, R. L. Quass, H. C. Spryer and T. C. Wright.

It has been a hobby of Mr. Williams to keep a record of the whereabouts of the various members of this group and several anniversaries have been observed in recent years by those around New York.

During the Months of May and June the United States Patent Office Issued Patents on Applications Previously Filed by the Following Members of the Laboratories

W. P. Albert	C. S. Fuller (2)	P. V. Koos	E. E. Schumacher
G. E. Atkins	E. W. Gent	J. A. Kreecek (2)	C. F. Seibel (2)
C. C. Barber	H. W. Goff	W. Y. Lang	O. A. Shann
H. I. Beardsley	E. Gray (2)	W. V. K. Large (2)	E. J. Singer
W. M. Bishop	N. J. Hall	G. A. Locke	E. A. Thurber
W. L. Bond	C. D. Hanscom	C. W. Lucek	D. E. Truckseß
A. R. Bonorden	H. C. Harrison	R. F. Mallina (2)	H. E. Vaughan
L. G. Bostwick	I. H. Henry	T. A. Marshall (2)	L. Vieth
G. M. Bouton	F. H. Hibbard	M. B. McDavitt	W. O. Wagenseil
A. J. Busch	W. H. T. Holden (3)	J. B. McKim	J. W. West
C. J. Christensen	A. W. Horton, Jr.	J. M. Melick	J. H. White (2)
K. G. Compton	A. E. Joel, Jr.	O. S. A. Mesch	L. T. Wilson
F. S. Corso	K. S. Johnson	J. F. Morrison	L. A. Wooten
H. L. Coyne	A. C. Keller	O. Myers (2)	C. H. Young
H. E. Curtis	A. R. Kemp	N. D. Newby (2)	W. R. Young, Jr.
C. A. Dahlbom	R. J. Kent	G. S. Phipps	M. K. Zinn
K. H. Davis	G. V. King	P. H. Richardson	E. A. Zupa
O. J. Finch (2)	J. H. King	H. C. Rubly	

Markers for the Crossbar Toll System

By O. MYERS
Switching Development

THE function of a marker is to find an outgoing line or trunk conforming to a code transmitted to it by a sender, and then to find and establish an idle path through a train of two crossbar frames to this line from the incoming trunk whose position is indicated to the marker through the sender. In the local crossbar* system there are always two such trains: a district link and office link frame at the originating office, and an incoming and line link frame at the terminating office. Since the grouping of the trunks and links on the office link frame differs from that of the lines and links on the line link frames, marker operation for the two trains is different, and two types of markers—originating and terminating—are employed. In the No. 4 toll office only one train of switches is involved in any one call, and the markers employed resemble the originating markers in some respects and the terminating markers in others. Besides these functions it has in common with local markers, the toll marker has certain additional ones required by toll traffic. The apparatus with which it is associated and the major paths over which it operates are indicated in Figure 1.

After a sender has recorded the code for the desired trunk group, it seizes a marker through a relay connector, and transmits the code to it. The marker performs its



work in a number of successive stages. It records the code transmitted by the sender, and then operates a trunk-block relay associated with the desired group of trunks. It then tests these trunks to find an idle one. Having found an idle trunk, it seizes the outgoing frame to which this trunk is connected, and then seizes the incoming frame to which the incoming trunk is connected. On gaining access to these two frames, it finds an idle path through them, and then establishes the connection. It then notifies the sender of this fact, and asks for release. Had it encountered trouble in the course of this work, it would have momentarily connected itself to a trouble indicator, and informed it of the type and approximate lo-

*RECORD, February, 1939, p. 173.

cation of the trouble, and would then have signalled the sender to make a second attempt to complete the call by means of using a different marker.

With the No. 4 toll office, two different arrangements of frames are possible depending on the size of the office. In the simpler arrangement, all the switch frames form part of a single train. Both outgoing toll lines and trunks to local offices terminate on the secondary switches of the outgoing frames, and the same group of common equipment handles the traffic for both. Where the traffic is greater than can economically be handled by a single group of outgoing frames, two trains are provided: one for connecting to outgoing toll lines, and one for connecting to trunks to local offices. The markers will vary slightly depending on whether one or two trains are employed. With one train, "combined" markers are used, and these must be able to handle any type of call. When two trains are used, "intertoll" markers are used for the train completing calls to outgoing toll lines, and "toll completing" markers are used for the train completing calls to local offices. The Philadelphia installation is of the two-train type, but the operating features differ in only a few details from the markers of the "single train" system.

One of the unusual features of the toll marker is the large variety of codes that it must be able to record and act upon. The outgoing trunks to which it may be required to make connections may be divided into four major types depending on their destination. They may run to local central offices in the area in which the crossbar toll office is located; they may be toll lines to distant cities; they may be

service trunks to special operators such as information; or they may be TX trunks, which run to switchboards where operators handle calls that cannot be completed at the time, generally because all trunks are busy or—on a person-to-person call—because the called person is not available. Moreover, the codes for toll trunks may have either three or four digits—three digits being used when it is not expected that there will be more than 469 toll codes, and four digits when there are more than this number. Similarly, there are three possible types of codes for TX trunks depending on the size of the office. A one-digit TX code is used when there are not more than 9 TX positions; a two-digit code, when there are from 10 to 90; and a three-digit code when there are more than 90 TX positions.

In any one marker, however, only one type of TX code will be used, but a marker may handle both three-digit and four-digit intertoll codes. All TX codes have a prefixed 11 to indicate the nature of the 1, 2, or 3-digit code that follows, and the first digit of the four-digit toll codes is a prefixed 0 to differentiate it from the three-digit codes.

Actually, the marker itself records three

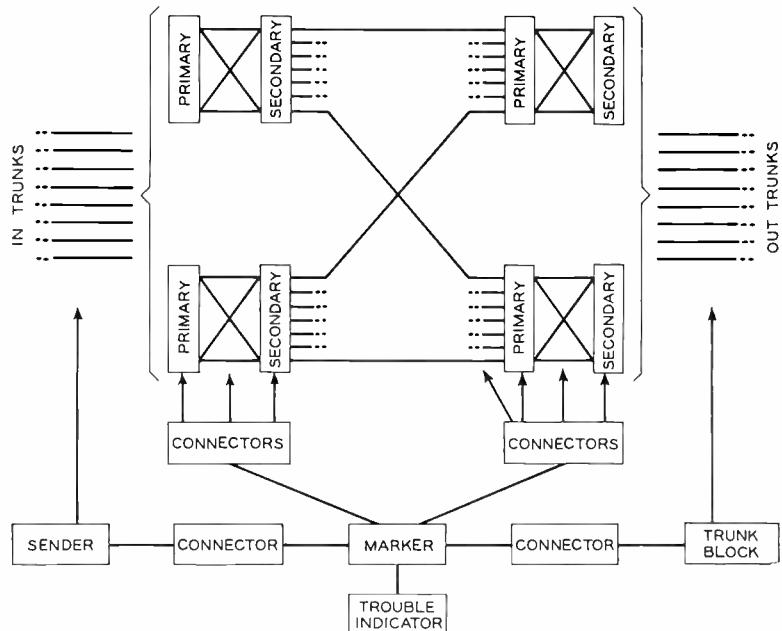


Fig. 1—Block schematic for crossbar toll train showing paths of control and association for the markers

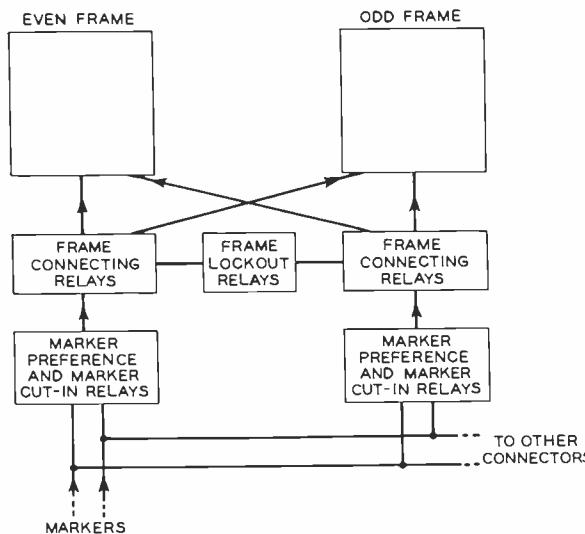


Fig. 2—Block schematic indicating the possible paths over which markers gain access to odd-numbered and even-numbered frames

digits for all codes. The prefixed digits indicating the type of code, such as the 0 for four-digit codes and the 11 for TX codes, are retained by the sender, and some other indication is transmitted to the marker to indicate the type of code. With the one-digit TX codes, the sender builds out to three digits for transmitting to the marker by adding two 0's, while with the two-digit TX codes, it adds one 0.

All markers are arranged to record and decode three-digit codes for either toll lines, local offices, or service positions. TX codes are required only in connection with calls for local completion, and thus provisions for recording and decoding them are not required in intertoll markers. All combined and toll-completing markers, however, are arranged for decoding TX codes, but they will provide for only one of the three possible types, that is, either one-digit, two-digit or three-digit.

The marker decodes the digits it has recorded by operating route relays in the same way as do the originating markers* of the local system. For each code used, the marker may provide from 1 to 12 route relays, each capable of directing the marker to a maximum of 40 outgoing trunks, the number of route relays depending on the

*RECORD, June, 1939, p. 327.

size of the trunk groups, and in some cases upon the nature of the incoming and outgoing trunks. Thus for a single destination there may be one set of route relays for terminal-grade toll lines, and another set for via-grade lines, or there may be one route relay for trunks capable of switching in repeaters, and another for high-loss trunks not arranged for switching in repeaters.

Each route relay has twelve contacts, ten of which are cross-connectable to permit the variations required by the route. The cross-connecting arrangements are similar to those of the originating marker. Some of these contacts operate the desired trunk-block relay and indicate the trunks that should be tested. One contact operates one of a group of class relays, which in turn operates relays in the sender to condition it to fit the call in progress. Another contact tells the marker one or more of the following facts about the outgoing trunk group:

that it has facilities for switching in a repeater; that it is high loss but cannot switch in a repeater; that it connects to equipment arranged to receive a-c key pulses; or that the trunk group is provided with overflow trunks. These overflow trunks return a flashing signal to the originating operator to indicate all trunks are busy, and when a trunk becomes idle the rate of flashing is changed. This prevents operators from making useless attempts to complete calls when all trunks are busy. Other contacts on the route relay are used to operate a peg-count register for traffic studies, to operate a succeeding route relay when all trunks controlled by the first relay are busy, or to perform other required functions.

The trunk block connector operated by the route relay gives access to ten block relays each serving forty trunks, and leads from the route relay indicate the particular block relay required and the position of the desired trunk group on that relay. The trunk block connectors, to which all the markers have access, are provided with lock-out circuits to prevent more than one marker from seizing them at the same time.

While the marker is operating the route relay, a group of three frequencies received from the incoming frame over a lead

through the sender identifies the incoming frame on which the incoming trunk is located. This lead is later used to operate the incoming primary select magnet. The outgoing frame on which the selected trunk is located is similarly identified by a group of three frequencies after the idle trunk has been selected. As soon as the marker has located an idle trunk, therefore, it attempts to gain access to the outgoing and incoming frames required for setting up the connection.

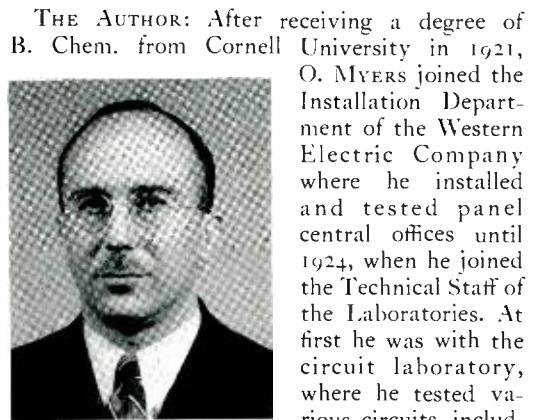
Access to any frame may be secured through either of two sets of connectors, each connector in turn having access to two frames—an odd-numbered and an even-numbered frame. The arrangement is shown in Figure 2. In reaching a frame, a marker can use either of the connectors that give access to it, but half of the senders cause the markers they seize to prefer even-numbered connectors, and half, odd numbers. In reaching a frame, the marker must pass through two sets of connecting relays, each associated with preference or lock-out circuits. The marker preference and cut-in relays prevent more than one marker from gaining access at a time to the frame connecting relays. These give access to either the odd or even frame of the pair, but since the frame connecting relays for the other frame of the pair also have access to both frames, a set of interconnecting lock-out relays is required so that both sets cannot be connected to the same frame at the same time.

Assume, for example, that an odd-numbered sender has seized a marker and that the marker after finding a suitable outgoing trunk finds that the trunk is connected to an odd-numbered link frame. It then attempts to seize the marker preference relays for the odd-numbered frame and does so if they are not in use. If it succeeds in getting these relays, it attempts also to seize the odd frame-connecting relays. If at that moment a connection is being established on the odd-numbered frame through the even frame-connecting relays, the marker will be locked out, and will have to wait until the frame is released. If the frame had not been busy, the frame-connecting relay would have connected it through at once.

Assume, on the other hand, that the odd marker preference relays had been busy.

Under these conditions, the marker seizes the even-numbered preference relays if they are idle, and then attempts to reach the odd-numbered frame through the even frame-connecting relays. These, in turn, will at once connect it to the odd-numbered frame unless it is being used by some other marker through the odd marker preference and frame-connecting relays. This paired arrangement of frames and connectors, used for both incoming and outgoing link frames, gives more dependable service since all markers still have access to all frames even though there is trouble with one of the marker cut-in relays.

After the marker has obtained connections to the incoming and outgoing frames it needs, it locates an idle path through the two frames from the calling trunk to the selected outgoing trunk, operates the proper select and hold magnets, and then signals the sender to release it. In this work, the marker tests the leads over which it operates for open circuits or false grounds, and after the connection has been established, it tests the complete circuit through the sender, incoming trunk, incoming frame, outgoing frame, and outgoing trunk, and if on any of these tests it finds trouble, it seizes the trouble indicator to report the condition.



THE AUTHOR: After receiving a degree of B. Chem. from Cornell University in 1921, O. MYERS joined the Installation Department of the Western Electric Company where he installed and tested panel central offices until 1924, when he joined the Technical Staff of the Laboratories. At first he was with the circuit laboratory, where he tested various circuits, including the decoder sender, and the toll key-pulsing system. In 1929 he transferred to the sender design group where he worked on senders, decoders, and test circuits. In 1932 he took part in the fundamental design work of the crossbar system. Since that time he has been engaged in the development and design of the crossbar system, mostly in connection with marker circuits that are used for both local and toll crossbar systems.

All of the marker operations are completed in about eight-tenths of a second.

Since markers complete their functions in such a very short time, their call-handling capacity is very great, and as a result, comparatively few of them are needed in an office. This makes it important to make sure they are never delayed by equipment troubles. Steady progress in handling the call is assured by three timing circuits, one or more of which time each phase of the marker's operation, and if an unusual delay is encountered, causes the condition to be reported to the trouble indicator and the marker to be released. These three timing circuits are called the condenser time-out, the short time-out, and the long time-out. The condenser time-out allows about one-

half second for each of the several marker stages, and when trouble is encountered causes release of the marker. If a marker is delayed, this timing is cancelled.

The short time-out provides five possible intervals, and for each stage in the marker's progress it selects an interval corresponding to the maximum delay the marker might normally encounter at that stage. It does not stop when the marker is locked out by a connector, and thus takes care of excessive delays in waiting for access to busy equipment, and also guards against failure of the condenser time-out circuit.

The long time-out provides an overall safeguard against failures of both of the other two and in addition gives an alarm should a marker be held busy falsely.



Signal Corps Photo

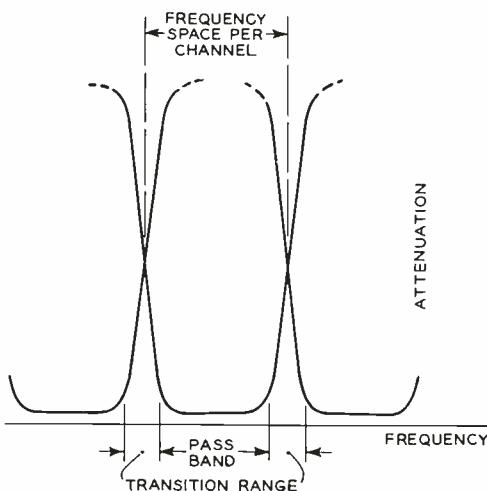
Some three years ago the lashing machine for aerial cable was described in the RECORD. The method proved popular with Bell System construction forces—so popular that when Ira Craddock, a former Southern Bell splicer, found himself at work on a cable job for the Army near Port Moresby, he felt lost without his lasher. Like all Technicians 3rd Class, what the Army didn't issue he must improvise. The result is pictured above. Note the counterweight, adjustable to offset the decreasing weight of the spool as the lashing wire is paid out



Historic Firsts: Quartz Crystal Filters

IN THE earlier carrier systems, band-pass filters made of coils and condensers were used to divide the available frequency range into channels. Such filters interpose very small loss to frequencies within a certain range, and very high loss to frequencies both above and below this range. Between the regions of high and low loss, however, is a transition range in which the loss is changing from low to high. The minimum width of this transition range depends directly on its position in the frequency spectrum, and inversely on the ratio, usually called Q , of reactance to resistance of the filter elements. The frequency space required for each channel is thus not the width of the pass-band alone, but of the pass-band plus the transition range, or of the pass-band plus half the transition range on each side. For any given range of frequency, therefore, the smaller the width of the transition range, the greater will be the number of channels that can be provided.

Since condensers can be obtained with Q 's many times higher than those of ordinary coils, it is the Q of the coil and the frequency of the pass-band that control the minimum width of the transition range. With commercially practicable coils, the highest Q that can be obtained is about three hundred. With the only moderately high frequencies of the early carrier systems, this value of Q provided a fairly satisfactory ratio between the width of the pass and transition bands. It was recognized that this limitation in the value of Q would be serious at much higher frequencies.



A short time after World War I, Lloyd Espenschied was carrying on radio and carrier research at the higher frequencies, and was acutely aware of this limitation. The piezo-electric oscillator had already been invented by A. M. Nicolson of these Laboratories, and in the early 1920's, Professor W. G. Cady of Wesleyan University called attention to the extremely sharp resonance effects obtainable from piezo-electric crystals of quartz. Put in other words, such crystals had a Q of twenty thousand or more. Mr. Espenschied at once conceived the possibility of using such crystals as elements of band filters so as to narrow their transition ranges

and to take advantage of the lower and more uniform losses obtainable over the pass-band because of the smaller dissipation of the quartz elements.

At this time carrier transmission was used to only a limited extent and at moderate frequencies, and thus the need for narrowing the transition range was not pressing. Moreover, considerable study was required to discover the most effective means of utilizing crystals as a part of a band filter network. As a result, it was not until 1926 that an investigation revealed the manner of substituting a crystal element for the coil and condenser resonators of the filter circuit. Patent No. 1,795,204 was issued to Lloyd Espenschied as the original inventor on March 3, 1931.

The first use of crystal filters in a communication circuit was in 1930; and in the coaxial and other broad-band carrier systems they have proved of great value.

Nylon for Silk

By E. B. WOOD

Transmission Apparatus Development

WHEN Joseph Henry wound his first electromagnet, the wire he used was insulated with silk. That was over 100 years ago, and ever since, silk has been used for wire insulation in spite of its high cost and the frequently uncertain supply during periods of unsettled trade conditions. Silk possesses a unique combination of properties that has made its continued use desirable in some fields and essential in others.

For telephone equipment, silk insulation has been employed on two major classes of wire: "switchboard wire," which is used either as individual wires or in the form of cable to interconnect apparatus and equipment assemblies, and "magnet wire," which is used for coil windings. These two classes of wire differ widely in their physical requirements, and employ entirely different types of silk.

Switchboard wire, which is made in conductor sizes from No. 14 to No. 24, has used a comparatively heavy silk yarn wrapped in a double layer over the conductor and then covered with a layer of cotton. This silk in more recent years has been a comparatively cheap grade—spun both from the short lengths that result when the moths eat their way out of the cocoons, and from other waste fiber accumulated in processing.

For the silk-insulated magnet wires, on the other hand, it has been necessary to use the finest and most expensive grade of continuous-filament silk.

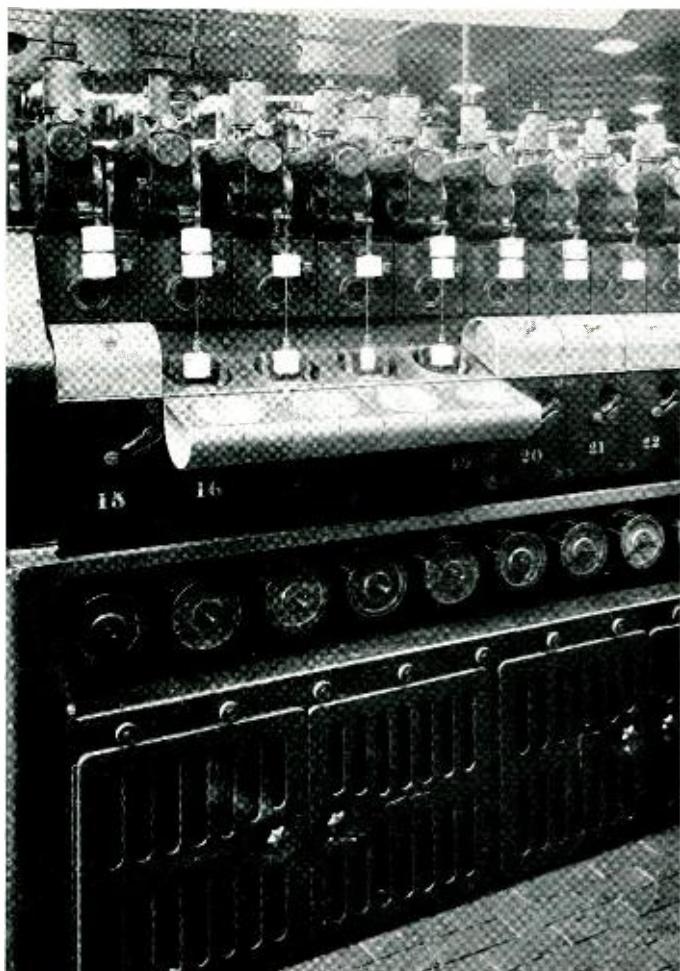
For a number of years the Laboratories and the Western Electric Company have been actively engaged in an effort to replace silk with domestic substitutes. With the unsettled world conditions that developed in the later '30's, this effort was intensified with the result that in 1940* most of the silk used for the switchboard type wires was replaced by cellulose acetate rayon yarn.

Magnet wires, in general, use several



types of insulation, including enamels and textiles. In the communication field, much of the magnet wire is in small sizes, such as No. 30 to No. 42, and the insulation must meet special requirements. To obtain the required electrical coil-constants, the insulation must be as thin as is practicable so that a large number of turns of the wire may be wound in very small space. It must also be extremely uniform in size and quality so that coils may be made in large quantities within precise limits. Most important of all, the insulation must be free from impurities that might cause electrolytic corrosion, with resulting open circuits in coil windings. High grade enamel insulation meets these requirements to a considerable extent, and enamelled wire has found extensive application in communication coils. An enamel covering alone, however, is not sufficiently free from imperfections to meet the performance requirements necessary for many types of precision high-frequency coils. In some applications, also, enamel cannot be relied upon to withstand the combined effects of heat, pressure between turns in the winding, and applied voltage; and, as a result, it has been found necessary to add the protection of a textile covering.

*RECORD, January, 1942, p. 123.



One end of a magnet wire insulator which simultaneously applies nylon yarn insulation to twenty-eight wires at the Kearny plant of the Western Electric Company. From spools of enamelled wire on horizontal spindles on the lower part of the machine, the wires are carried vertically up through "packages" of multiple nylon yarn, which is wound around the wire at high speed. The wires thus insulated are carried through reserve packages, which are used successively as the yarn on the preceding package is exhausted, and thence to take-up spools at the top. The multiple thread packages are wound from single thread supply cones similar to the one shown at the head of this article

For these reasons it has been necessary to retain silk for those uses where enamels alone were not satisfactory, and where very thin high-grade insulation was needed. The silk for this purpose was carefully selected for purity, uniformity and freedom from broken fibers or other imperfections.

When silk was used on wire, it was applied by wrapping it around the wires at high speed without spacing or overlap to form a smooth single layer less than one-thousandth of an inch in thickness. This was called "serving" the silk on the wire. In other cases the silk was applied in two layers wrapped in opposite directions. In still other cases the silk was applied over enamel to give greater dielectric strength.

The material for this use must be strong, light, and flexible, and must have the proper elasticity in addition to good electrical properties. Cellulose acetate rayon, although of satisfactory insulating value, could not be applied in the fine size required for magnet wire insulation and at the high speeds employed, without excessive breakage of the fibers. Other commercial rayons were investigated, but these were even less promising because of similar breakage difficulty, inferior electrical characteristics, poor heat resistance or other limitations.

In 1932, after Carothers and Hill of the duPont Company had published a series of articles on condensation superpolymers and their preparation, engineers of Bell Laboratories recognized that these materials had properties making them of probable interest for wire insulation; and an investigation of their use for such a purpose was begun.

When the duPont Company, in 1938, announced the development of yarn of one of these condensation superpolymers, which they called nylon, the Laboratories at once obtained samples to test for wire-insulating purposes. The preliminary test results were so promising that a program of investigation looking toward the

use of nylon as a general substitute for magnet-wire silk was initiated.

Test runs by the Western Electric Company showed that nylon could be applied to all the commercial sizes of magnet wire, at standard insulating speeds, to produce coverings closely approximating in thickness and smoothness those obtained with silk. Also it was found that, in general, nylon-insulated wire could be used in coils in place of the standard silk-insulated wire without any changes—in coil design information, so that from the point of view of production, nylon could be substituted directly for silk.

In the meantime, the Laboratories were making an extensive investigation of the electrical and chemical properties and the chemical stability of nylon yarn in comparison with silk under adverse aging conditions. Also, comparative studies were being made of the performance of representative types of coils wound with nylon wire and the standard silk-insulated product, with respect to electrical characteristics, aging properties, and corrosion tendencies under severe conditions of temperature, humidity, and voltage. As a result of these studies, the conclusion was reached that nylon yarn, as represented by the samples studied, was superior to silk in insulation resistance and in protection against electrolytic corrosion of copper. Its aging properties appeared satisfactory, and its dielectric characteristics were considered acceptable for its use in high-frequency coils. Nylon yarn was accordingly approved by the Laboratories as a general substitute for silk for magnet-wire insulation on January 7, 1942.

As soon as war with Japan was declared, it was recognized that silk imports would be cut off, and the OPM, now the WPB, requested the magnet-wire industry to find or develop a substitute for magnet-wire silk. A meeting of representatives of the silk suppliers, the magnet-wire manufacturers, and the Defense Supplies Corporation was held January 15, 1942, and a committee was appointed to carry out this work. Representatives of the Laboratories and the Western Electric Company attended this meeting, and as a result of the work that had been done already, were in a position to offer definite recommendations for the use of nylon yarn as the only satisfactory substi-

tute for magnet-wire silk that could be applied successfully with existing insulating machines and methods. The Laboratories and the Western Electric Company made available all their technical information on the use of nylon yarn for this purpose and later furnished the requirements used in the specification for magnet-wire nylon yarn adopted by the industry and the departments of the Government.

The initial requirements specified by the Laboratories called for a nylon yarn made up of twenty individual filaments. This yarn, which had been furnished for the initial experiments, was closely equivalent to silk in filament size, softness, and handling properties. The filament size of this yarn was smaller than that of yarn manufactured for fabrics, and since the finer filament required considerably more production capacity per unit weight of yarn, it was necessary to consider yarn of larger filament size because of the great demand for this material for special war purposes. Samples equivalent in over-all size to the twenty-filament yarn, but made up of seven, ten, and thirteen filaments respectively, were investigated. The thirteen-filament material was considered usable, and was adopted as standard under the specification. The larger filament yarns were unsatisfactory for two reasons. First, they were too stiff, and in wrapping them on fine wires there was a

THE AUTHOR: E. B. Wood was graduated from Princeton University in 1915 with the B.S. degree and received an A.M. there the following year. He served overseas during the war as a captain in command of a battery of coast artillery. On returning he taught physics for a year at Pratt Institute and then joined the Laboratories in 1920. Here his work has been largely on central office wire, cable and cords, and has been active in the development of purified textile insulation and cellulose acetate treatment. In this connection he has developed methods and apparatus for the precise control of humidity.



tendency for the conductor to wrap itself around the insulation instead of the insulation being wrapped smoothly around the conductor. Furthermore, the larger, stiffer filaments did not lie as smoothly and closely, and the wires were over-size.

In the manufacture of nylon yarn, molten nylon is forced out through tiny holes to form fine filaments, which become solid on striking the air. The desired number of filaments is then grouped together to form the yarn. This operation is called "spinning." To lubricate the fibers during the spinning operation, and to prevent them from becoming tangled due to the effects of static electric charge, it is necessary to apply to the fibers an oil or similar material called a "finish." Also, it may be necessary to add a similar material later during the operation of winding the yarn into suitable forms, known as "packages," for use on the insulating machines that apply the yarn to the wire. It is necessary that the finish materials used on the nylon shall in no way have a deleterious effect on the insulating properties of the wire covering or upon the other parts with which the wire comes in

contact. As a result of the Laboratories' coöperative work with the manufacturer, a spinning finish was developed which, according to the results of exhaustive electrical and chemical tests, is free from any appreciable deleterious effect on the insulating value of nylon yarn. Also the Laboratories recommended the specific material to be used for any additional finish required in subsequent winding operations. Requirements and test procedures were set up to detect any significant deviations in these finishes that might affect the insulating quality of the yarn. These have been included in the general nylon specification noted above.

Many of the wartime substitutions necessitated by scarcity of materials or cessation of imports have been authorized only on a temporary basis, until supplies of the standard materials are available. The substitution of nylon yarn for silk as magnet-wire insulation, however, has been adopted by the Bell System as a permanent change, since the evidence appears conclusive that nylon will continue to prove the better material for this use.

"ELECTRONICS, TODAY AND TOMORROW"

This is the title of the latest book by John Mills, Director of Publication, which has just been published by D. Van Nostrand, New York City. The New York Public Library in its July Exhibition of Technical Books describes the book as "A readable, non-technical discussion aimed at intelligent lay readers. Electrons, electron tubes and electronic devices such as cathode-ray tubes, television, the electron microscope, ultra-high-frequency wave generators, and the cyclotron are explained."

The book covers the entire field of electronics including the lightning discharge and X-ray tubes, the experiments which identified the electron, its early application to practical purposes in the three-electrode vacuum tube, and the use of that device as a telephone repeater and as the agent for the generation, modulation and detection of high-frequency currents in radio transmission. The book also covers tetrodes, pentodes and cold-cathode tubes, and various other recently developed electronic devices and their non-military applications. The field covered is so large and complicated that the book, although easy reading, should be taken slowly by those not trained in the subject and each chapter reviewed before proceeding to the next.