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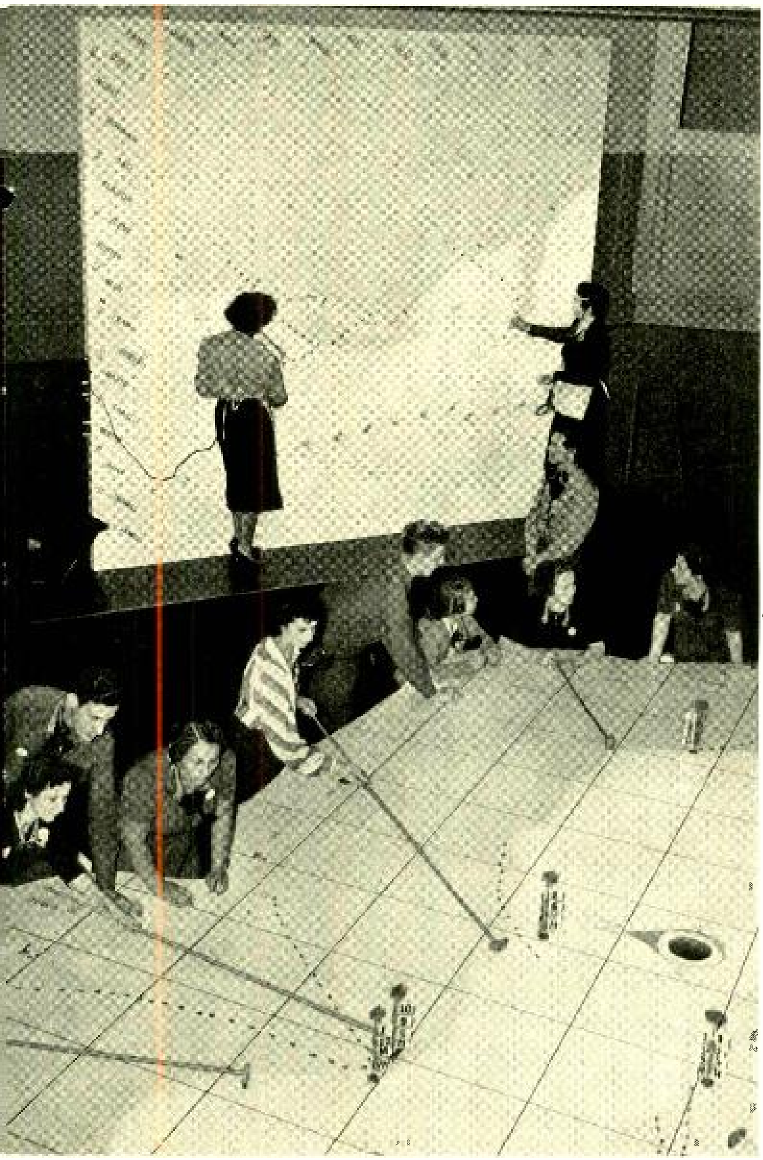

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1941

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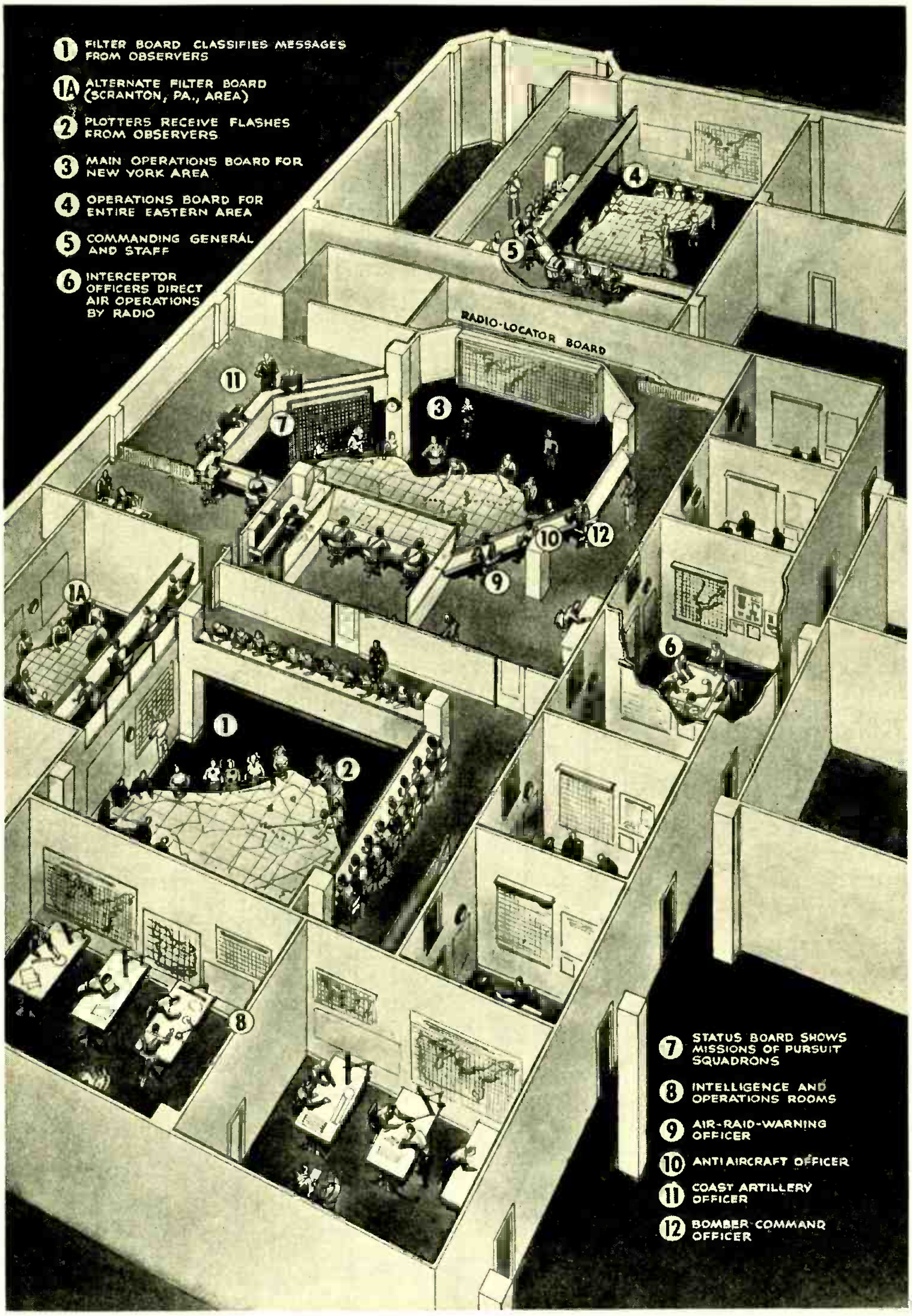
Operations Board at an Army Information Center



Courtesy "Popular Science"

A cut-away drawing of a complete Air Raid Information Center

Telephone Network Aids Air Raid Interceptors

By ALBERT TRADUP
Private Branch Exchange Engineer

AMONG the factors which brought about the defeat of the German Air Force in the Battle of Britain in 1940 was the highly organized and very efficient system of communication for air information and command. That system permitted the pursuit squadrons to operate from "ground alert" — that is, to remain in readiness on the ground and take the air against definitely located targets only. From the standpoint of delivering a blow where it was needed, the system gave to one plane on ground alert the effectiveness of 16 planes cruising about "on patrol." It also made possible the giving of air raid warnings to the civilian population in time for them to take necessary precautions.

A similar system developed by the Army with the coöperation of the Bell System has recently received extensive tests in air defense maneuvers extending along our northern Atlantic Coast. Describing this system and its operation, a statement of the First Air Force said:

"Forty thousand or more civilian observers are watching the skies for 'hostile' bombers and reporting their courses to some three thousand other

Fig. 1—Civilian Air Raid Warning Board in foreground; beyond are the test and patch boards

volunteer civilian plotters who are at work in the filter and information centers in Boston, Philadelphia, New York, Baltimore, Harrisburg and Norfolk, where operations to combat the 'enemy' with pursuit ships and anti-aircraft fire are directed by the ground and air commands.

"The men and women of the Aircraft Warning Service who are participating in this unprecedented battle drill of the air are stationed at 1800 observation posts. They may be on mountain peaks or on skyscrapers. They may be deep in the country or on rocky headlands facing the sea. All are in direct communication with the filter and information centers.

"This all-embracing network is made possible by the country's highly developed telephone system, unparalleled abroad. It leaves scarcely any area of the skies unwatched. And a constant check on the accuracy of any given observer's information is made by the reports of the other observers who are stationed along any paths the 'invader's' planes may take.

"When a civilian observer sees a plane he notes these things: its type (whether, say, it is a single, bi-, or multi-motored airplane), the compass direction in which it is flying, and insofar as possible, its altitude. This information is immediately phoned to the filter center, where most effective use is made of it.

"The filter center contains a very large table map of the area, marked into squares. These squares are identified by words and numbers—so that arrow markers representing the planes may instantly be placed in the localities where the civilian observers have reported them.

"As further reports from other observers come in, the trail of colored

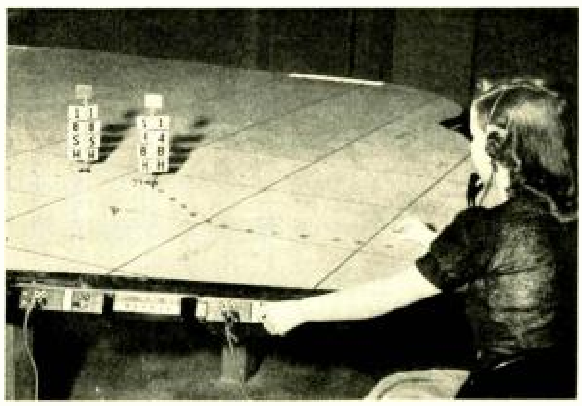


Fig. 2—A close-up of the key equipments that are provided for two plotters

arrows grows, and standards bearing the growing amount of information about their type, number, and altitude are added by the civilian volunteers who have been trained for their work.

"The filter center, true to its name, filters out erroneous judgments. The weighed evidence on the enemy's course and numbers is transferred to the information center in the next room, where on a similar but even larger map of the region his course is shown. A 'status' board shows what steps are being taken by defending aircraft, where they are, in action or in readiness, and, if they are in the air, how long they have been there and the state of their fuel supply.

"Above the status board and the table map of the region there are glass-enclosed galleries. Here, officers in communication with the defending fighter squadrons, the searchlight and anti-aircraft batteries and the balloon barrages swiftly take the measures that are called for.

"Interceptor planes from the fields nearest the area where the 'invaders' have been sighted are ordered into the air. Their navigation is plotted by officers in separate rooms at the information center, and sent by radio, so that they know exactly where to go to meet the enemy.

"Meantime, the Civilian Air Raid Warning Officer, who is also stationed in the gallery, alerts the civilian air raid wardens in areas threatened by the invading planes, and the organizations there go into action."

Development of the present air raid communication system began with one set up by various Telephone Companies in coöperation with the Army during maneuvers, using standard telephone equipment and circuits. Improvements suggested by those experiences were incorporated in larger systems set up by the New York and the New England Companies, in New York City and Boston, respectively. So promising were the results and so necessary did a nation-wide system seem that the Laboratories were requested to proceed with development of the telephone portion of the system.

Fig. 3—Officers in the balcony reach various points through 101*-type Key Equipments*

In planning the telephone facilities for the First Interceptor Command, the conditions were that quick intercommunication be afforded; that a minimum of costly circuits be tied up; and that standard telephone equipment and circuits be used as far as possible. It was contemplated that the Signal Corps would secure the facilities from the Bell System and that regular commercial rates for exchange and toll service would apply.

To spot hostile aircraft, many thousand observation posts must be set up, from any one of which reports would be infrequent. A permanent wire network would be costly, and would tie up toll facilities which might better be left available for public use. Accordingly, reports are transmitted over regular exchange service facilities to a nearby central office. Assume that this observer is on a hilltop back of Poughkeepsie. When he has anything to report, he says to his local operator "Army-Flash-Hickory." Operators—local and toll—who may receive such a call have been instructed that such a call is to be given preference, and completed to any one of a group of jacks in the New York Long Distance board marked "Hickory." From these jacks a group of toll terminal lines extends to the Information Center and terminate on subscribers' key equipment mounted just below the edge of the "filter" map, adjacent to the area designated as "Hickory," on which the observers' stations are spotted. The equipment consists of a box containing a 3-position key, two lamps, and a subscriber's set circuit. The user, generally a woman called a plotter, is warned by a lamp and buzzer, when a call is on her line. In addition, a supervisor has a line of 101B Key Equipments in front of her by which she can intercept calls which require special attention, or help out in a peak load. All of the incoming lines pass through a training and patching board, for flexibility and so that Signal Corps men can give the plotters dummy calls for practice.

Intercommunication between the various boards and between officers is afforded by standard circuits, connected to the user's head or handset as required. A few long private lines connect the operations board with similar boards in other cities, so as to follow a flight from one area to another. Other lines are connected to distant Air Corps radio equipment, in order to give direct communication with planes in flight.

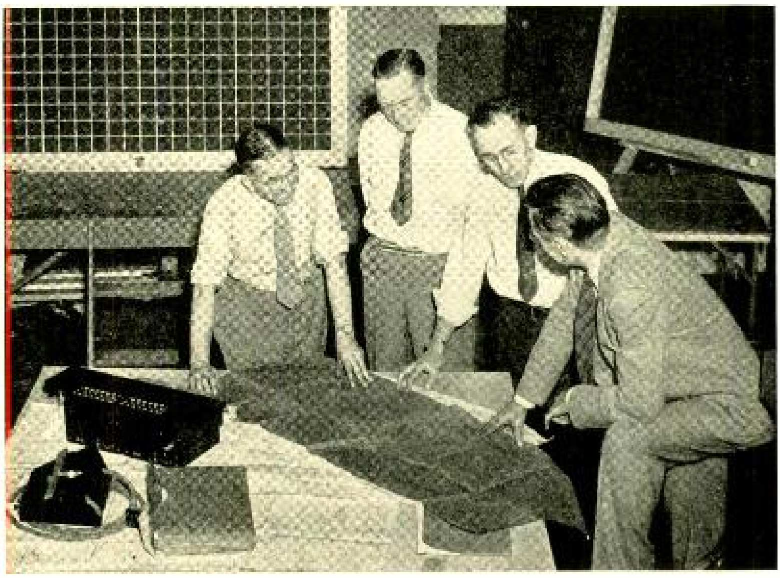
The Civilian Air Raid Warning Officer must be able to reach quickly all of his district warning centers, but calls to any one center will necessarily be infrequent. The warnings are therefore sent over toll lines. There are four kinds of warning—yellow, blue and red, for varying imminence of danger, and white for "all clear." Should the movement of enemy aircraft indicate immediate danger for the Albany district, the C.A.R.W. Officer at New York says to the attendant at his special PBX, "Albany red." That attendant plugs into a red-ringed jack in the "Albany" group and says to the New York toll operator who answers, "Albany red." At the Albany toll board, the call is completed over a line which sounds special signals in the district office. Receipt of the warning is then acknowledged by voice, and further particulars given if desired. On completion, the P.B.X. attendant leaves a dummy plug in the red jack as a reminder of the warning transmitted.

During the air defense maneuvers the system set up along the northeastern seaboard was in practical operation. A broadcast from the New York Information Center was arranged by the Columbia Broadcasting System during which Captain Wyllis Cooper, Military Commentator for CBS, said:

"This is essentially the same warning and interception system that the British have used in interdicting large sections of their island to enemy bombers. The systems were developed independently, and we are adapting British methods to our own use, while we pass on to them whatever we have discovered that they don't already know.

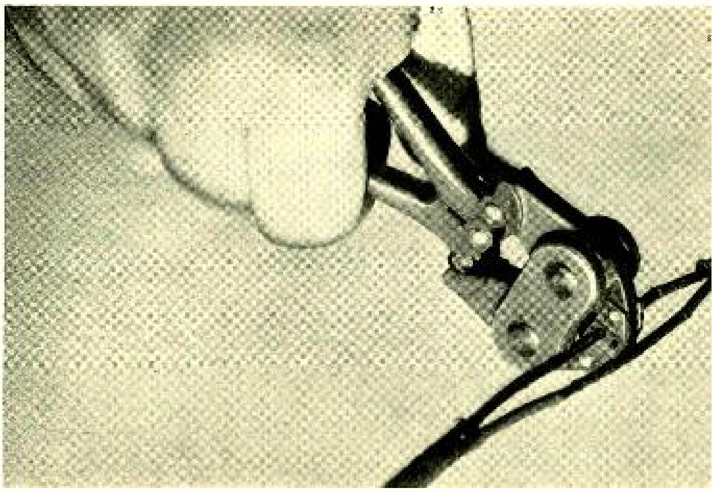
"The difference between our system and the British is this: England has high-quality telephone service, but there are relatively fewer telephones. That means that there are blank spaces that aren't covered by observers.

"That's not the case with us—we can have more observers because we have the finest telephone service and equipment in the world, all concentrated under one company; a company that has been so enthusiastically helpful in coöperating with the Army that it can be said with assurance that it couldn't have been done without the telephone company. They have developed special equipment; their engineers have worked with the Army over long periods; they have designed and built information centers and lent their experts to teach people how to run them; they have done, are doing, a magnificent job. However, the essential point about this whole ingenious system is so sound—proved so sound in battle—that it may well be the determining factor that wins wars."



Dr. Buckley has received a letter from Colonel Ira C. Baker of the Air Corps expressing appreciation for the coöperation and assistance rendered by the Laboratories during the recent Carolina maneuvers. He says, "Specifically, I wish to thank you for the technical assistance and advice given us by Mr. L. A. Dorff and Mr. L. A. Yost whom it was our privilege to have with us during part of these maneuvers. Mr. Dorff and Mr. Yost not only worked tirelessly but also displayed unusual ingenuity by installing for the first time in our Army, a mobile Information Center on wheels."

The picture shows Mr. Dorff, H. M. Hagland, A. C. Gilmore and C. W. Halligan discussing the mobile Information Center while it was being built at the Western Electric Shop at Hudson Street



Improved Method of Splicing Rubber-Insulated Wire

By C. SHAFER, JR.
Outside Plant Development

EACH year more than two million splices are made in rubber-insulated wires by Bell System workmen. Every one of these splices involves joining the conductors and putting on insulation to replace that which has been cut off. Improvements have been made in both the materials and methods; a new tool and new sleeve have been developed for joining the conductors, and a new kind of insulating tape made available.

Rubber-insulated wires used in outside plant and station wiring cover a wide range of characteristics to meet the various conditions under which they are installed. At one extreme are bronze drop wires used for extending the telephone circuit from a cable terminal to the subscriber's premises. These wires are characterized by high tensile strength. At the other end of the range are the station wires, in which compactness and appearance are primary factors. These wires are as small as is consistent with transmission requirements, and their annealed copper conductors have low tensile strength.

For joining the conductors the principles involved in the rolled sleeve splice for open wires* were utilized to provide a single-tube pressed sleeve. Both sleeves are similar except that the latter is proportionately smaller, and made of annealed brass. Because the tension in insulated conductors is lower and the sleeve-closing pressures required are smaller, it was found feasible to apply them with a pressing tool. This has advantages over a rolling tool from the standpoints both of size and of convenience.

The pressing force required, and the

*Record, *Nov.*, 1940, *p.* 89.

need for a one-handed tool small enough to be usable in confined locations, led to the selection of toggle-action pliers. As the toggle approaches dead center, the pressure on the handles actually decreases and they snap to the closed position. Stops control the die closure and thus provide a uniform splice of good quality.

Although the tool, shown in the headpiece, weighs only eight ounces and is approximately six inches long, it develops 2000 pounds pressure on a three-sixteenths inch length of sleeve with twenty-five pounds applied to the handle. The small size of the presser was achieved principally by using mated concave and convex bearing surfaces rather than pins to transmit the loads. This construction also minimizes wear and promotes long service. The small pins, seen in the illustration, serve merely to secure the assembly. Since the bearing pressures on these surfaces are high, a wax lubricant is employed.

The sleeve presser reduces the diameter of the larger sleeves at least fourteen mils and that of the smaller sleeves twelve mils. Nine mils decrease in the former and eight in the latter are adequate to produce full holding power, so the tool can wear considerably before it loses its effectiveness.

There are two pressing grooves in the pliers to accommodate sleeves of different diameters. The larger groove is for drop and buried wire and the smaller one for station and bridle wire. Sleeves for the 20- and 22-gauge bridle and station wires are an inch long and about one-sixteenth inch in diameter after pressing. Those for the 17- and 18-gauge bronze and the 14-gauge hard-drawn copper drop wire conductors differ in bore size but both types are two inches long and one-tenth inch in diameter when pressed. The bores of the latter sleeves are coated with emery and lacquer, as are open-wire sleeves, to attain the high holding power required.

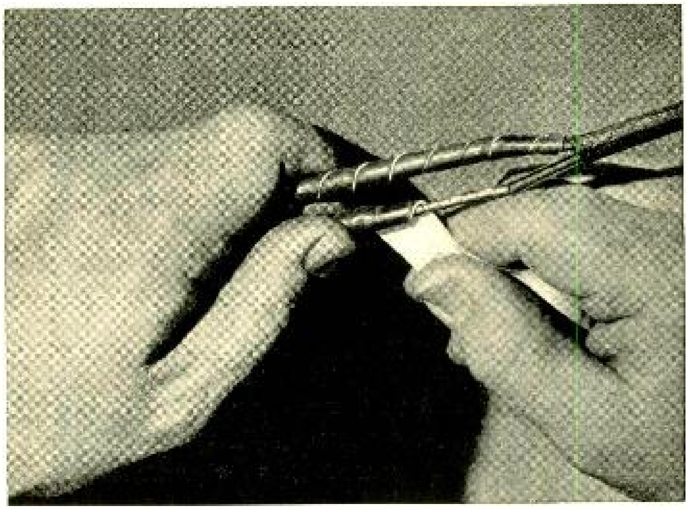


Fig. 1—Applying DR rubber-insulating tape to a pressed sleeve splice in drop wire

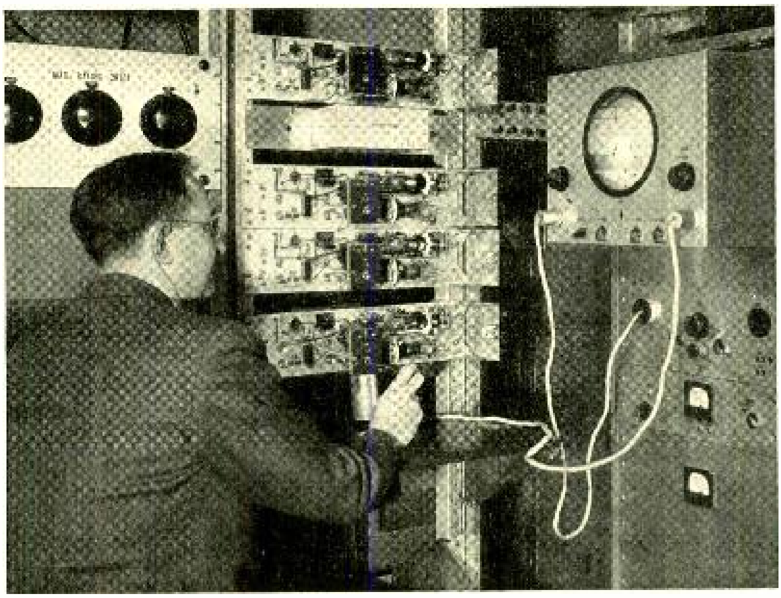
Pressed sleeve splices provide full mechanical strength and being airtight, they make permanent electrical contact. They have a smooth exterior and a small diameter; moreover, the pressing operation elongates the sleeves, a feature which has been used in splicing multi-conductor wire. If the conductors are of unequal length, after the minimum number of presses required for adequate holding power are made in each sleeve, discrepancies can be rectified by additional presses in the sleeve on the shorter conductor. A proper equalization of length distributes tensile loads equally between the conductors and, with reasonable care, splices are produced which approximate the strength of the unspliced wire.

An equally important feature of the improved splices is the use of a newly developed rubber tape, known as "DR" insulating tape, which has a layer of adhesive rubber bonded to a backing of vulcanized elastic rubber. For easy identification the plastic layer is white and the vulcanized one black. The tape is always applied with the white surface next to the conductor, so that the splice is enclosed in a layer of plastic insulating compound which flows into all the surface irregularities and bonds securely to the insulation on the conductor to form a water-tight seal. The vulcanized layer on the outside provides mechanical protection for the conductor splice and the plastic material of the inner layer.

Mechanical protection provided by the vulcanized layer in the tape, and the small diameter of the sleeves, make it unnecessary to splice the individual conductors at separated points. This shortens the length of the splice and ordinarily eliminates the need for additional wire when a broken wire is repaired.

In splicing wires which have 18-, 17-, and 14-gauge conductors, each conductor is insulated individually. A serving of DR tape is applied with each turn half overlapping the preceding one and the tape is stretched in application. This exerts a constraining effect on the underlying plastic layer. Splices made in finer insulated wires, such as the station wires which have 22-gauge conductors, are protected by folding the tape longitudinally around the sleeve and some of the adjoining insulated conductor at each end. Since the tape is ¾ inch wide it will enclose two of these conductors. With triple conductors the three splices are pressed between two layers of tape. Splices in these fine wires have not previously been protected with rubber tape but its use has markedly improved their electrical qualities. All splices are protected by an outer layer of friction tape.

Although this development was initiated primarily to improve the quality of splices, it became apparent as the work progressed that the new splice is actually more economical than those previously used.



A Ten-Megacycle Oscilloscope

By J. O. EDSON
Transmission Development

CATHODE-ray tubes used as oscilloscopes have been very helpful to engineers by making visible the recurrent variations in voltage or current at any desired point of a circuit. Such tubes have four deflecting plates, arranged in pairs at right angles to each other. Voltage proportional to the current or voltage to be measured is impressed across the vertical plates, and causes the beam of electrons to be deflected up or down in proportion to the intensity at the point of measurement. Across the horizontal plates is connected a voltage that varies as shown in Figure 1. From A to B there is a steady rise in voltage that moves the electron stream steadily from left to right for the workable width of the tube. From B to C, which is made not more than one-tenth of the time from A to B, the voltage drops rapidly to its original value, and the electron stream returns rapidly to the left side of the tube. This latter voltage cycle is provided by a "linear sweep circuit"*—a name that is descriptive of the function performed.

Previous oscilloscopes have usually employed a gas-filled tube in the sweep circuit. The AB section of the sweep cycle results from the charging of a condenser in the plate circuit. At point B the tube breaks down; the gas becomes ionized, and the condenser discharges through the ionized gas. Before the condenser can start its charging cycle, however, the gas in the tube must become deionized so that the tube will be non-conducting, and this deionization requires a small but appreciable time. Because of this

*RECORD, *August*, 1931, *p.* 571.

deionization time, a sweep circuit of this type is not suitable when the frequency to be measured is greater than about 100 kc. Until a few years ago such a frequency was high enough to cover most of the studies being made, but with the increasing use of higher frequencies in recent years, a need has been felt for a high-frequency

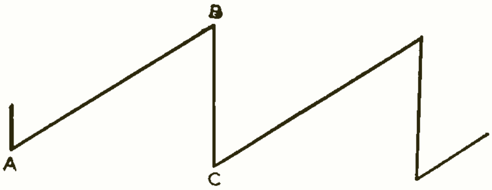


Fig. 1—Desired wave form of sweep circuit

sweep circuit. Such a circuit was developed by using a high-vacuum tube to provide the sweep frequency. No deionization is involved with such a tube, and it has been possible to secure sweep frequencies up to one million cycles. This permits frequencies as high as ten megacycles to be satisfactorily displayed. Along with the development of this new sweep circuit, it was necessary also to provide high-gain high-frequency amplifiers for use between the sweep circuit and the circuit under test and the plates of the cathode-ray tube.

The circuit employed to provide the sweep frequency is shown in simplified schematic form in Figure 2. The sweep voltage, E3, is taken off across the condenser C3 in the cathode circuit of tube V2. When this condenser is charged to a voltage higher than E1, the cathode is at a higher potential than the grid, and current flow through the tube ceases. The condenser then stops charging and at once starts to discharge through the high-resistance R3. The discharge current of a condenser through a resistance decreases exponentially with time, but over a short initial section of the discharge, the decrease is nearly linear, and it is this essentially linear drop that provides the section AB of the sweep cycle.

During this discharge period, tube V1 is passing current, and its plate current passing through R4 reduces the voltage of the grid of tube V2 below E1. As the condenser continues to discharge, E3 finally falls below the voltage of the grid, and at some definite voltage—fixed by the characteristics of the tube and the operating voltages—V2 starts to pass current. As soon as plate current flows, the voltage E5 drops because of the voltage drop of the plate current through R5. This reduction in E5 results in a decrease in the grid voltage of V1 through the coupling condenser C1. The reduced grid voltage of V1 reduces the plate current of V1, and the decreased current flow through R4 increases the grid voltage on V2. As a

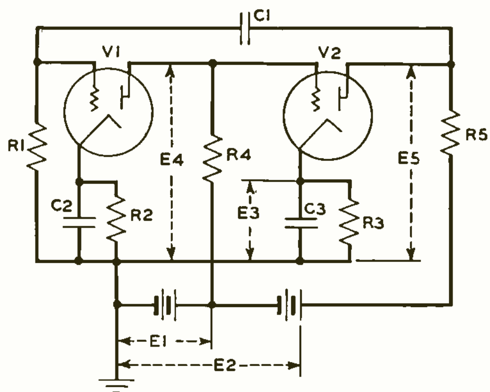


Fig. 2—Schematic of sweep circuit

result there is a rapid increase in the plate current of V2, and the condenser C3 charges very rapidly.

As it charges, the voltage E3 rises, thus decreasing the flow of plate current in V2, and resulting in an increase in E5 because of the decreasing drop across R5. This rise in E5 again affects the grid potential of V1, increasing the plate current of V1 and thus decreasing E4, which is impressed on the grid of V2. This decrease in E4 together with the increase of E3 very quickly blocks the flow of current through V2, and another cycle is ready to begin. This interaction between the plate voltage of V2 and the grid voltage of V1, and between the plate voltage of V1 and the grid voltage of V2, results in a very rapid increase and decrease in the plate current of V2. The complete increase and decrease takes place during the period BC of the sweep cycle, and it is during this very short interval that the electron stream of the cathode-ray tube is returned from the right end to the left.

Condenser C3 is adjustable in steps, and R3 is continuously adjustable. Since it is the relative value of these two elements that determines the sweep period, the sweep frequency is continuously adjustable. The range is from twenty cycles to one megacycle.

For proper functioning of the oscilloscope, the sweep frequency must be some exact submultiple of the fundamental frequency being observed; that is, it must be such that there are exactly 1, 2, 3, 4, or more complete cycles of the observed wave on the front of the tube. To secure this synchronization, C3 and R3 are set to the approximately correct values, and the precise sweep period is obtained by feeding a portion of the observed voltage to the vacuum tube V2. The value of this voltage has considerable influence on the point at which discharge of V2 begins, and by supplying it with an adjustable portion of the voltage on the vertical plates of the cathode-ray tube, the sweep cycle can be made to begin always at the same point of the wave being studied.

To deflect the electron stream to full width of the cathode-ray tube, potentials of several hundred volts are required. It is necessary, therefore, to

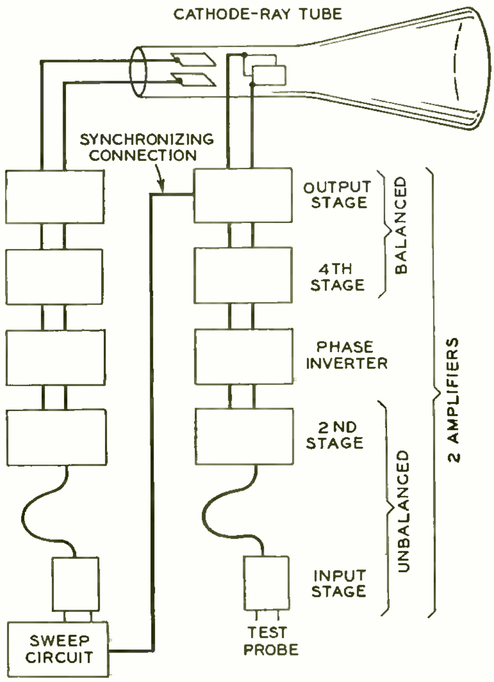


Fig. 3—Block schematic of oscilloscope

use amplifiers between the sweep circuit and the horizontal plates and between the voltage to be studied and the vertical plates. The output required is the same for both amplifiers and the frequency range required is of the same order of magnitude. It seemed desirable, therefore, to use identical amplifiers in the interest of flexibility. It was desired that the amplification be substantially constant from three cycles to ten megacycles, but the greatest difficulty in the design was to secure sufficient load capacity without wave distortion at the peak voltage.

At their output, these amplifiers must be connected push-pull because the deflecting plates of the cathode-ray tube must be balanced with respect to the anode of the tube. The input, however, should be unbalanced because the most common measurements are of voltages to ground. Moreover, it is desirable to view the wave form without disturbing the circuit being studied, and for this reason the input of the amplifier should be of very high impedance. At ten megacycles, high impedance is difficult to secure since the capacitance to ground of even short lengths of wire may result in impedances lower than the desired value. For these reasons, the first stage of the amplifier was mounted in a small aluminum shield and connected to the second stage by a shielded cord to permit the amplifier itself to be taken to the point of the test circuit where the voltage is to be taken off. This first-stage amplifier has two short prongs to which the connection to the test circuit is made.

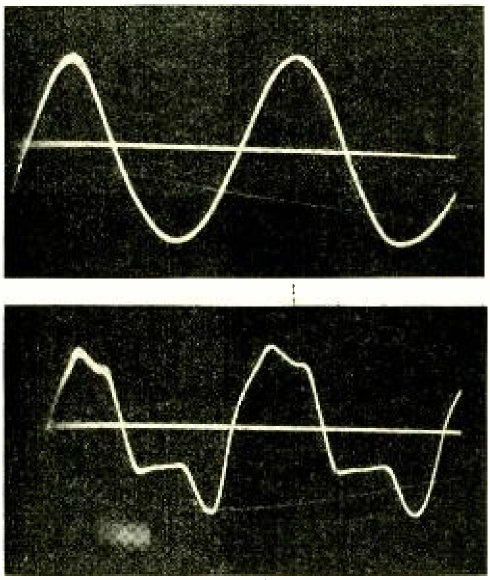


Fig. 4—A two-megacycle wave as shown by the new oscilloscope; above, nearly semisoidal; below, a distorted wave

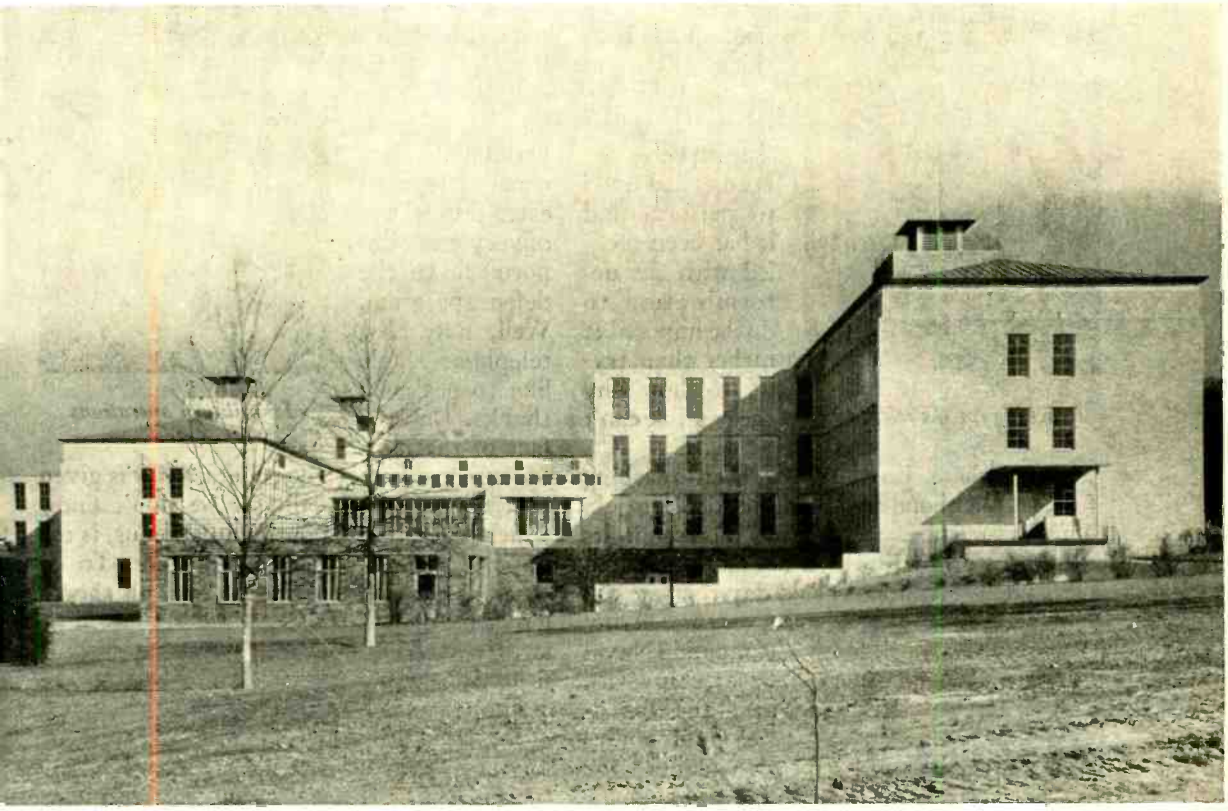
A block schematic of the entire oscilloscope is shown in Figure 3. The first-stage amplifiers on their flexible cords are called "probes," and one is connected to the circuit under test and the other to the sweep circuit. The third-stage amplifier acts as a phase inverter to transform from an unbalanced to a balanced circuit. The connection from final stage of the test amplifier to the sweep circuit runs to the screen grid to control the timing as already noted.

The two amplifiers, the sweep circuit, and the cathode-ray tube are all mounted on a single frame as may be seen in the photograph at the head of this article. Rectifiers are provided on one of the lower panels so that the instrument may be operated from a 115-volt a-c line. About 400 watts is required. Regulators are included to prevent variations in the a-c power line from affecting the operation of the oscilloscope. Oscilloscopes like this one have already proven very useful in the carrier systems laboratory, especially for checking singing conditions in feedback amplifiers. Since the horizontal time scale can be extended until ten inches represents one-millionth of a second, it is possible to observe recurrent phenomena whose time of duration is very short.

NEWS AND PICTURES

of the

MONTH



Looking from the Acoustics Laboratory toward the main group of buildings at Murray Hill. The Restaurant and Club Rooms are in the low structure shown in the left foreground

The Bell System's Biggest Job

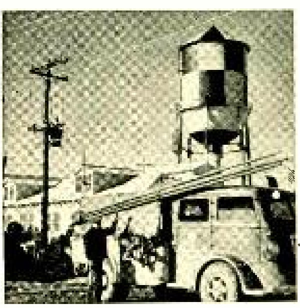
WALTER S. GIFFORD

A transcript of "The Telephone Hour," November 10, 1941

WHEN I last spoke to you, just about a year ago, I told you that the Bell System was ready to do its part on all fronts in the nation's defense program. Now, after twelve months, and on this Armistice Day eve, I want to tell you how the job has been going. First of all, it is a big job—the biggest we have ever been called upon to perform and it has been tackled with the determination to do the impossible rather than trying to show why the possible can't be done.

Reaching for the telephone

Everywhere people have been reaching for the telephone to speed the defense job. This has meant a tremendous increase in its use and we now have to handle many millions more telephone calls a day than we did a year ago. Army camps and Naval bases, shipyards, airplane factories and munition plants have had to have new or greatly expanded telephone facilities—most of them with the word "RUSH" written all over them, and many of them in areas that a year ago were cornfields or sand dunes.



Army camps

Yes, it is a big job, because we must maintain all telephone service at a high level if calls vital to national defense are to be sure to go through quickly. Let me illustrate. Just the other day we received a letter from a man in Buffalo. In it he thanked us because a long distance call he made to San Francisco had been completed in a moment or so. He said that in this case we had done an unusual service because the call was of very great importance to the defense program. Well, naturally, telephone people like to get such thanks. But the fact of the matter is that no *special* consideration was given to that particular call, for we don't know which call, of those pouring in upon us, is the important one to national defense. To be sure of serving defense needs, *all* calls should go through swiftly and efficiently.

In military operations

I hope you will agree that we have so far successfully met the demand for telephone service, great as it has been. Because of conditions beyond our control, such as the shortage of copper and other essential materials, it may be, as time goes on, that we cannot continue to meet the demands with the same success. However, I pledge you

Civilian observers

that we shall continue to do our level best.

The telephone and the radio are essential in very special ways in military operations. Fast-moving tanks and airplanes, for instance, keep in touch with their commands by radio telephone. The Air Raid Warning Service relies on what are called "radio-sentries" and on civilian observers who telephone their observations of enemy aircraft to the proper defense center. These and many other military needs mean new communication devices. We have about a hundred different military research jobs under way and a large proportion of the 2,000 scientists and engineers in our Bell Telephone Laboratories are devoting their full time to this work.

2,000 *scientists and engineers*

Our manufacturing branch, the Western Electric Company, is supplying great quantities of telephone and radio equipment for the Army and the Navy. Among the many things that are being produced are tens of thousands of radio telephone sets for training and combat planes. Also, there are special field telephones, switchboards and wire for the Army, and complete communicating systems for new battleships and for aircraft carriers. There are many other new devices, such as, for instance, a new microphone for the pilots of fighting planes which fits around the pilot's throat, so that the sound of his voice can be heard clearly, without interference from noise. All of this inventing, designing and making of military equipment is an important part of our defense responsibility and is in addition to our regular but greatly increased telephone task.

In conclusion, I want to express my sincere appreciation to the 380,000 men and women of the Bell System for a big job being done in the best Bell System tradition. The credit for this big job goes first to them. Then it goes back further to the system of private initiative and free enterprise which made it possible for them to develop their skills and their abilities. And then, finally, the credit goes back to the very system all of us now are working to defend—our own American Democracy.

Wave Filters and Networks in Theory and Practice

Three members of the Laboratories—H. A. Affel, A. J. Grossman and A. R. D'heedene, were chosen by the Communication Group of the A.I.E.E. New York section to participate in a lecture series on wave filters and other networks which was concluded on December 1. The seven lectures of this course emphasized the practical design, use and theory of communication networks.

Throat microphone

Mr. Affel presented the introductory lecture, *Functions of Filters and Other Networks*, on October 20; Mr. Grossman discussed *Filter Design Practices* and *Attenuation and Phase Equalizers* on November 10 and 24, respectively; and Mr. D'heedene, *Crystal Elements in Wave Filters* on November 17. The other lectures were *General Network Theory* and *General Wave-Filter Theory* by Prof. E. A. Guillemin, M.I.T., and *Coaxial-Line Elements Applied to Filters and Networks* by C. W. Hansell and P. S. Carter, R.C.A. Communications.

Air Defense System

In acknowledgment of the Laboratories' contribution to the Army Information Center, described on page 87 of this issue, Dr. Buckley has received the following letter from the Commanding General, First Interceptor Command:

> After many months of hard work and preparation by the Army, Telephone Companies and Civil Defense units, the Air Defense System has been completed in a portion of the vital North-eastern Area, and our recent test proved to the satisfaction of the Army that with minor changes the system is adequate.
>
> The part played by the Telephone Company in this endeavor was large. In order to complete

installations at Information and Filter Centers in time for maneuvers, long hours of hard work were necessary. This was accomplished with much credit to you and your organization.

I wish to express my deep appreciation to you and, through you, to your organization, especially Mr. A. Tradup and his associates, and Mr. C. W. Halligan and his associates, for the splendid work and coöperation which made all of this possible.

Sincerely,

JOHN C. MCDONNELL,
Brigadier General, U.S.A.

OUTSIDE PLANT DEVELOPMENT MOVES TO MURRAY HILL

OUR NEW BUILDING at Murray Hill crossed the line from project to actuality on Monday, November 17, when 140 members of the Laboratories reported there for work. Parking their cars or alighting from busses, they entered the building, to find their desks in place with telephones connected and building services ready for their needs.

Since the Outside Plant Development forces had been selected as the first group to be moved, work was begun several days earlier on the heavy laboratory equipment at West Street. Every piece was tagged for the space it was to occupy at Murray Hill, including desks, files and chairs. Under the general direction of J. G. MOTLEY, construction engineer for the project, the move was handled by A. F. LEYDEN of the Plant Department with the assistance of R. L. TOWNE of Apparatus Staff.

Engineers must look to others for many services, so members of several other departments accompanied them to Murray Hill. They came for the most part from Drafting, Apparatus Staff, General Service, and Plant, but Publication is currently represented by MISS LEVESQUE, the receptionist; Personnel by F. D. LEAMER and his staff; and Financial by FRANK BOYLE. At noon on Monday the restaurant formally opened for cafeteria service with a line headed by R. A. HAISLIP, Director of Outside Plant Development. A bus company furnishes service between the building and the railroad station in Summit. Automobile service primarily for departmental mail is available to New York with three round trips daily; passengers will be carried on company business up to the capacity of the car. Telephone service is given at Murray Hill by a dial PBX with thirteen trunks to the Summit central office and ten tie lines to the West Street board.

M. B. Long who has been responsible for the coördination of construction and related operations at Murray Hill

About the middle of December the Metallurgical group and their laboratory will go to Murray Hill. Later Station Apparatus Development, the Physical Research, and Circuit Research people and the rest of the Chemical Laboratories will move; then the Murray Hill building will be fully occupied.

COLLOQUIUM

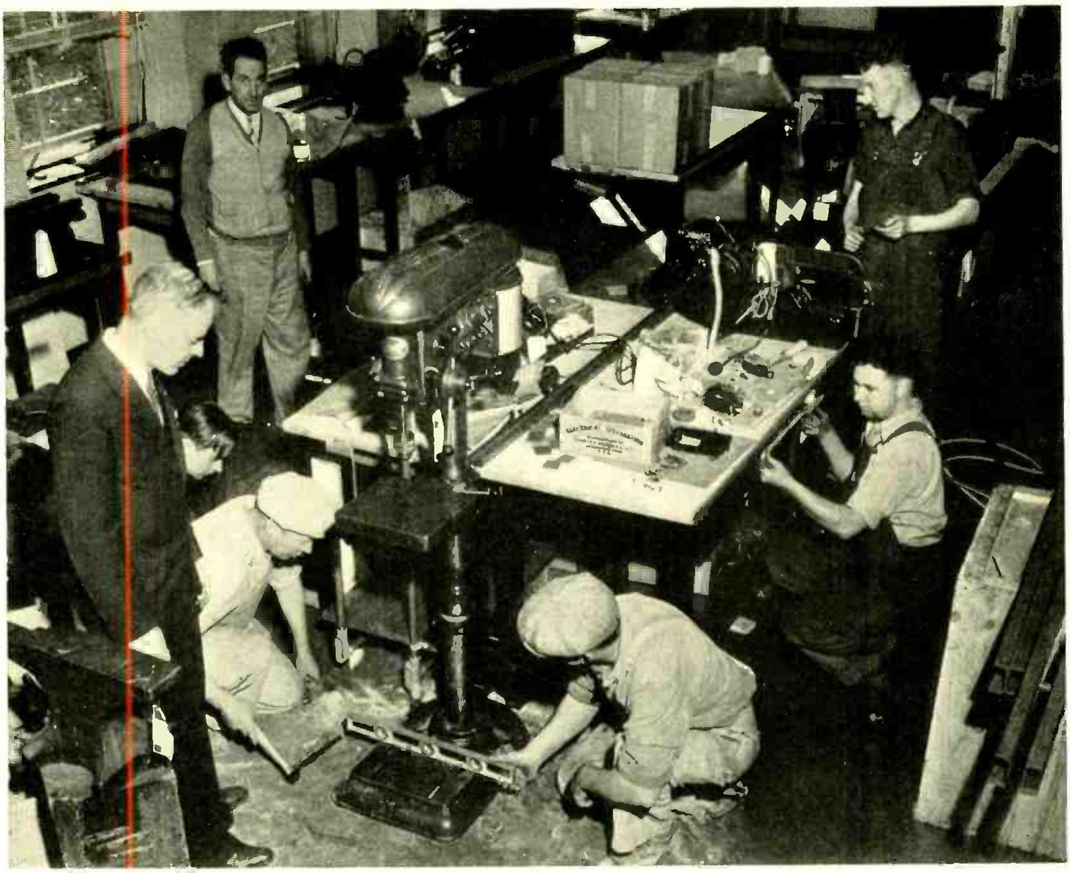
E. I. GREEN, at the October 20 meeting of the Colloquium, spoke on *Automatic Curve Tracing in Telephone Transmission Measurements*. The ever-increasing number and variety of measurements required in telephone transmission work has necessitated recourse to automatic measuring techniques. New instruments have been developed for tracing automatically, on a recording chart, continuous curves of amplitude, phase, etc., versus frequency. Devices are also available whereby such characteristics can be thrown instantaneously on a fluorescent screen for observation and analysis. Examples were given of mechanized measurements of both the recording and viewing types, including schemes already being used and others expected to be needed in the future.

Dr. W. E. Forsythe of the Lamp Development Laboratory of the General Electric Company discussed *The Scientific Aspects of Recent Radiation Sources* at the November 3 meeting. Dr. Forsythe, who has been prominent in the development of new radiation sources, described the radiating characteristics of some of the newer tungsten lamps, including the "sealed-beam" headlight lamps and some of the projection lamps made after this pattern. The constructional details and radiating characteristics of the new intense-mercury arcs were also discussed. He then considered the new fluorescent lamps and showed the radiating characteristics of the low-pressure mercury arc used to excite the fluorescence in these lamps and the radiating characteristics of various fluorescent powders when they are excited with this low-pressure arc.

Telephone Service During the Christmas Holidays

The handling of Christmas holiday toll traffic presents one of the most difficult service problems. Not only are there more calls in most offices on Christmas Eve and Christmas Day than in other comparable periods, but the calls are longer haul, go to many more small places, involve more switching, and require more operating time per call than on normal days.

In view of the present trend in toll board business the traffic experts in the telephone organization expect that the Christmas holi-



Setting one of the machines used in the mechanical laboratory of the Outside Plant Development Department at Murray Hill

Capt. Emil Alisch is now Plans and Training Officer of the 71st Infantry

day load this year will be heavier than ever and service more seriously affected. The telephone-using public will be informed of the critical service situation and its coöperation requested. Employee coöperation is expected not only in advising the public of service problems which the Christmas traffic will present but in refraining from making personal calls during the holiday period.

The Telephone Business

Thirty-four editorials commenting favorably about telephone matters in relation to the defense effort appeared during July, August and September in newspapers scattered over the country. Developments of the Laboratories underlay twenty-two of these editorials—saving and substituting of materials in nineteen and the safety of underground toll cable in three.

* * * * *

There was a gain of about 120,300 telephones in service in the Bell System during October, making the net gain for the first ten months of this year 1,128,300 as against 748,300 for the same period in 1940. At the end of October there were about 18,609,400 telephones in the Bell System.

* * * * *

The Pacific Telephone and Telegraph Company reports that in one month they installed about 22,000 new telephones as compared with 16,000 for the same month last year. A lot more long distance calls are being made in that section. The company has added nearly seven thousand people to its payroll, and is spending this year more than $75,000,000, mostly for construction to take care of the unusual service demands.

Staff Sergeant Bukur of the 2nd Battalion, 71st Infantry, using a field telephone set during maneuvers in the Carolinas

Military Items

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

Charles T. Bolger, Troop A, First Training Squadron, Building 2041, C.R.T.C, Fort Riley, Kan.

RAYMOND P. CHAPMAN, Company A, 35th Infantry Training Battalion, Camp Croft, S. C.

CAPT. ALBERT G. KOBYLARZ, Office of Chief Signal Officer, Washington, D. C.

* * * * *

GEORGE R. STIBITZ has been granted a leave of absence in order to engage in National Defense Research Committee work for the Office of Scientific Research and Development.

THE FOLLOWING MEMBERS of the Laboratories have returned from military service: THOMAS J. GILCHRIST, HAROLD W. KOWAL, KARL J. OGAARD, PAUL F. PETERSON and JOHN H. STELLJES.

Lieut. Einar Reinberg uses a "walkie-talkie" during Southern maneuvers

LIEUT. EINAR REINBERG, who took the photographs shown on these two pages, writes from the present army maneuvers in the Carolinas:

The 71st Infantry since its induction September 16, 1940, has traveled twice to Fredericksburg, Va., and Ft. Meade, Md.; once to Indiantown Gap, Pa., and at present is rediscovering the South.

I have served in this Regiment as an enlisted man and officer for thirteen years. Since induction (Sept. 16, 1940) as a 2nd Lieutenant I have been appointed a 1st Lieutenant and recently assigned as Adjutant of the 3rd Battalion.

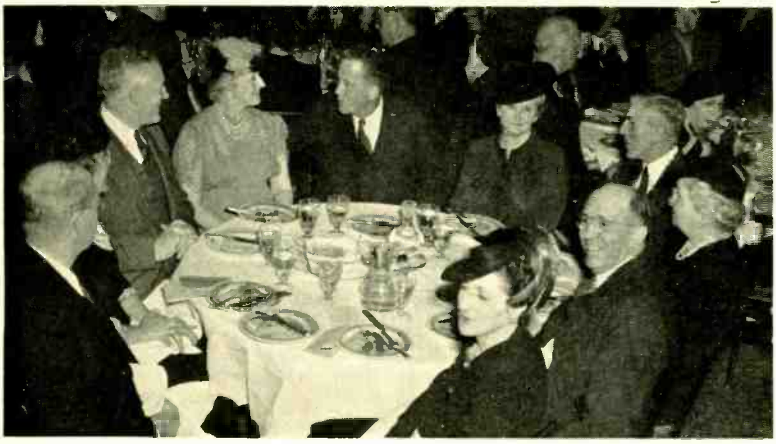
Communications, which used to play a big part in Battalion Headquarters Companies under the old table of organization, have been "streamlined," leaving the message center and semaphore signaling as their only responsibility. The "Company" is now known as a "Detachment." Field telephones and "walkie-talkies" (radios) are supplied with operators from Regimental Headquarters Company.

We have started our additional eighteen months' service by roughing it in the field, bedding down wherever we stop and living in pup tents. The boys have overcome the fear of snakes and spiders, often being too tired to worry about them.

NEWS NOTES

THE ANNUAL AWARD of the Associated Grocery Manufacturers of America was presented to R. R. WILLIAMS at a meeting held in New York on November 6. The award

First Sergeant Nils Anderson of the 2nd Battalion, 71st Infantry, with "walkie-talkie" in carrying position



At the Fall Social Meeting the Edward J. Hall Chap of the Telephone Pioneers America:

Left to right around table—O. Buckley, Mrs. Buckley, W. Wils Mrs. Wilson, A. B. Clark, Mrs. G Thomas, Leo Montamat, Mrs. Mon mat, Mr. Thomas and Mrs. Cl

Left to right—Miss Blanche Wolfe, Miss Elsie McKay, Mrs. G. F. Fowler, Mr. Fowler, E. C. Molina and Mrs. Molina

Left to right around table—T Solan, Bill Moore, John Tengstro "Sparks" Betzner, Ralph Fish George Hamm, George Rupp, Jo Jeskie, Max Schrauth and M Hickey

Left to right—William Carroll, Mrs. Carroll, George Scheeler, Mrs. Charles A. Frank (Mary Cross), Mr. Frank and Edward White

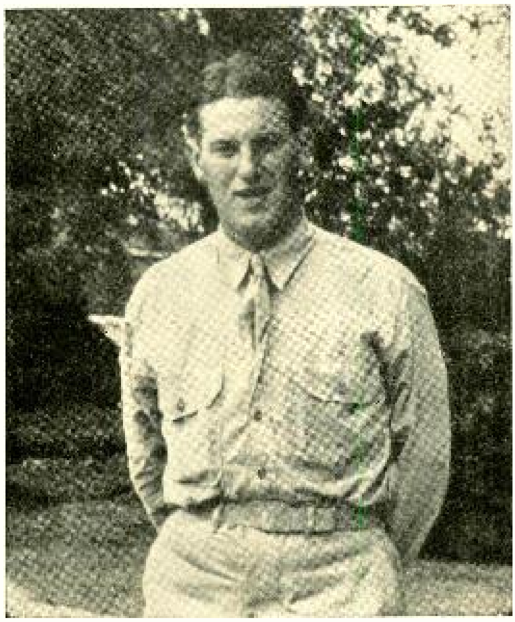
read: "This Award of Distinction is presented to Robert R. Williams, M.S., D.Sc., in recognition of his outstanding and fundamental contributions to our knowledge of vitamin B_1, carried on over a period of many years and culminating in the isolation, synthesis and naming of this essential dietary factor—results of far-reaching significance to the science of nutrition and to food technology." The presentation was made by Paul V. McNutt, Federal Security Administrator, and Dr. Williams, in his acceptance, spoke on *Where Do Vitamins Come In?*

R. K. POTTER has been appointed Research Engineer reporting to the Director of Research. Mr. Potter will act as technical aid in connection with research and development programs for defense that are being carried out for the Western Electric Company by the Laboratories.

Continuous transmission records of a cable-carrier system over the cable installed on the roof of Section R at Bethune Street are being studied by A. C. Velia of Transmission Development Department

H. S. SHEPPARD, before the recent convention of the North Carolina Independent Telephone Association, spoke on recent developments made by the Laboratories.

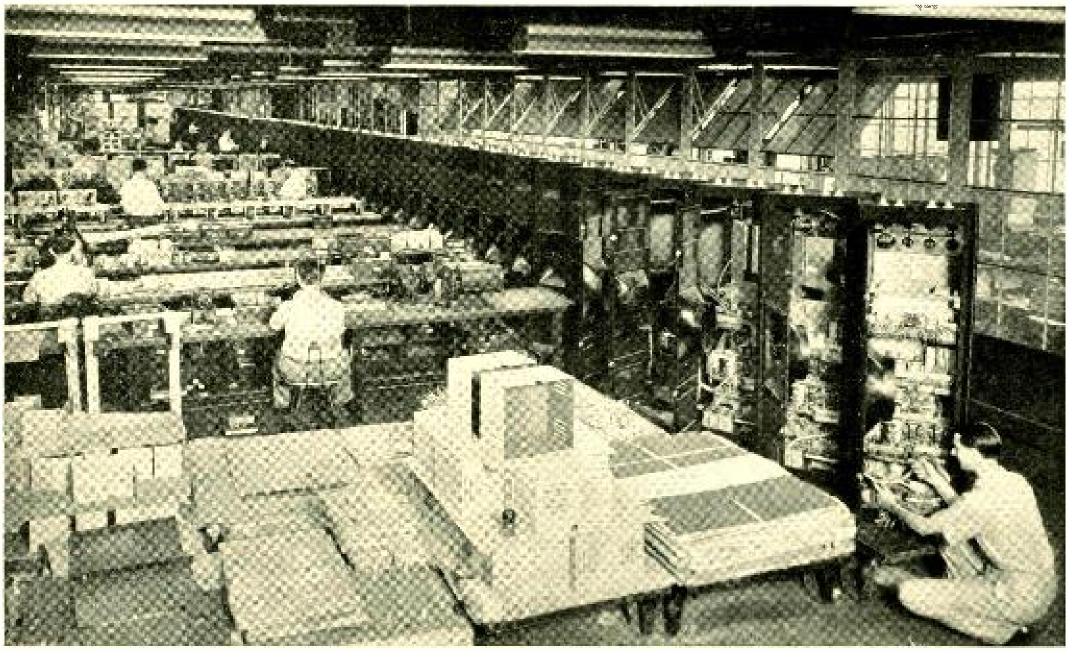
DURING THE WEEK of October 20 several members of the Laboratories either participated in or attended meetings of several societies which held meetings in the Pennsylvania Hotel, in New York City. The societies were the Acoustical Society of America, the Optical Society of America, the Society of Rheology, and the Society of Motion Picture Engineers. Papers presented were *Pressure Radiation in Moving Systems* by H. E. IVES before the Optical Society; and *Apparatus for the Direct Measurement of Force-Displacement Characteristics of Mechanical Systems* by J. R. HAYNES before the Acoustical Society.



C. T. Kuhn, Jr., is with Company C, 42nd Engineers, Camp Shelby, Miss.

THE TRUSTEES OF PRINCETON UNIVERSITY have elected O. B. BLACKWELL and P. B. FINDLEY to membership on the Advisory Council of the Department of Electrical Engineering and W. A. SHEWHART to membership on the Advisory Council of the Department of Mathematics. Mr. Blackwell has been a member for several years of an informal group of outstanding electrical engineers who performed the same functions, and Mr. Findley, an alumnus, is a member of the executive committee of the Princeton Engineering Association.

THE OCTOBER ISSUE of *The Journal of the Acoustical Society of America* carries three



At the rate of twenty a week, upwards of 300 radio transmitters, designed for ground-to-plane communication, are rolling off the assembly lines at Western Electric's Kearny Works for delivery to Pan American Airways System. These transmitters will form a vital part in Pan American's far-flung communications system which links the flying Clippers to terminals in the United States, Alaska, South and Central America, Africa, New Zealand, the islands of the Pacific, and the Far East. The transmitters are of the 300-400-watt class, and were designed by the Laboratories to Pan American specifications

articles by members of the Laboratories which discuss the stereophonic sound film system. They are *General Theory* by HARVEY FLETCHER; *Mechanical and Optical Equipment for the Stereophonic Sound Film System* by E. C. WENTE, R. BIDDULPH, L. A. ELMER and A. B. ANDERSON; and, *Stereophonic Sound Film System—Pre- and Post-Equalization of Compandor Systems* by J. C. STEINBERG.

R. M. BOZORTH attended the National Metal Congress and Exposition at Philadelphia. He was chairman in charge of the joint technical session of the Institute of Metals

MEMBERS OF THE LABORATORIES TO WHOM PATENTS WERE ISSUED DURING THE MONTH OF OCTOBER

R. H. Badgley
M. W. Baldwin, Jr.
W. R. Bennett
H. H. Benning
B. G. Bjornson
H. S. Black (2)
J. R. Boettler
A. E. Bowen
D. E. Branson
A. J. Christopher
H. C. Curl
C. H. Dagnall
J. F. C. Dahl
R. C. Davis
P. B. Drake
L. L. Eagon
I. E. Fair
P. B. Flanders
F. Gray (3)
R. O. Grisdale
R. B. Hearn
G. Hecht
H. A. Henning
R. E. Hersey
F. H. Hibbard
W. H. C. Higgins
H. Hovland
R. J. Kent
L. F. Koerner
F. K. Low
A. A. Lundstrom
W. P. Mason (3)
B. McKim
D. A. McLean
D. Mitchell
J. B. Newsom
H. Nyquist
G. L. Pearson
C. E. Pollard (2)
W. B. Snow
A. L. Stillwell
W. B. Strickler
A. C. Velia
F. W. Webb
E. C. Wente
W. W. Werring
P. Winsor, Jr.

Division and the Iron and Steel Division.

A. C. WALKER discussed *Drying of Textiles* before a group meeting of textile school deans held in New York on November 13. Following the meeting the group came to the Laboratories for an inspection trip which covered laboratories of particular interest in their work.

J. C. STEINBERG took part in discussions of hearing-loss disability ratings at the annual meeting of The American Academy of Ophthalmology and Otolaryngology held in Chicago on October 23.

E. E. SCHUMACHER was in Philadelphia on October 21 where he participated in the O.P.M.-A.S.M. National Defense Meeting dealing with Conservation of Copper. He also attended the Symposium on *Powder Metallurgy* held on September 25 and 26 at the Massachusetts Institute of Technology and presided as chairman of one of the four technical sessions.

C. S. FULLER and B. S. BIGGS visited the Research Laboratory of the Resinous Products and Chemical Company, Bridesburg, Pennsylvania, in connection with plastics problems.

R. M. BURNS attended the Electro-Chemical Society Convention which was held in Chicago.

C. C. HIPKINS, in Washington, attended the monthly meeting of the Protective Coatings Section of O.P.M.

G. L. PEARSON presented a paper entitled *Thermistors — Their Characteristics and Uses* before a meeting of the Metropolitan section of the American Physical Society, held in New York City.

C. MAGGS of the Electronics Research Department received a B.S. in M.E. degree from New York University in October.

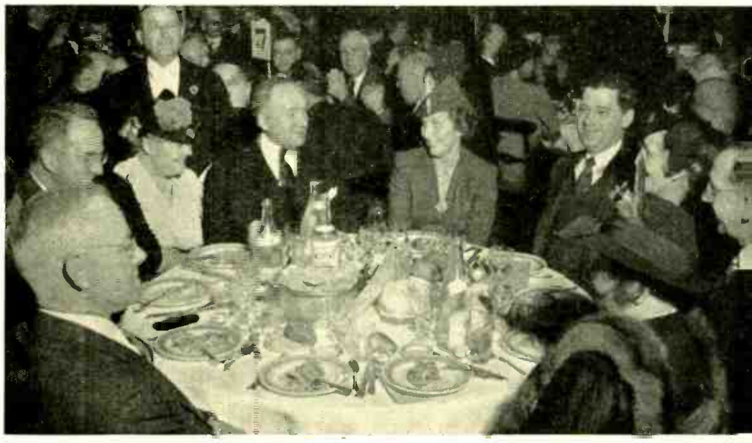
A PAPER on *Some A-C Properties of Paper Dielectrics Containing Chlorinated Impregnants* was presented by D. A. MCLEAN and C. C. HOUTZ at the annual meeting of the National Research Council held at Williamsburg, Virginia. S. O. MORGAN presided at one session of the Conference that was devoted to substitute insulating materials. W. A. YAGER and L. EGERTON also attended this meeting.

K. K. DARROW spoke on *Physical and Chemical Forces* at the first meeting of the 1941-1942 season of the Radio Colloquium, held at the Deal Laboratory on November 7.

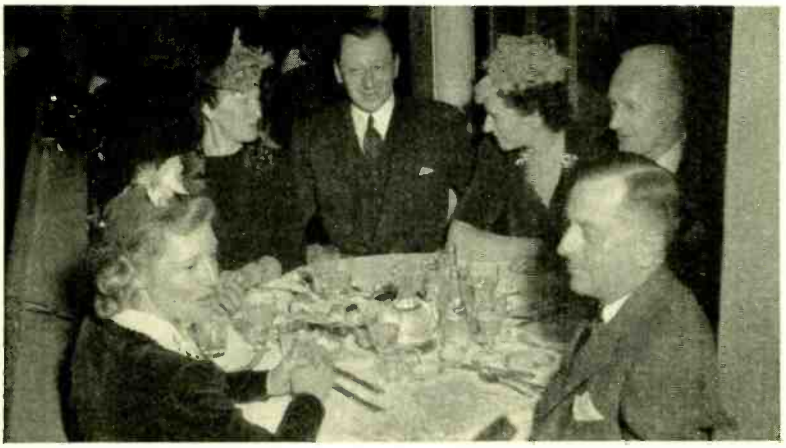
AT THE HAWTHORNE PLANT of the Western Electric Company, J. R. BARDSLEY discussed the design of a submarine loading-coil case for The Pacific Telephone and Telegraph Company and miscellaneous problems on loading-coil cases in general; T. S. HUXHAM, plastic housing for the combined telephone set; H. A. FREDERICK and C. G. MCCORMICK, step-by-step equipment problems; G. E. ATKINS, manufacturing problems on the 204-type selector; E. J. KANE and F. A.

At the Fall Social Meeting the Edward J. Hall Chap. of the Telephone Pioneers America:

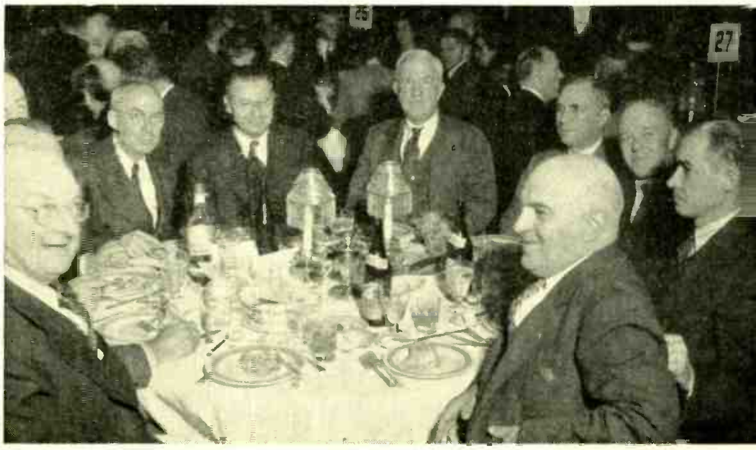
Left to right—A. G. Jeffrey, B. Bouman, G. T. Ford, W. G. Sch. and D. Ross



Left to right around table—D. T. May, H. A. Frederick, Mrs. H. O. Siegmund, Mr. Siegmund, Mrs. J. R. Townsend, Mr. Townsend, Mrs. J. J. Kuhn, Mr. Kuhn and Mrs. May. Mrs. Frederick, who sat between Mr. May and her husband, is just out of the photograph



Left to right around table—M. G. F. Doppel (the former M. Marion Grimm), Mrs. H. W. Di pel, Mr. and Mrs. Roy Beck (Shephard Warehouses), Mr. Dopp and Mr. Dippel



Right foreground and around table counter-clockwise—W. A. Bollinger, W. A. Olson (Long Lines), C. G. Von Zastraw, P. A. Jeanne, W. E. Mougey, A. F. Price, E. Vroom, F. R. Lack (Western Electric), A. H. Inglis and A. H. Leigh. This entire group were in the Research and Inspection Division of the Signal Corps during the First World War and served together in France

Korn, various crossbar problems; and A. B. S. Kvaal, drafting practices.

William Fondiller and C. A. Webber visited the Point Breeze plant of the Western Electric Company in connection with cord development problems.

J. R. Townsend and W. E. Ingerson attended a meeting devoted to *Indentation Hardness* and sponsored by the American Society for Testing Materials, the American Society for Metals, and the Society of Automotive Engineers. The meeting was held in Philadelphia.

H. E. DeCamp, I. G. Barber and H. P. Heath of the Hawthorne Works of the Western Electric Company visited the Laboratories to discuss common problems in connection with developments that are now in progress.

C. Erland Nelson was in Pittsburgh in connection with panel-bank contact studies.

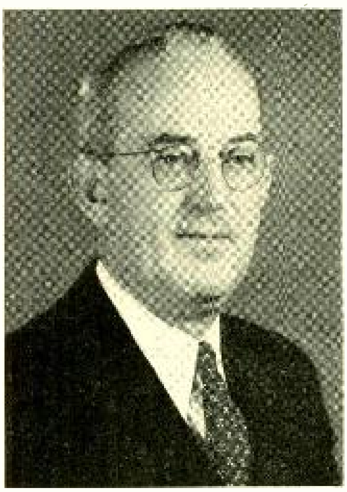
F. F. Romanow, on November 14, gave a talk on the calibration of sound systems before the Graduate Seminar at the Brooklyn Polytechnic Institute.

W. M. Bacon, T. L. Corwin and W. R. Young were in Cleveland to test the 81B1 private-wire teletypewriter system installed for the Republic Steel Company. Commercial service started October 1 and on October 30 E. F. Watson observed its operation.

August Koernig assembling an amplifier chassis in the Development Shop

G. E. Stowe and R. B. Simon visited Princeton and Philadelphia in connection with the coaxial-cable trial installation between New York and Philadelphia.

Henry H. Hall
of the Commercial Relations Department completed thirty-five years of service in the Bell System on November 15



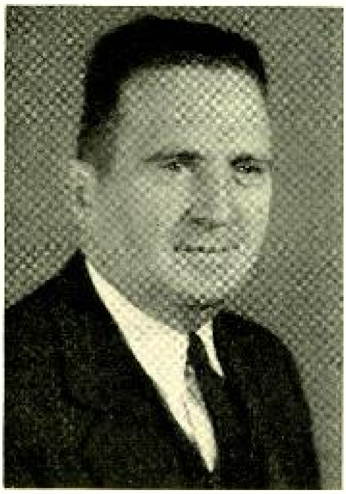
Edmund F. Ketcham
of the Equipment Development Department completed thirty-five years of service in the Bell System on Nov. 24

F. R. Dickinson and T. J. O'Neil are supervising the installation of the new carrier telephone equipment for the Key West-Havana submarine cable.

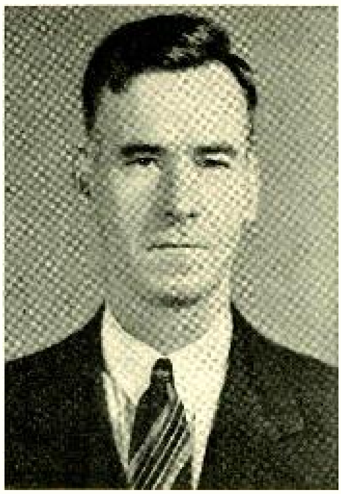
J. E. Greene, in Chicago, discussed additions to the Oakland crossbar office with engineers of the Illinois Bell Telephone Company.

Machine design problems took J. H. Sole to the Pioneer Gen-E-Motor Corporation in Chicago and to the General Electric Company in Fort Wayne, Ind.

J. L. Larew was at Reading, Harrisburg and Lewistown, Penna., on matters pertaining to the power equipment for the K2 carrier trial between New York and



H. B. Smith



J. J. Collins

P. C. Seeger

Pittsburgh. J. L. Allison, in connection with the same trial, visited repeater stations at Ligonier and Pittsburgh.

R. P. Jutson went to Eau Claire, Wis., where he discussed power problems associated with the coaxial installation between Stevens Point and Minneapolis.

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

Research Department
Joseph Bell

Apparatus Development Department

E. W. Kane	John Whytock
J. W. Van De Water	W. H. S. Youry

Systems Development Department

A. F. Grenell	C. R. Meissner
Miss Fay Hoffman	T. D. Robb

Twenty-Five-Year Service Anniversaries

After receiving his B.S. in E.E. degree from Rutgers University in 1915, Harry B. Smith spent a year with the Public Service Company of New Jersey and six months in reinforced concrete and steel construction work. His first work in the Engineering Department of the Western Electric Company, which he joined in 1916, was on the life testing of step-by-step switching apparatus. During most of the war period he was concerned with special machine-switching apparatus for government use. Later he spent several years on the development of measuring apparatus in the electrical design group of the Special Products Department.

From 1927 to 1938 Mr. Smith was in the apparatus analysis laboratory where he was concerned with investigations of contact noise and resistance of base metal contacts. During the early development of the crossbar switching system he was engaged in testing this apparatus. In 1938, when cost reduction studies on the crossbar switch were being made, he transferred to the dial apparatus laboratory of the Switching Apparatus Development Department and since then has been associated with the design and analysis of the card-operated crossbar switch and of the multi-contact relay.

Mr. and Mrs. Smith live in Plainfield, N. J., and have one daughter who is married. His hobbies are gardening and woodworking. Mr. Smith is a charter member of the Plainfield Mendelssohn Glee Club and a member of the Edward J. Hall chapter of the Telephone Pioneers of America.

* * * * *

Since 1929 John J. Collins has been in the Metallurgical Laboratory where he has been engaged in the fabrication of wires and tapes from precious metals and alloys. His principal work has been the rolling of filament tapes for vacuum tubes and the rolling of magnetic recording tape. The production of this recording tape has required considerable ingenuity and patience on his part.

Mr. Collins was with the manufacturing organization of the Western Electric Company at West Street for three short periods from 1909 to 1911. In 1918 he joined the vacuum-tube shop where his work was on vacuum tubes for government uses. Following the war he was placed in charge of the maintenance of pumping stations in the tube shop. From 1921 until he transferred to the Metallurgical Laboratory he was a maintenance electrician in the Plant Department.

The Cellinses, who live in West Norwood, N. J., have four sons. Three of these boys are in service—Wilfred, a corporal with the 165th Field Artillery; Edward, with 104th Engineers; and Thomas, a seaman on the U.S.S. *Prairie*. Their youngest son is in elementary school. Mr. Collins is an ardent deer hunter.

* * * * *

After completing a two-year course at Pratt Institute in machine design, Paul C. Seeger joined the Engineering Department of the Western Electric Company. His first work was in the Apparatus Drafting Department where, for twelve years, he was concerned with the drafting phases involved in the development of panel and step-by-step systems and associated apparatus, such as dials, relays and keys. In 1928 Mr. Seeger transferred to the Apparatus Specifications Department where he has since been engaged with the preparation of specifications covering coils, transformers and various types of testing apparatus.

Mr. and Mrs. Seeger, who live in East Rutherford, N. J., have two daughters in elementary school. Mr. Seeger is an ardent gardener and during vacations at Montauk, Long Island, does a great deal of fishing.

* * * * *

The annual meeting of Technical Drawing Association was attended by A. B. S. Kvaal and W. A. Bischoff. This meeting was held in Chicago on October 9 and 10.

J. M. Duguid discussed ringing-machine development with engineers of the Northern Electric Company in Montreal.

In response to the request for books to be added to the Camp Monmouth library, members of the Laboratories brought in approximately 1500 *volumes. Morton Sultzer (center) and D. D. Haggerty are looking over a part of the collection while Miss C. W. Ackerman pastes in special bookplates indicating that the books were donated by Laboratories people*

L. J. Stacy and P. Winsor visited Hartford where they continued their field study to determine the operational characteristics of step-by-step switches.

T. D. Robb went to Wilmington, Del., in connection with a trial installation of supplementary position cabinets for "outward" operators.

R. K. Honaman has been elected a member of the Municipal Council of Glen Ridge. He was nominated by the Civic Conference Committee—unique in New Jersey municipalities—which considers a large number of suggested names without political bias. M. B. Long is also a member of the Council.

Pierre Mertz is the author of an article entitled *Television—The Scanning Process* published in the October issue of the *Proceedings of the I.R.E.*

Several members of the Laboratories were installed recently as officers of Western Electric Post 497 of the American Legion at that organization's regular October meeting held in the Hotel Taft. The Post originally

At the Annual Installation Meeting of Western Electric Post 497 of the American Legion

Top left—County Commander Lawrence J. McNally installing L. E. Gaige as the new Commander. Top right—F. T. Deputy, British Purchasing Commission, formerly with ERPI, E. G. Andrews and A. J. Akehurst. Bottom—A. H. Inglis, L. E. Gaige, W. A. Bollinger, Major James V. Demarest of the United States Army and S. G. Timmerman of the Western Electric Company, retiring Commander

Conference at Murray Hill between those responsible for the design and construction of the Laboratories and those who will be responsible for its building plant and services. Left to right: C. A. Chase, T. J. Crowe, E. V. Mace, P. Venneman, M. B. Long and J. G. Motley

consisted of employees of that branch of the Western Electric Company which was located at 463 West Street. It retained its identity in spite of the fact that its membership roll was made up almost exclusively of Bell Laboratories veterans when that company was formed later.

The new Commander is L. F. GAIGE who succeeded S. G. Timmerman of the Western Electric Company. Officers installed with Commander Gaige include H. R. Allen, First Vice-Commander; O. H. DANIELSON, Second Vice-Commander; L. B. EAMES, Third Vice-Commander; A. H. INGLIS, Adjutant; J. R. BARDSLEY, Assistant Adjutant; S. H. LOVERING, Finance Officer; J. F. Beattie, Service Officer; S. L. Leverone, Chaplain; and H. Bongard, Sergeant at Arms. The Executive Committee consists of L. H. ALLEN, E. G. ANDREWS, D. S. Cloughly, R. B. Ferris, E. C. HAGEMANN, F. T. MEYER, F. J. PRACHNAIK, S. J. STRANAHAN and M. F. Travers.

P. F. JONES was in Pittsburgh and H. C. FRANKE and L. R. MONTFORT were at various intermediate points in connection with the trial of the type-K2 carrier telephone system between New York and Pittsburgh.

JOHN MALLETT and MISS E. RENTROP returned to New York after making static noise tests at type-K frequencies at various points along the Omaha-Denver cable route. Miss Rentrop subsequently returned to Ogallala, Nebr., to take part in crosstalk tests at type-K frequencies on this cable. Others engaged in crosstalk studies in the vicinity are C. O. CROSS, C. H. GORMAN, H. B. NOYES, W. E. REID and E. S. WILCOX.

D. F. HOTH has been investigating methods of reducing resistance unbalance in exchange cables at locations in New Jersey and Long Island.

THE STEVENS POINT-MINNEAPOLIS coaxial system was turned over to the Laboratories for a period of one month for special studies. During this period H. H. BENNING, M. E. CAMPBELL, B. DYSART, M. M. JONES, R. R. BLAIR and P. G. UPPSTROM carried out transmission measurements for use in the design of systems longer than 200 miles, and G. R. FRANTZ, S. A. LEVIN and I. E. WOOD were in Eau Claire for equalization studies. K. C. BLACK went to Minneapolis at the time the system was returned to commercial service.

L. A. O'Brien, E. H. Sharkey and K. D. Smith have returned from Chicago where they supervised the construction of apparatus for the Army.

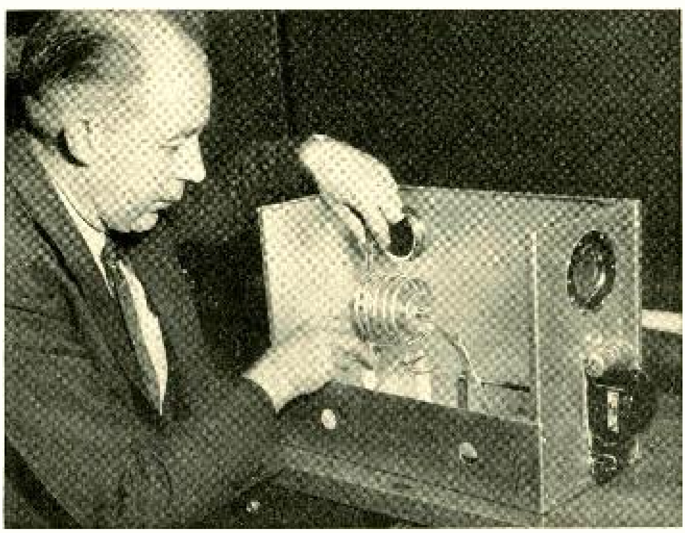
O. D. Grismore spent some time in Baltimore arranging for the installation of apparatus for an 0.8-mc coaxial trial on the Baltimore-Washington cable.

Lectures on coaxial terminal equipment were delivered by R. E. Crane before the Long Lines Training School held recently at 32 Sixth Avenue.

R. W. Lange returned from Boston where he had been stationed for over four months in connection with the trial of carrier-program facilities over the New York-Boston K1 systems. J. Maurushat, Jr., carried on the work at Boston until the end of the trial, then moved to Pittsburgh with the terminal equipment in preparation for the coming tests of program transmission over K2 carrier telephone facilities between New York and Pittsburgh.

R. S. Caruthers went to Salt Lake City and Wyeth (Oregon) to coöperate in clearing troubles encountered in a new installation of J2 systems.

G. B. Engelhardt visited the Point Breeze Works of the Western Electric Company in connection with the construction of the Philadelphia-Baltimore coaxial cable.



A. A. Skene inspecting a motor-driven inductance to be used in a 10-kw FM transmitter

O. R. Garfield and J. O. Smethurst were in Norfolk and Cape Charles, Va., to test and place in service the twelve-channel radio telephone system connecting these points and spanning Chesapeake Bay. A. C Dickieson and P. G. Edwards inspected the arrangements during the testing period.

H. S. Winbigler, A. W. Lebert and V. J. Hawks spent some time in Miami on field engineering tests of a new two-channel bank circuit. The New York terminal of this experimental circuit was operated by L. Schott and C. W. Carter, Jr.

In connection with the trial of K2 carrier systems, the following engineers were at different repeater stations between New York and Pittsburgh: F. B. Anderson, F. A. Brooks, H. C. Fleming, H. K. Krist, O. H. Loynes, J. C. Lozier, J. T. O'Leary, E. H. Perkins, W. H. Tidd, A. C. Velia and H. A. Wenk.

J. A. Hall and E. B. Cave appeared before the Board of Appeals at the Patent Office relative to applications for patent.

The Laboratories were represented in interference proceedings at the Patent Office by B. H. Jackson before the Examiner of Interferences and by H. S. Wertz before the Primary Examiner.

During October, G. T. Morris, J. W. Schmied, H. O. Wright and G. F. Heuerman were at the Patent Office in Washington on matters pertaining to routine patent problems.

J. W. Schmied and W. F. Simpson were in Cleveland during October relative to patent matters.

H. P. Franz made several trips to Washington in connection with the Government regulations on the export of patent and technical data.

On November 13 Dr. L. D. Bristol, Health Director, and Miss T. E. Boden, Supervisor of Health Education of the American Telephone and Telegraph Company, and C. R. Kendall, Supervisor of Safety Methods and First Aid Training of the New York Telephone Company, attended the Laboratories' Women's First

Aid Class conducted by L. E. Coon to observe the methods of training used by the Laboratories. These individuals will supervise First Aid training in their respective companies where the Standard Course of the American Red Cross will replace shortly the former Bell System First Aid and Health Course.

G. B. Thomas and R. A. Deller attended the Ninth Annual meeting of the Engineers' Council for Professional Development held in New York City on October 30.

Mr. Deller has been elected to membership of the Eastern College Personnel Officers Association. During the latter part of October he visited a number of universities and the headquarters of several of the Operating Companies in the Middle West on matters pertaining to current employment needs and on the 1942 program covering the employment of technically trained men.

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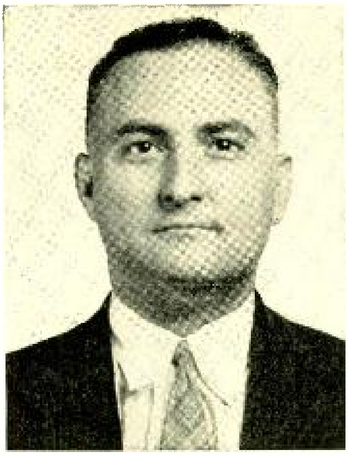
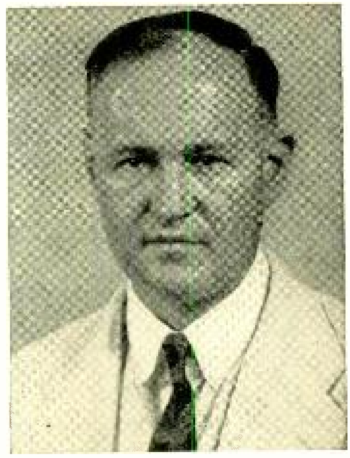


Thomas Brown, 1902-1941



W. S. Hayford, 1896-1941

Thomas Brown, a member of the specifications group of the Transmission Apparatus Development Department, died on November 7. Before he joined the Bell System in 1930 he had spent nine years on installation work for the Service Maintenance Company, as a draftsman with Gibbs and Hill, and as a specification writer with Rainbow Light, Incorporated. During this time he took evening courses at Cooper Union from which he received his B.S. degree in 1926.

Mr. Brown entered the Specifications Department of the Apparatus Development Department in 1930 and for several years was engaged in writing specifications on many types of apparatus including sound picture apparatus and telephone maintenance tools. Since 1937 he specialized in electrical indicating instruments and voltmeter relays. This work involved consultation with project engineers and suppliers and making recommendations on the selection of suitable meters and relays for telephone and radio equipment and, more recently, on similar apparatus for defense projects.

Walter S. Hayford of the Outside Plant Department died on October 21. Mr. Hayford was graduated by Northwestern University with a B.S. degree in 1918 and received a C.E. degree from the same University in 1921. From December, 1917, to September, 1919, he was with the Taylor Instrument Company. He joined the Engineering Department of the Western Electric Company in 1921 and for the next seven years was with the metals division of the Materials Standards Department. During this time he was responsible for the development of mechanical test methods which have since been adopted through the American Society for Testing Materials as national standards for the control of such properties as hardness, standard tension test methods for thin sheet metals including the design of the specimen, fatigue-testing machinery and specimens, and the development of a reverse bend testing machine.

Since 1928, when Mr. Hayford transferred to the Outside Plant Development Department, he had been engaged continuously with the development of outside plant tools. He conceived the idea of a sleeve-rolling tool for joining line wires and was responsible for the detailed development work along this line over a period of several years. He also had much to do with laboratory studies of linemen's climbers, these studies resulting in considerably improved design from the standpoint of service life.

Mr. Hayford's work included the development of tools for use in line-wire construction and maintenance and similar tools for cable construction and maintenance, both aerial and underground. He was an expert on the testing of the hardness of metals and acted as a consultant on practically all such measurements made in connection with outside plant development studies.

L. E. Coon attended the National Safety Congress held in Chicago from October 5 to 10. The keynote of the meetings was *Help Defense—Stop Accidents.*

R. Linsley Shepherd, at a meeting of the Young Peoples Association of Christ Church, Short Hills, N. J., discussed the work of the Laboratories and demonstrated the Mirrophone.

Transmission measurements on type-K carrier systems between Chicago and Joplin were made by a group of Laboratories engineers during October. Participating in the tests were A. L. Bonner, F. A. Brooks, L. L. Glezen, L. C. Roberts, H. A. Wenk, and S. B. Wright. Mr. Goetz and Mr. Reichel, of the Long Lines Engineering Department in New York, and various members of the Long Lines Plant Department in the Chicago and St. Louis areas also participated in this work.

In the September 27 issue of *Nature* (London) appear two reviews of articles published in the July issue of the Record: *Sound-Integrating Machine* and *Bell Telephone Laboratories Lecture Equipment.*

A. F. Gilson is now Purchase Engineer of the Plant Department in charge of outside shop work. K. G. Compton has been transferred to Whippany where he will act for the Plant Department as Coördinator of Shop Work.

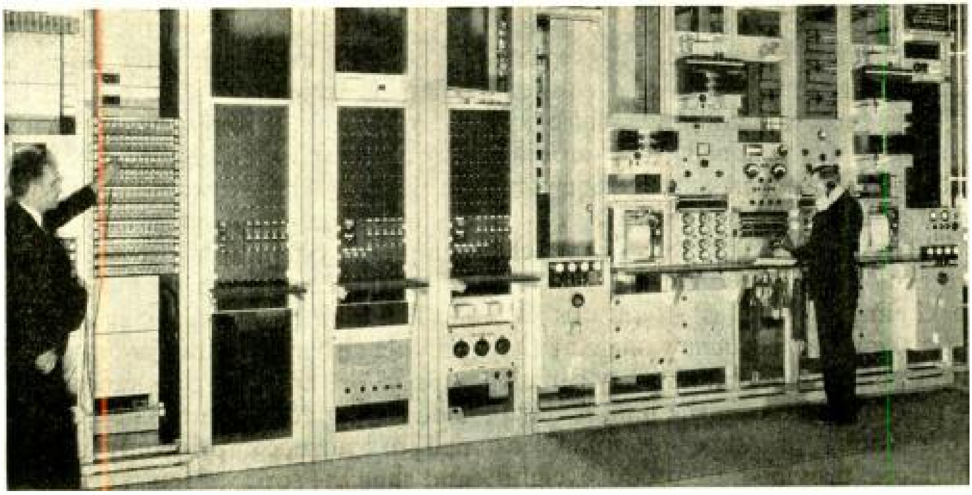
George Dobson has been transferred to the Plant Department where he will be in charge of Order Analysis and Shop Schedules. F. Keeling is now associated with Mr. Dobson with responsibility for procurement of materials and apparatus required for Development Shop Work.

D. J. Hendrick and the plant engineering and drafting group have been transferred to the Plant Occupancy Department.

Defense Bonds for Christmas

This year many persons are planning to give at least part of their gifts in the form of Defense Savings Bonds and Stamps. Stamps, with values ranging up to $5 apiece, may be bought at post offices, banks and savings and loan associations.

To those who can spend $18.75 for one gift, a Series "E" Defense Savings Bond is ideal. It increases regularly in value until at its maturity date, ten years hence, it can be redeemed for $25 or one-third more than you paid. Other Bonds in the Defense series are priced all the way up to $1,000 each, and have corresponding increases in value.



Terminal Equipment for the L1 Carrier System

By R. E. CRANE
Carrier Telephone Development

A NEW coaxial telephone system has recently gone into service between Stevens Point, Wisconsin, and Minneapolis. It forms one of a series of broad-band carrier systems that have assumed particular importance with the steadily increasing demands for telephone service accompanying the rapid expansion of national defense production. Of these broad-band systems the K and the J, as well as a forerunner of the present coaxial system, have already been described in the RECORD.* The new coaxial system, known as the type-L1 carrier system, far surpasses all the others in the number of channels it provides—480 in a complete system. In the installation between Stevens Point and Minneapolis only a small part of the full capability of the system is utilized at present, but additional channels may be added from time to time as desired.

Like other broad-band systems, the type-L1 system uses sets of twelve voice channels to form a channel bank. Each of the twelve voice channels of the set is modulated by a separate carrier, and after modulation, the twelve channels lie in the frequency band from 60 to 108 kc. Since there are 480 channels in a complete L1 system, there will be forty of these channel banks, but only twelve channel carriers are required in the system since all channel banks occupy the same frequency band after channel modulation.

Following the channel modulation, which forms a bank from each twelve channels, there is a second, or group, modulation that raises these 12-channel banks in sets of five to form a

**April*, 1937, *p.* 242; *April*, 1938, *p.* 260; *April*, 1940, *p.* 226; *May*, 1937, *p.* 274.

60-channel bank occupying the frequency range from 312 to 552 kc. Only five group carriers are required for this second modulation since all groups of 60 channels that are involved occupy the same frequency band after group modulation.

The forty banks of twelve channels are thus formed into eight groups of 60 channels. Since these groups occupy the same frequency range at the output of the modulators, they cannot be placed directly on the line. A third modulation, or super-grouping, is therefore provided to produce eight super-groups, each occupying a different frequency band. After this super-group modulation, the eight super-groups occupy adjacent portions of the frequency band from 68 to 2044 kc. This scheme of modulation is indicated schematically in Figure 1.

It will be noticed that as transmitted over the coaxial cable, the second super-group occupies the frequency band from 312 to 552 kc, which is the band occupied by all the 60-channel groups after group modulation. For this super-group therefore no third modulation is required. Since only 48 channels were to comprise the initial installation of the system between Stevens Point and Minneapolis, it was possible to avoid the necessity of a third modulation by using 48 channels which are in the same 60-channel bank. Without further modulation it could then be placed directly on the line, where it would occupy the No. 2 super-group position of the complete system. This greatly facilitated the completion of the new installation since it was unnecessary to provide either the super-group carrier supply or any of the super-group modulating equipment. The 48 channels, of course, comprise only 4 groups and thus the super-group they form is short of completeness by one group. It is expected that this fifth group will be added shortly.

The channel modulating equipment is identical with that used for the J and K carrier systems, and has already been described in the Record.* For group modulation, copper-oxide modulators, coil-and-condenser filters, and stabilized feedback amplifiers are employed, and in general the equipment and circuit is similar to that used for the J carrier system.† The J system, however, has only a single bank to deal with, and since the group carrier is at some distance from the

*Record, *May*, 1938, *p.* 315.
†Record, *June*, 1940, *p.* 292.

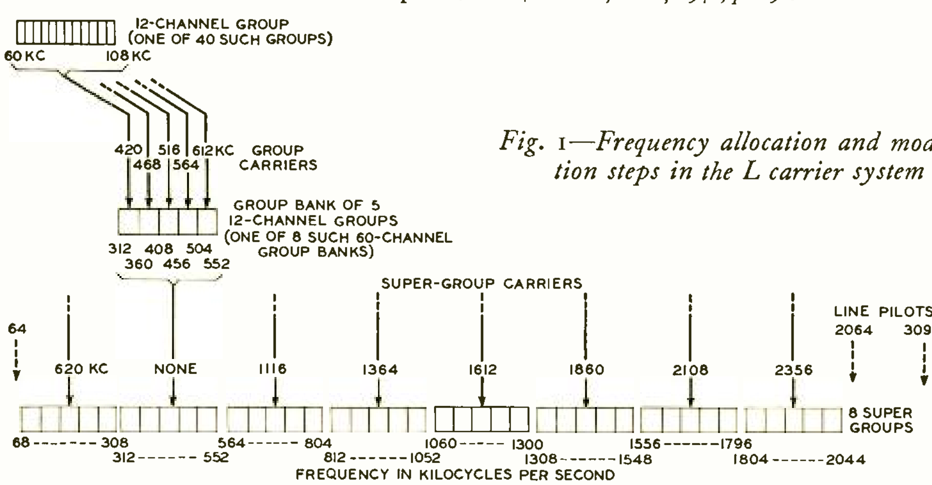


Fig. 1—*Frequency allocation and modulation steps in the L carrier system* group frequencies, the separation of the desired sideband from the carrier and the other sideband is accomplished with a comparatively wide band filter giving low distortion in the band. With the L system, on the other hand, five banks are placed side by side to form a 60-channel group, and it would be impossible to parallel such wide band filters without distortion in adjacent banks due to overlapping bands. This difficulty is avoided by connecting the filters of odd-numbered banks together; and similarly those of the even-numbered banks. These two sets of groups are then combined through a hybrid coil so that both sets supply input to the line, but neither interferes with the other. This arrangement is indicated in Figure 2. Here the frequency boundaries of the five banks forming the group are indicated by vertical dashed lines, and the approximate filter range for the even bands is shown above, and the range for the odd bands below.

Group modulation in the L system also differs from that in the J in the amount of apparatus required. While the J system transmits only one group in each direction, the L system transmits forty. Another difference arises indirectly because of the much larger number of channels handled by the L system. When 40 groups are handled by a single system, it is desirable to take greater precautions to insure continuity of service than when only one group is involved. As a result the L system has been designed with liberal provisions for replacing equipment that may require maintenance. The cable is provided with four coaxial units, but only two are required for a complete L system—one for each direction of transmission. The other pair of coaxial units, with spare repeaters at each repeater point, are held as a spare to be cut into service whenever that may be necessary.

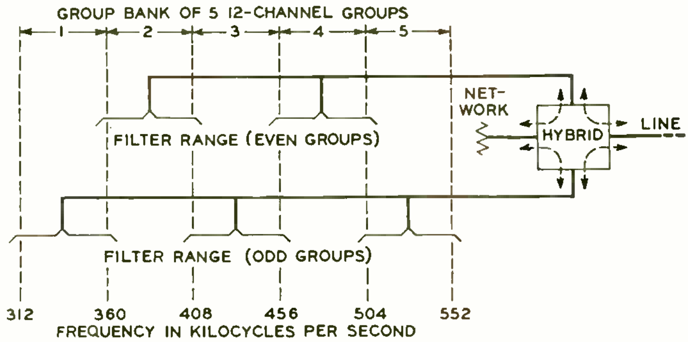


Fig. 2—Frequency allocation and filtering arrangements for the five groups of each super-group

Duplication of facilities is provided also in the group terminal equipment. For each group, the modulating equipment includes a band-elimination filter to remove any vestige of the 92-kc channel carrier (which is reintroduced as a separate pilot), a group modulator, and a band-pass filter to pass the desired sideband. In the complete system, there will be five of these sets of apparatus and a common amplifier for each of the eight group banks. One or more of these group banks is provided as a spare, and is arranged so that it can be substituted for any of the regular sets on a moment's notice. On the receiving side of the circuit, there will also be provided one or more spare receiving group banks.

This provision of spare equipment will be carried over into the super-group modulating equipment, but at the present time there is no super-group modulation for the Stevens Point system. No spare channel modulating equipment is provided on an immediate transfer basis, since the majority of the equipment is individual to a single channel, and an interruption to a single channel of this coaxial system is not so serious as an interruption in other parts of the circuit common to more channels.

To facilitate substitution of spare equipment when maintenance work is required, the spare and regular circuits are connected together through hybrid coils on either their input or output sides. The arrangement is indicated in Figure 3. The outputs of the channel modulators in the transmitting side are connected to the regular and spare group modulating equipment through the hybrid coil "A." Also, the outputs of the regular and spare super-group modulating equipments, when installed, will be associated through the hybrid coil marked "B," and the output of this hybrid coil is supplied to the regular and spare coaxial units through the hybrid coil "C." With this arrangement the spare group modulating equipment may be energized at its input without disturbing regular transmission. When the outputs are first paralleled, and then interchanged, there is a slight rise in transmission during the parallel stage. The spare group modulating equipment has jacks at both input and output sides so that it may be patched in place of any of the regular group equipments.

In Figure 3, which represents the arrangement for the Stevens Point

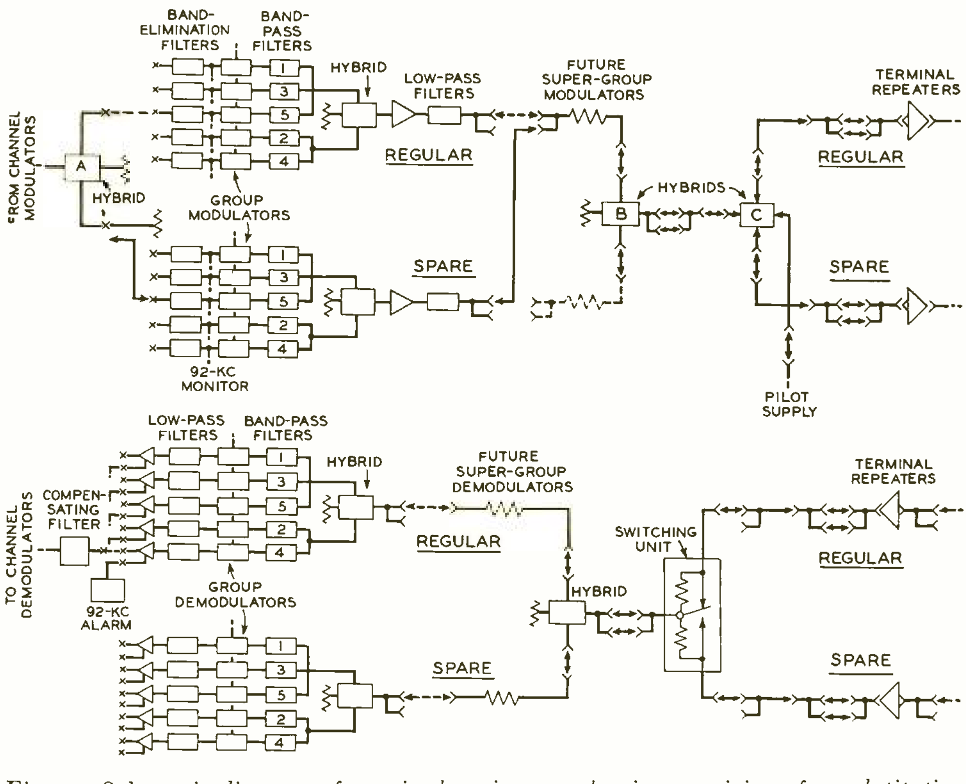


Fig. 3—Schematic diagram of terminal equipment showing provisions for substituting spare equipment in order to facilitate maintenance work

system, no super-group modulating equipment is shown since none is required. In a complete system, this super-group modulating equipment will appear between the low-pass filter at the output of the group modulating equipment and the "B" hybrid coil. Spare group modulating equipment will also be provided, and there may be a substitution of spare group equipment without the substitution of spare super-group equipment, and vice versa. For this reason the patching connection is shown going from the output of the spare group modulating equipment to the upper branch, where the regular super-group modulating equipment would appear in a complete system.

On the receiving end of the line, the arrangement is in general the same. In place of the "C" hybrid coil, however, there is a switching unit so that transmission will take place over only one of the coaxial units at a time. No hybrid coil is used between the group and channel demodulating equipments. The substitution of spare equipment at this point is made by patching cords.

All patching for substituting the spare for the regular equipment, as well as all transmission measuring and testing, is done at patching bays as shown in the photograph at the head of this article and in more detail in Figure 4. These bays are arranged so that jacks for later additions to the system may be added in orderly fashion. The bay at the right contains jacks associated with the transmitting side of the circuit; the bay in the center, those associated with the receiving side; and the bay at the left, those for transmission testing while the system is in service.

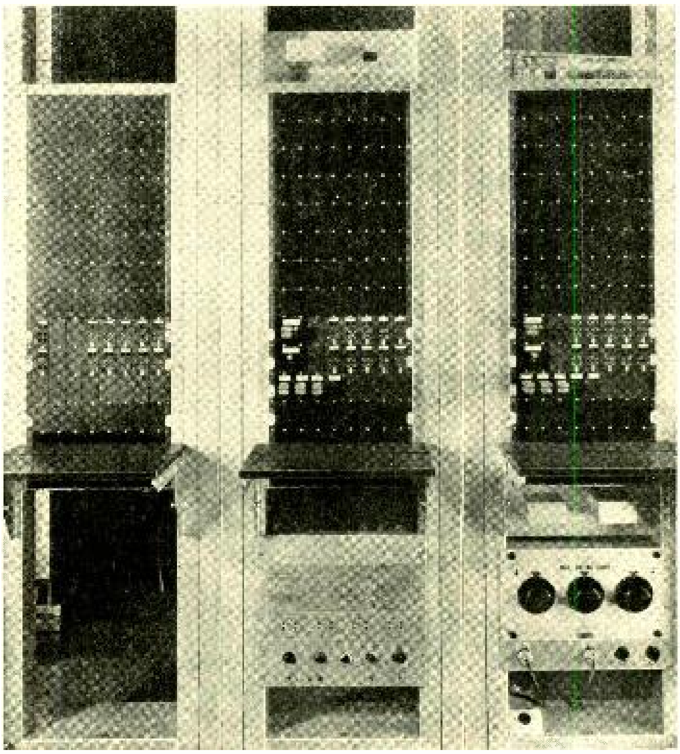


Fig. 4—Patching bays in the Minneapolis terminal

Following J and K system practice,* the L system derives all its carriers from a single 4-kc source. The arrangement provided for the Stevens Point installation is shown in Figure 5. Duplicate carrier generators are employed and they supply various groups of carriers through hybrid coils so that on failure of one generator the load may be carried by the other immediately. One hybrid sup-

*Record, *May*, 1938, *p.* 315.

plies the carriers for the odd channel modulators, and another for the even. In addition, there is a hybrid for each of the five group carriers. Amplification is required for these group carriers, and duplicate amplifiers, supplied from the two branches of the hybrid, are multipled at their outputs to supply the carriers. For a complete L system, a 124-kc carrier derived from this circuit will be supplied to a harmonic producer to obtain the super-group carriers.

Besides the modulating carriers, four pilot frequencies, 64, 556, 2064, and 3096 kc, are required for regulation, and a pilot of 92 kc is employed to give an overall test of circuit continuity of each group. This latter pilot—the continued use of which will depend on its maintenance value—is introduced into each group just ahead of the group modulators, and is taken off at the output of the amplifiers that follow the group demodulators at the receiving end. Both 64 and 92 kc are channel-carrier frequencies, and the pilots of these frequencies are taken from the channel carrier supply. The 556-kc pilot is obtained by adding in a modulator the channel carrier frequency of 88 kc to the group carrier frequency of 468 kc. To secure the 2064 and 3096-kc pilots, a frequency of 516 kc is taken from one of the group-carrier supplies and passed through a harmonic producer. The fourth and sixth harmonics provide the desired pilots.

The stability required of the basic 4-kc source of the carriers and pilots depends directly on the highest frequency to be transmitted over the line, and for a complete L1 system, 40 times greater stability is required than for the K system. For the limited frequency range utilized at present between Stevens Point and Minneapolis, however, a stability only ten times greater than that of the K system is required. The 4-kc oscillator and harmonic generator circuit provided at Minneapolis and Stevens Point is the same as for the K system except the tuning forks controlling the frequency were selected for particularly good temperature coefficients. As the system grows the 4-kc oscillator will be replaced by even more stable crystal-controlled oscillators.

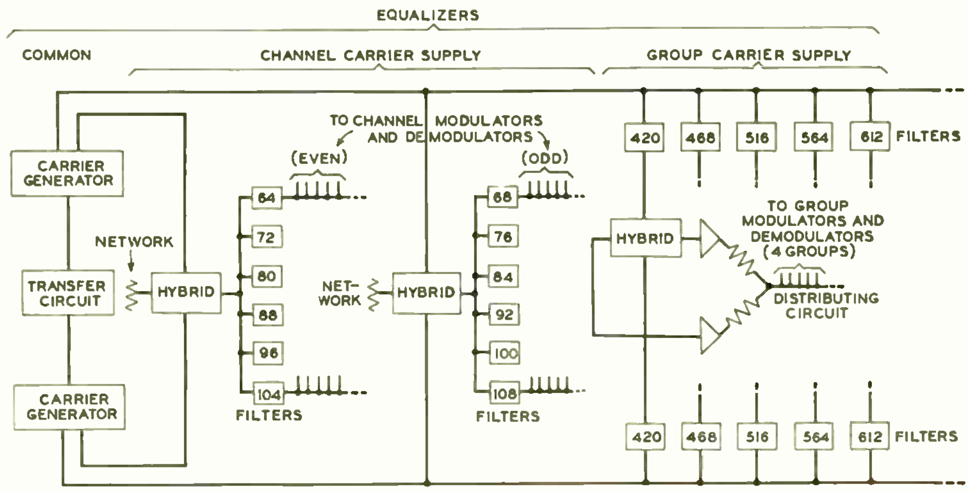
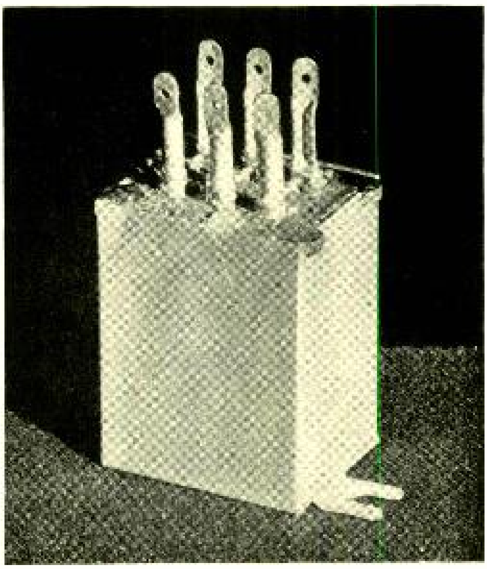


Fig. 5—Carrier supply arrangement for the Stevens Point system

Varistors as Modulators



WHEN two voltages of different frequencies are applied to a vacuum tube arranged in a suitable circuit, the output will include not only the two frequencies of the input but an infinite series of combination frequencies of which the most important are the sum and the difference of the two input frequencies. This process is called modulation. It arises from the non-linear relationship between input voltage and output current of the vacuum tube. Any circuit device with a similar non-linear characteristic is capable of modulating. It is the production of these sum and difference frequencies that makes possible all carrier telegraph and telephone communication and practically all radio transmission.

Copper oxide varistors have non-linear characteristics somewhat similar to those of a vacuum tube and they also may serve as modulators. Their small size, long life, and low original cost and maintenance as compared to vacuum tubes make their use highly desirable, and at least as early as 1927 they were being tried as modulators in carrier systems. Along with these experiments, development work was being continued on the copper oxide varistors themselves, and both developments were crowned with considerable success. The first commercial use of copper oxide modulators was in the type-G carrier system, but since then they have been used with the H, J, K, and C5 carrier systems.

When used as modulators in carrier systems, four or more sets of copper oxide varistors are arranged in a square network like a Wheatstone bridge, and usually assembled in a small metal case. The modulator used for the type-K carrier system is shown above. The method of connecting the modulator into the circuit varies with the type of system, since the type of connection affects the output components. In the G1 system, for example, the connection is such that the carrier is transmitted, while with the C5, K, and J systems, the connection is such as to eliminate the carrier. An indefinite number of circuit configurations are possible, and five are already in use.

Another of the advantages of the copper oxide modulator is that it transmits signals in either direction. The same unit may thus be used either as a modulator or demodulator. The small size of the units permits the modulating and demodulating units to be mounted on the same panel, and when this is done the combined unit is called a modem.

Station Keys for Telephones

By E. C. MATTHEWS
Switching Apparatus Development

A BROAD variety of wiring plans and key sets have been available for a number of years to enable telephone subscribers to connect to any of several lines, to transfer calls, signal extensions, or perform any of a number of switching operations that would make their telephone service more useful. With the advent of the combined telephone set, which includes the ringer and other equipment in the base of the telephone, the 1A key telephone system* was developed to provide a large number of switching arrangements, all controlled by keys mounted in the telephone base. Such an arrangement greatly improves the appearance of the station equipment by avoiding separately mounted keys and ringers, and is more convenient to use because of the close association of the keys with the telephone itself. Ordinary telephone keys, however, are far too large to use in the restricted space of a handset base. It was necessary, therefore, to develop keys that would fit in the shallow clearance of the base.

To reduce the vertical space required by the keys, the contact springs were made L-shape, the contact ends extending horizontally and the terminal ends extending vertically upward with small soldering lugs projecting horizontally backward. A further reduction in the vertical space required was obtained by using a conical spring in place of the usual cylindrical restoring spring. With a cylindrical spring, the minimum height is the number of turns times the diameter of the wire, while with a conical spring the turns lie within one another so that the minimum height becomes the diameter of the wire alone. In this way the depth required is less than half that needed for the usual

*Record, *June*, 1940, *p.* 315.

type of key. A maximum of nine contact springs may be assembled in each unit, and such an assembly is shown in Figure 1. The contact springs are operated by a plunger with a hard-rubber tip that is pushed down between the two lipped springs.

It was desired to mount as many as six of these assemblies in the base of a telephone set, and thus horizontal as well as vertical space was at a premium. The springs themselves were therefore made of lighter material than that used for ordinary keys, and the amount of travel between operated and unoperated positions was reduced. To insure adequate contact pressure and sequence under these conditions, a strip of insulating material is included in the spring pile-up to pre-position the springs. This strip, evident near the front ends of the springs in Figure 1, is slotted to receive projections from the springs. It permits each stationary spring to be given an initial tension so that only a slight displacement of the moving spring is needed to build up adequate contact pressure. The slots also fix the unoperated positions of the stationary springs so that the desired operational sequence may be more readily obtained. Spacing strips of this type are commonly used with relays, where the amount of motion is also strictly limited, but they are not ordinarily used with keys.

One of the complete keys is shown in Figure 2. The spring assemblies are fastened to a brass mounting plate, and two steel brackets are used to attach to the base of the handset both the mounting plate and an insulating plate that serves as a terminal block for both the keys and the handset. The front edge of the brass plate is drilled for the plungers that operate the keys, and a narrower brass strip is held beneath the mounting plate and drilled for the hard-rubber tip of the plungers. A metal washer is fastened to the plunger just above the hard-rubber tip, and between this washer and the lower brass strip is the conical restoring spring that holds the plunger in its normal or "up" position. A third strip, called a slide plate, is mounted so as to be

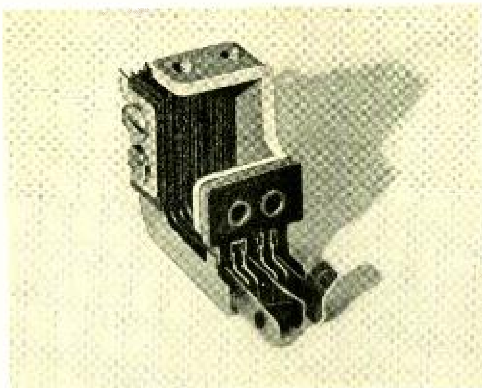


Fig. 1—Spring assembly of keys used for 1A *key system*

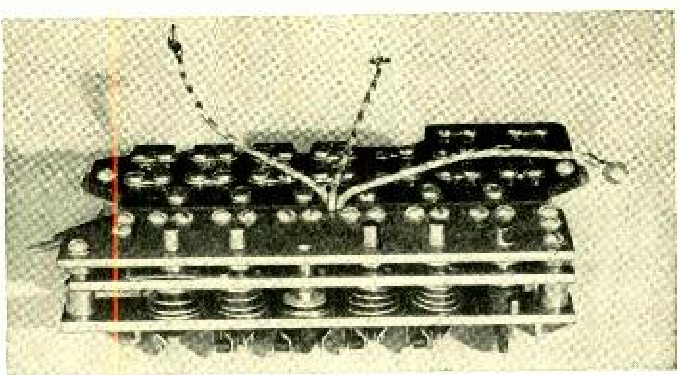


Fig. 2—One arrangement of the six-button key used with the 1A *system*

just above the washers when the plungers are in the normal "up" position. This plate is drilled for the plungers with an oversize hole, and is free to move horizontally in the direction of its length. It provides the locking and releasing feature commonly used with mechanically locking keys. Most of the spring assemblies are used to associate the handset with

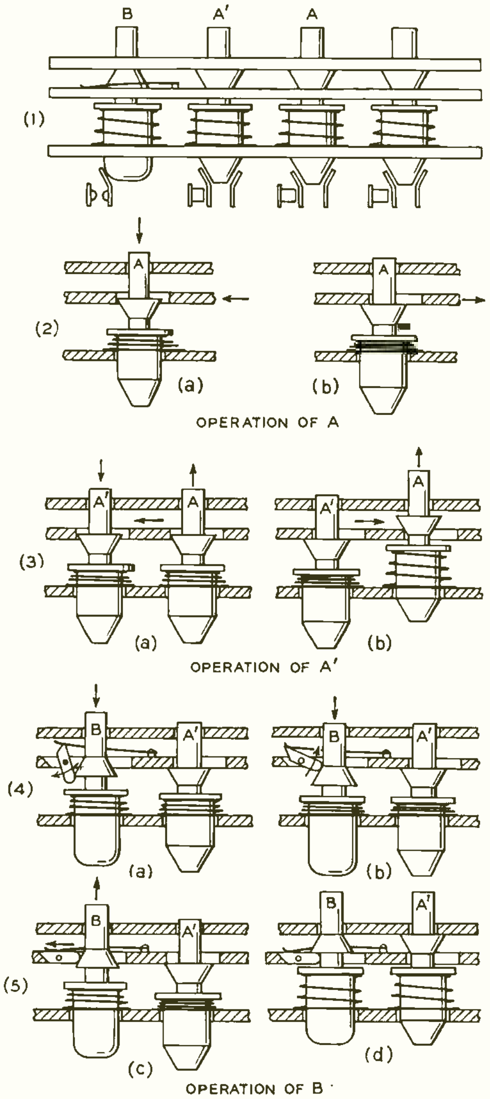


Fig. 3—Diagrammatic representation of the locking bar and the pawl mechanism for the hold button

one or another of a group of lines, and by the use of the slide plate, the depression of any one of the "line" keys will release any other, and will lock itself in.

This slide plate is slotted at each end for the two end posts holding the plates in place, and is held in one extreme position by a coiled spring fastened to the top plate. Each plunger has a flat-topped cone-shaped section just above the hole, and as the plunger is depressed, the cone forces the slide plate to one side until the top of the cone is below the slide plate, which then snaps back above the shoulder of the cone and holds the plunger depressed. When another plunger is operated, its cone will push the slide plate to one side, and the key already operated will release just before the newly operated key is locked. These actions are shown in lines 2 and 3 of Figure 3.

With the 1A key system it was desired to provide a common holding key so that a call on any line could be held, and the handset disconnected from that line and connected to another. This requires that there be an appreciable interval between the closing of the contacts of the "hold" button and the releasing of the line button operated. With this slide plate construction, however, it is evident that the releasing of the line would follow almost immediately the closing of the holding contact. To secure the time interval desired, the cone on the "hold" plunger is inverted so that its flat shoulder faces down, and in the slide plate the edge of the hole that normally rests against the plunger is cut out and fitted with a pawl. This is tipped down by the shoulder of the cone when the plunger is depressed, and then is snapped back by a flat spring as the shoulder passes beneath it. The arrangement is shown in lines 4 and 5 of Figure 3. When the "hold" button is depressed, the slide plate is not moved because of the deflection of the pawl. When the button is released, however, the slide plate is deflected by the upward motion of the cone, and the operated "line" button is released. In this way the "line" button is not released until an appreciable interval after the "hold" contact has been made.

The key plungers shown in Figure 2 are operated by insulating buttons that project through the handset base. If these buttons were rigidly attached to the plungers, either the manufacturing tolerances would have to be very small, or the holes in the base would have to be considerably larger than the plungers to allow for manufacturing variations. This is avoided by mounting hard-rubber buttons loosely in the base of the handset, and giving them a flanged base that is somewhat larger than the tops of the plungers. The arrangement is shown in Figure 4. With such a design, accurate alignment of plunger and button is not necessary.

Beside the "line" and "hold" buttons already described, other types are available. Fewer than nine springs may be used, or the locking feature may be omitted to give simple "push-button" action, which is desirable for signaling purposes. Another form is

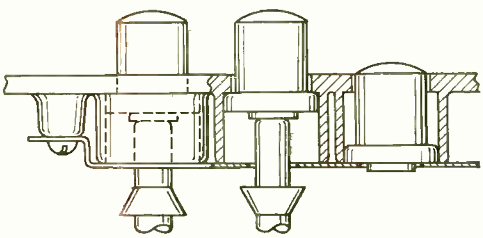


Fig. 4—Button construction in base of combined telephone set

the "turn" key, one of which is shown at the extreme right of Figure 2. A button of this type is useful for such operations as transferring a line or cutting off an extension or ringer.

Two standard multi-button keys have been provided for the 1A system: the 561 and the 562. The former has

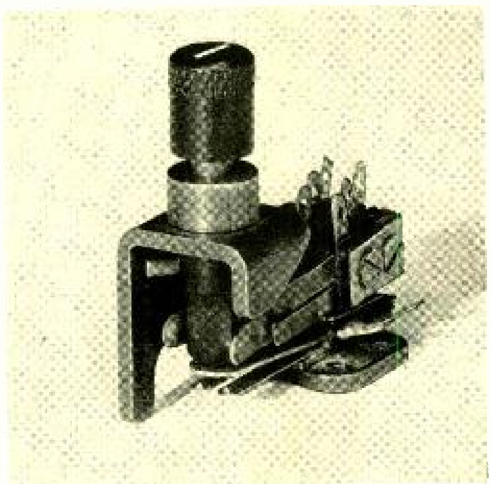


Fig. 5—Small key developed for the small combined telephone set

four spring assemblies and the latter six, but the keys of either type are available in a variety of spring combinations. Both units mount in the large telephone set used primarily for the 1A key system.

For stations of the 1A system that have access to only one or two lines, the smaller telephone set may be used. In this smaller telephone set, the only room available for a key is a restricted space between the ringer magnet and the wall of the housing. To fit in this space, the very small key shown in Figure 5 was developed. Known as the 559, it is a combination turn and push button. One set of springs is operated when the button is turned, and another set—usually employed for signaling—when the button is pressed. The "press" contact may be made with the button turned in either direction. The button of this key is fastened directly to the plunger, and alignment is provided by using slots instead of holes for the mounting screws. Shoulders on the mounting screws permit the key assembly to be firmly held while still permitting a small amount of lateral motion in any direction. This key may be used for picking up either of the lines associated with the telephone set, for transferring a call to an extension, for cutting off an extension or ringer, or for signaling.

With these three types of keys, the 1A system can provide almost any form of switching service desired. The keys are ordered to meet the operating requirements, and all the connections for the telephone set are made on the terminal block of the key when the system is installed.

Contributors to this Issue

SINCE PRIVATE BRANCH EXCHANGES and key telephone systems have been ALBERT TRADUP's life work, he was very well prepared to undertake the coördination of development work on the telephone system for the Air Corps' Information Centers. Entering A. T. & T. in 1920, Mr. Tradup was assigned to formulating the electrical, mechanical and physical requirements for PBX switchboards. Since the consolidation of the D. and R. with the Laboratories in 1934, he has continued that work in the Systems Development Department. He was graduated by the University of South Dakota in 1915 with a B.S. degree, when he entered the Northwestern Bell.

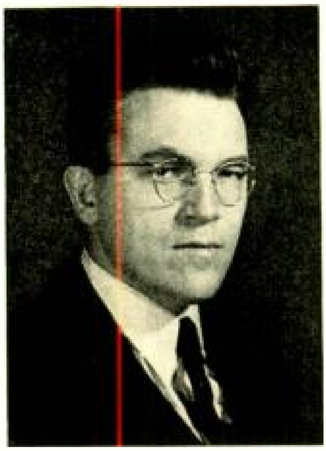
Albert Tradup

Clinton Shafer, Jr.

CLINTON SHAFER, JR., joined the Laboratories in 1925, shortly after receiving an M.E. degree from Stevens Institute of Technology. He started in the Inspection Engineering Department and was transferred to the Outside Plant Development Department when it was organized in 1927. From then until 1940 he was engaged principally in development work on rubber-covered wire. Since then he has been engaged in outside plant facilities studies.

J. O. EDSON received the B.S. in E.E. degree from the University of Kansas in 1929, and at once joined the Technical Staff of the Laboratories. Here, with the Toll Circuit Development Department, he has devoted the greater part of his time to the development of carrier telephone systems—in later years chiefly the type-J and type-K systems. He has also developed a certain amount of measuring apparatus, such as the oscilloscope described in this issue.

R. E. CRANE graduated from the Harvard Engineering School in 1923 and immediately joined the Engineering Department of the Western Electric Company. He has been engaged since that time in development work on carrier telephone systems. For the last several



J. O. Edson

R. E. Crane

E. C. Matthews

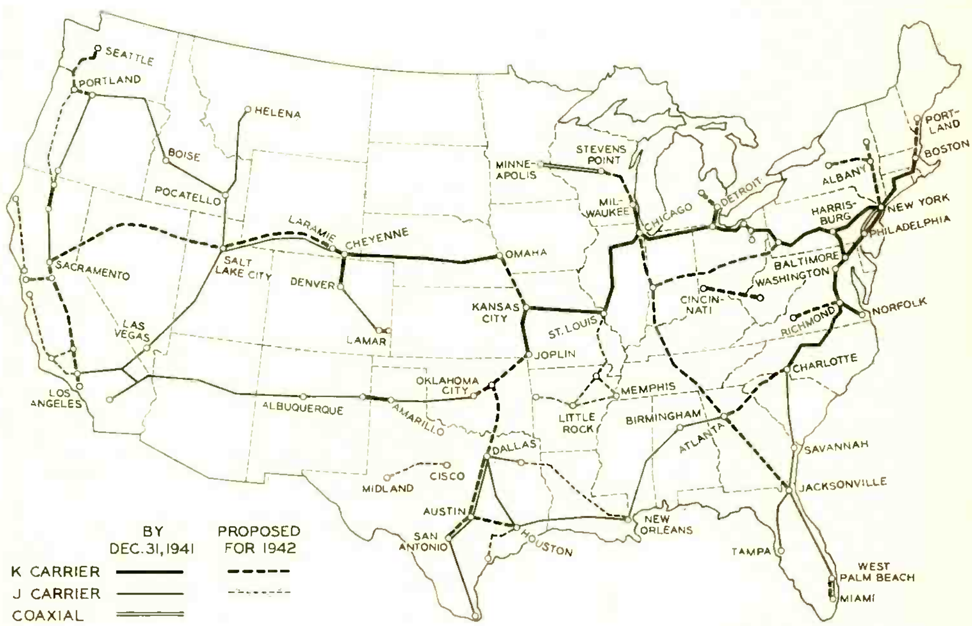
years he has been in charge of a group which has been concerned with the terminals of broad-band carrier systems, principally those for application to voice-frequency and coaxial cables.

E. C. MATTHEWS joined the Engineering Department of the Western Electric Company in 1914, and for five years was engaged as a draftsman in the development of dial system apparatus. During this time he attended the Newark Technical School from which he graduated in 1917. He worked for about two years on the preparation of apparatus manufacturing specifications, but since 1922, in the Apparatus Development Department, he has been engaged in the design and development of manual central office and subscribers' station apparatus, and more recently has been particularly concerned with the development of the keys for the new combined telephone sets used in key telephone systems. He recently transferred to the Whippany Radio Laboratory.

Bound copies of Volume 19 *of the* RECORD (*September*, 1940, *to August*, 1941) *are now available* — $2.75, *foreign postage* 25 *cents additional. Remittances should be addressed to Bell Laboratories Record*, 463 *West Street*, *New York. A separate index to Volume* 19 *is now available and may be obtained upon request*

Routes of Broad-Band Carrier Systems

DURING September, national magazines carried the Bell System advertisement reproduced on the opposite page. To indicate the extensive coverage of the type-K and other new broad-band carrier systems, the routes over which they are expected to be in operation at the end of this year and at the end of next are indicated on the map below. The number of systems in use or projected along routes shown varies considerably. Only five systems, for example, are planned between St. Louis and Joplin by the end of this year, as compared with thirty-four between New York and Washington. The present tentative view, however, is that by the end of next year—December thirty-first, 1942—the number in the section between Joplin and St. Louis will be more than quadrupled, while in the section between New York and Washington the number will be nearly tripled. It is expected that some two and a half million circuit miles of broad-band carrier facilities will be available by the end of 1942.



Present and proposed routes of broad-band carrier systems