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Bell Telephone Magazine

Volume XXV, 1946

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Bell Telephone MAGAZINE

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erican Telephone & Telegraph Company · New York

Bell Telephone *Magazine*

Spring 1946

"*The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost.*"

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *Pres.;* Carroll O. Bickelhaupt, *Sec.;* Donald R. Belcher, *Treas.*

Who's Who & What's What

in This Issue

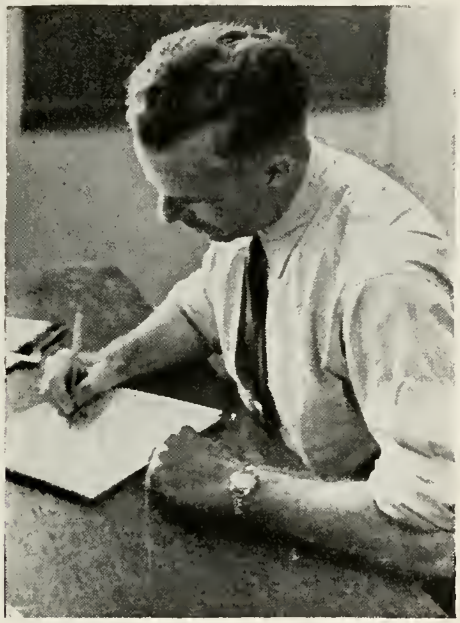
Gallup polls, *Fortune* surveys, and similar phenomena of the current American scene were not so commonplace back in 1929, when A. T. & T. Vice President Arthur W. Page asked Seymour L. Andrew, then Chief Statistician and now retired, to undertake the study of public opinion survey methods and their applicability to the telephone business. As a result of that request, Arthur H. Richardson and C. Theodore Smith were assigned to carry on the development of the work in this field. They have been at it ever since: asking questions and analyzing the answers, broadening the field and developing and refining methods, increasing the accuracy and the significance of the facts they uncover—and helping the Associated Companies of the Bell System to do more and more of the same. The article beginning on page 5 is the first general description of this System activity to be published.

Mr. Richardson started in the Statistical Division in 1919, and for a decade devoted himself to methods of statistical analysis and presentation and was active in the organization and development of statistical work in the Associated Companies. As General Research Statistician, his activities, in addition to public opinion research, cover the field of opinion surveys as applied to employee relations and to the telephone market. Mr. Smith, who has worked closely with Mr. Richardson since he joined the Statistical Division in 1929, contributed "Exhibiting Telephone Progress at the World's Fair" to the Bell Telephone Quarterly for January 1934.

Back from a "rather active assignment": Long-Liner Harold White

Fact-uncoverers: Arthur H. Richardson (right) and C. Theodore Smith

No extensive research is necessary to find out what members of the Armed Forces who were—or are—overseas think of the provision of telephone service which enables them to talk with family or friends even from the other side of the world. It is the final follow-through of the service which the Bell System has strained to make available at camps, hospitals, debarkation centers —wherever Service men and women have



Science Editor, editing: PHILIP C. JONES

needed it. And the literally hundreds of thousands of calls which have been placed to this country from the European and Pacific Theaters are all the evidence needed about GI public opinion of the service.

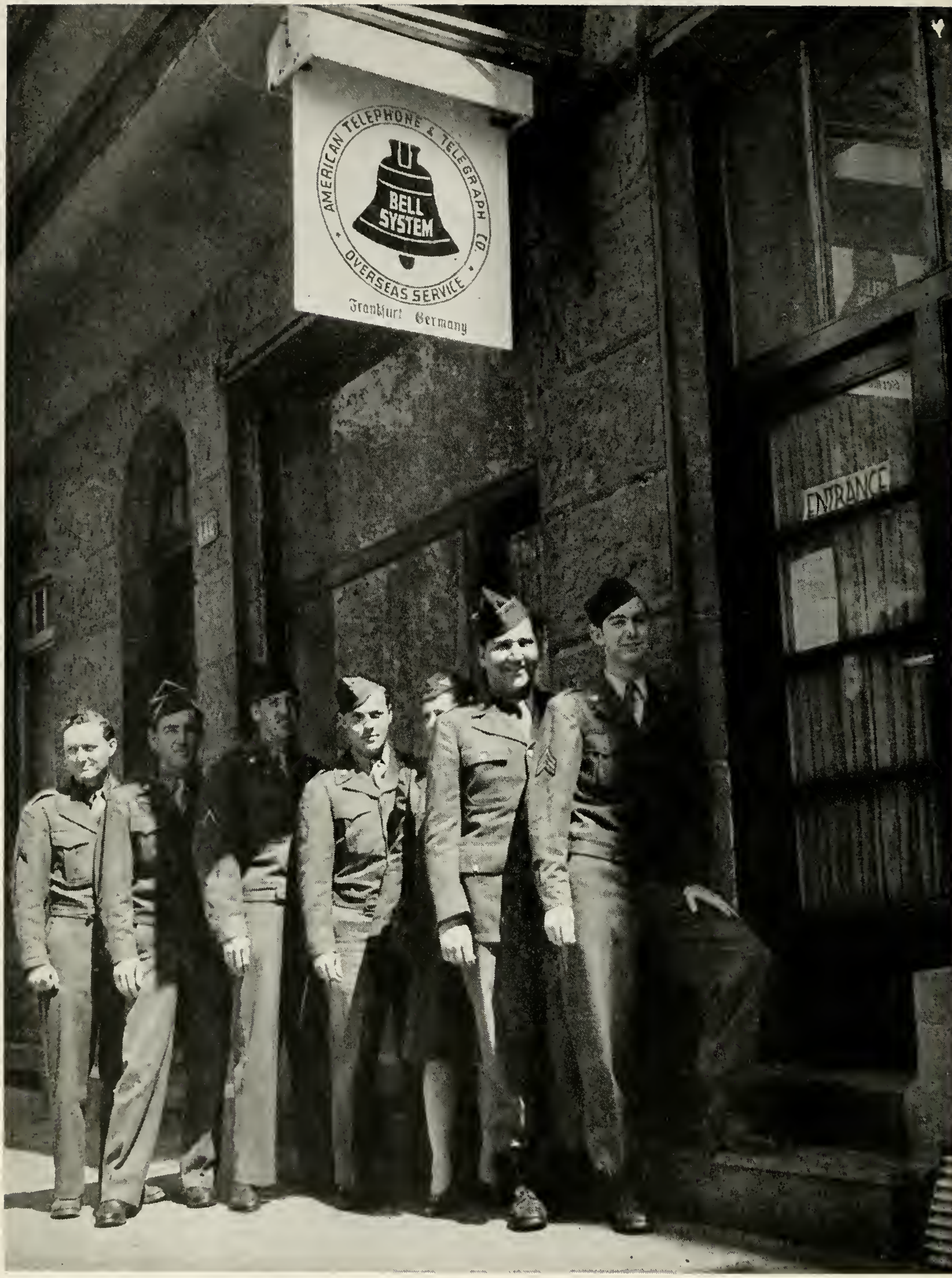
Overseas telephony is provided by A. T. & T.'s Long Lines Department, which HAROLD A. WHITE joined as a technical student in 1928. Various assignments preceded his appointment in 1939 as district plant superintendent at Washington, D. C. "Due to the war," he notes, "this was a rather active assignment"—which might be taken as an understatement. The war over, he was brought back to Long Lines headquarters at New York, where for a year he has been staff supervisor of overseas services.

OF BELL LABORATORIES' diverse and effective assistance to the Armed Forces of this nation and its allies in World War II, about half was devoted to the development of radar. But its resources and personnel were called on for help in other fields also, and some of its other contributions were not only invaluable but unique. A few of them PHILIP C. JONES describes in the article beginning on page 37. Mr. Jones is Science Editor of *Bell Laboratories Record,* and has thus been able to draw freely upon material which he had written or edited for that publication. Before joining the technical staff of the Laboratories in 1927, he had had 15 years' engineering experience in this country and in South America.

MEMBERS OF the Armed Forces responsible for the maintenance and operation of radar and other electronic devices, in all branches of the Service and in all parts of the world, found Western Electric's Field Engineering Force a supporting host in time of need. J. STEDMAN WARD tells some of the facts and some of the happenings which made it so; and he knows about such things. For it was he who formed the F. E. F. and guided its destiny for five years.

Mr. Ward was employed by Western Electric in its Engineering Department (later to become Bell Laboratories) in 1919. His early experiences included work with ship-to-shore radio telephone service and with Western Electric radio broadcasting equipment. When "talking movies" became a reality, he helped to introduce the Western Electric system of sound motion picture equipment; and he became director of operations for Electrical Research Products Incorporated in charge of its field installations and service organization. Now, with the F. E. F. on a peacetime scale, he becomes coördinator of personnel and training in Western's Installation Department.

Welcome to Hawaii: J. STEDMAN WARD (right) being greeted in 1944 by Navy Captain A. L. Becker, then Electronics Officer at Pearl Harbor



A FAMILIAR EMBLEM in an unfamiliar setting. Note the words "Frankfurt, Germany," at the bottom of the sign. At the request of the Army, the Bell System re-established and operates the overseas telephone circuits between the United States and the U. S. occupation zone in Germany—the only area abroad from which it operates. See "Three-Minute Furloughs," page 20

Carefully Conducted Attitude Surveys, Using Scientific Methods, Reveal Useful Facts about Customers' Opinions of Telephone Service and the Telephone Company

Finding Out What People Think of Us

Arthur H. Richardson and C. Theodore Smith

THE BELL SYSTEM now handles about thirty *billion* telephone calls a year. It sends out millions of bills; its installers and repairmen make millions of visits to customers' premises; and there are innumerable other contacts between the public and the System's operating companies. Add them all up, and you will have some idea of the number of occasions which the public has for forming impressions of telephone service and of the companies which furnish it.

For many years the Bell System has been using various ways of finding out what those impressions are. The continuous service-measurement plans of the departments, and the many contacts which employees have with users of the service, give a fairly good indication of how successful each Associated Company is in giving people the kind of service they want. And voluntary comments of customers, in person, over the telephone, by letter, supplement this information.

But there are many millions of telephone users whom the company seldom or never sees or hears from; and the great majority of people do not indicate what they think unless they are asked. To get the views of both the articulate and the inarticulate, and to cover subjects on which they are not likely to volunteer an expression of opinion, the System is making increasing use of opinion surveys. In these studies it finds out what people are thinking by going directly to them with questions; and by carefully selecting a relatively small sample of customers for questioning, a reliable indication can be obtained of the opinions held by the whole group under study.

The first organized customer opinion survey in the Bell System was made in Detroit toward the end of 1925. It was conducted by J. D. Houser and Associates, one of the pioneer firms engaged in measuring attitudes. Many of the methods employed, which have since had widespread use in other Bell System studies, were developed by Dr. Raymond Franzen, who was then a member of the Houser organization and with whom the A. T. & T. Co. has since maintained a consulting arrangement.

In 1929, subsequent to a Houser survey of the effectiveness of American Telephone and Telegraph Company advertising, made in Pittsburgh, a unit was set up in the Chief Statistician's Division of A. T. & T. to determine possible applications of opinion survey techniques to problems in the Bell System. Since that time this unit has been engaged in developing methods and in assisting the Associated Companies to conduct surveys, and has prepared numerous reports based on the findings of studies made in conjunction with the companies.

During the twenty years that opinion surveys have been made in the Bell System, the views of more than five hundred thousand people (representative of many millions) have been obtained on many different subjects in hundreds of studies carried out in many different cities, towns, and rural communities over the country. For the most part, these studies have been conducted by the telephone companies themselves, as early experience indicated that it was possible for company representatives to obtain from the public full and frank expressions of opinion regarding telephone service and other phases of the business.

The opinion surveys have varied widely in scope and purpose; but all have aimed to contribute facts about customer opinions needed to arrive at sound solutions of problems in which attitudes of our customers or of the public generally were involved. For example, surveys have been useful:

In finding out which specific aspects of telephone service the user feels most need improvement.

In measuring customer satisfaction with service in small offices where service measurements are not normally made.

In determining telephone service requirements of people living in rural areas.

In determining marketing habits of housewives, as a basis for promoting use of the telephone for shopping.

In determining the needs, attitudes, and expectations of applicants who are waiting for telephone service.

In deciding what improvements in pay station facilities are most desired by users.

In considering possible revisions of telephone exchange boundaries.

In revising the form of telephone bills to increase their clarity.

In determining how telephone directories may be improved to facilitate reference and to increase use.

In determining the most effective placement of advertising in daily newspapers.

In determining the size of audience of telephone company radio programs.

In determining the effectiveness of various campaigns to promote toll usage.

It was recognized from the start of the activity that the study of opinions and attitudes was not a simple undertaking. In dealing with intangibles of this character, it was apparent that a good deal of experimenting with methods would have to be done if sound conclusions were to be reached. The measurement of public attitude was a new field, and at the outset little guidance could be obtained from outside sources. So the early studies made in the Bell System were looked on as primarily experimental, and procedures were thoroughly tested to determine those which seemed to give the most reliable results. In this experimental work the Associated Companies co-operated, and they have contributed materially to the development of methods and procedures.

Conducting a customer opinion survey by means of telephone interviews

At the beginning of the survey activity it was feared that there might be some unfavorable reaction on the part of our customers and the public generally. However, the general experience has been that the public does not object to being questioned, but, on the contrary, is very willing to answer questions about telephone service and the telephone company. Apparently, people appreciate the interest shown by the company in soliciting their views, and it is now generally recognized that the survey activity has a definite customer relations value.

It is important, of course, that the procedures followed in obtaining the necessary information from people should not annoy or irritate them; for, in addition to the effect on customer relations, this could lead to inaccuracies in survey results. To avoid any possibility of such reaction, special care should be exercised in planning and conducting each study.

How Surveys Are Made

In setting up an opinion survey, the first essential, as in the case of most other scientific inquiries, is a clear-cut definition of objectives: specifically, what the problem is, what information is needed in connection with the problem, and along what lines the inquiry should be directed to obtain results which will have practical application. The actual steps followed will vary from study to study, but there are certain fundamental procedures common to most opinion surveys. These include:

Developing the Questionnaire
Selecting the Sample
Getting the Information
Analyzing the Results

Page Two — *What Is Your Opinion?*

4. Is there anything about your service that is in any way unsatisfactory? *Yes* ☐ *No* ☐
   (*If Yes*) What is unsatisfactory?________________

5. In general, would you say the telephone service you are getting is poor, fair, good or excellent? *Poor* ☐ *Fair* ☐ *Good* ☐ *Excellent* ☐

6. Do you feel your telephone service is better, or worse, than it was a year ago? *Worse* ☐ *No different* ☐ *Better* ☐ *No service year ago* ☐

7. Can you recall any occasion when you were particularly annoyed by something the telephone people did or failed to do? *Yes* ☐ *No* ☐
   (*If Yes*) What was it?________________

8. Can you recall any occasion when you were particularly pleased by something the telephone people did for you? *Yes* ☐ *No* ☐
   (*If Yes*) What was it?________________

9. In general, how would you describe the attitude of people at the Telephone Company? *Not very helpful* ☐ *Helpful* ☐ *Very helpful* ☐ *No opinion* ☐

What Is Your Opinion? — Page Three

10. Do you feel the Company is doing all it can to give good service, or could it do more? *Could do more* ☐ *Doing all it can* ☐ *No opinion* ☐

11. About how many local telephone calls are made from your telephone in a week? (*Your best guess*) ☐ *Number*

12. About how often are out-of-town calls made from your telephone—say to places more than 25 miles away? (*Your best guess*) *Don't make calls* ☐ *Less than once a month* ☐ *About once a month* ☐ *More than once a month* ☐

13. Do you regard your telephone as: *An absolute necessity* ☐ *A necessity* ☐ *Mainly a convenience* ☐

14. Do you feel that you get your money's worth out of your telephone? *Sometimes feel I do not* ☐ *Usually feel I do* ☐ *Always feel I do* ☐

15. At any time during the past year have you felt you wanted to change to: *A higher class of service* ☐ *A lower class of service* ☐ *Have not wanted to change* ☐

16. At any time during the past year have you considered doing without your telephone? *Yes* ☐ *No* ☐

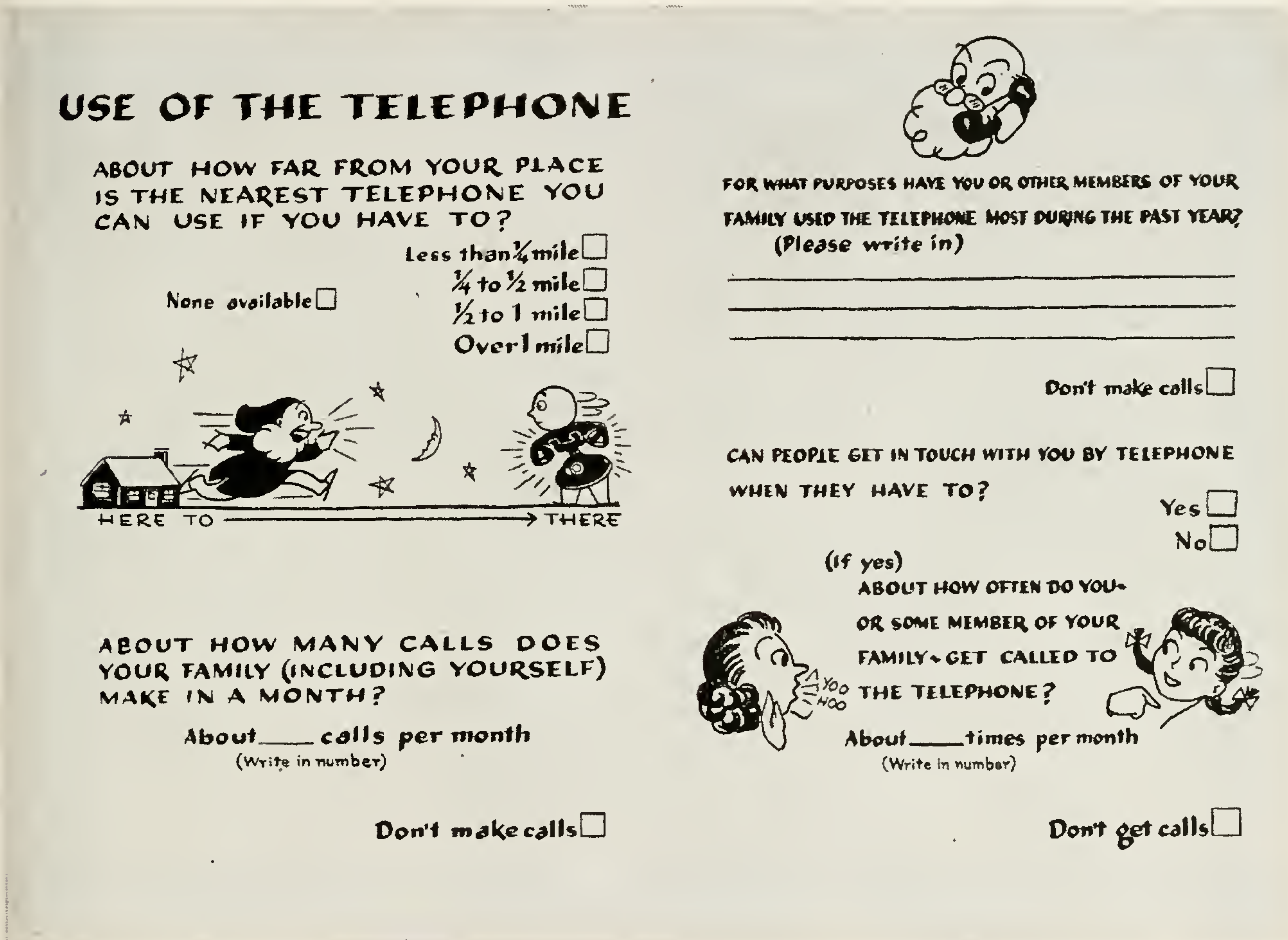
What is a telephone company questionnaire like? Here are two pages from one which was used in a nation-wide survey of customer opinion

Developing the Questionnaire

Most Bell System attitude surveys are conducted on a questionnaire basis, in which each individual in the sample is asked a prepared list of questions. This assures that all pertinent aspects of a subject will be covered with each person. Moreover, definite response categories are provided for most questions, which makes possible the statistical analysis of results. This does not prevent free expression of opinion, however, and space is always provided on questionnaires for customer comments.

There are, of course, certain general principles which should be observed, such as avoidance of words which may mean different things to different people, and of leading questions and of questions which might cause people to "cover up."

It is customary on a new project to



USE OF THE TELEPHONE

ABOUT HOW FAR FROM YOUR PLACE IS THE NEAREST TELEPHONE YOU CAN USE IF YOU HAVE TO?

None available ☐

Less than ¼ mile ☐

¼ to ½ mile ☐

½ to 1 mile ☐

Over 1 mile ☐

HERE TO → THERE

ABOUT HOW MANY CALLS DOES YOUR FAMILY (INCLUDING YOURSELF) MAKE IN A MONTH?

About____ calls per month
(Write in number)

Don't make calls ☐

FOR WHAT PURPOSES HAVE YOU OR OTHER MEMBERS OF YOUR FAMILY USED THE TELEPHONE MOST DURING THE PAST YEAR?
(Please write in)

Don't make calls ☐

CAN PEOPLE GET IN TOUCH WITH YOU BY TELEPHONE WHEN THEY HAVE TO?

Yes ☐

No ☐

(If yes)
ABOUT HOW OFTEN DO YOU—OR SOME MEMBER OF YOUR FAMILY—GET CALLED TO THE TELEPHONE?

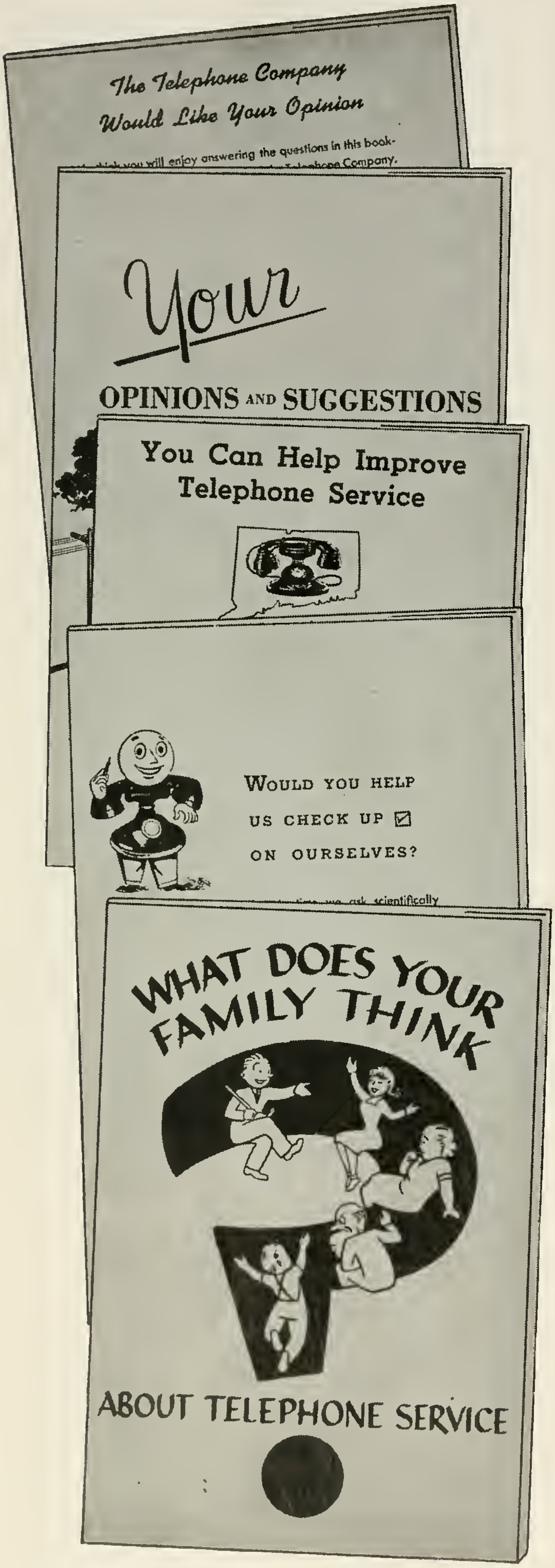
About____ times per month
(Write in number)

Don't get calls ☐

A NOT-TOO-SERIOUS ATMOSPHERE helps to create interest in answering questions: facing pages from a questionnaire to rural non-subscribers

The preparation of the questionnaire is one of the most exacting phases of the whole survey activity. There are few definite rules which can be laid down in framing the questions—for this depends on judgment, and on experience as to what has proved productive and what has not.

conduct a small-scale "pilot" study before proceeding with the survey proper. This provides an opportunity to experiment with introductions, question wordings, order of questions, and any special or unusual procedures which it may be desirable to try out.



Selecting the Sample

ALMOST ALL opinion studies are conducted on a sampling basis; that is, a cross-section is selected in such a way as to represent in miniature the total group of people whose views are desired. But to secure an accurate cross-section picture, the procedure used in selecting the individuals who are to comprise the sample is of first importance.

Methods of sample selection vary, depending on such factors as the characteristics of the group to be studied and on the availability of information regarding this group. In telephone company surveys of subscribers, sampling is greatly simplified because the names and addresses of all of our customers are listed in telephone directories and elsewhere in company records. These lists provide an excellent basis for sampling, since they make it possible to use a "random" method of selection.

To illustrate one of the simpler applications of this procedure: suppose it were desired to conduct a survey by telephone in which some 500 residence customers were to be chosen as a sample of all residence subscribers in some particular city or town. The telephone directory for the community would be divided into 500 equal sections. Interviewers might be instructed to obtain an interview with the first available residence subscriber in each of the 500 sections.

If the study were to be made on the basis of visits to the premises, a smaller number of so-called "interviewing spots" might be selected at

AT THE LEFT are the covers of some questionnaires used in attitude surveys random and a group of interviews obtained in each, thus reducing the amount of travel involved.

While the random method of sample selection might appear haphazard and unorganized, actually it follows certain fundamental mathematical laws. The reliability of this method in telephone company surveys is evident when comparisons are made of the known characteristics of the whole group with similar distributions for the sample.

As to the size of the sample necessary for a given study, a number of factors are controlling. All samples are subject to a certain amount of "error"; that is, results will differ somewhat from those that would have been obtained had the total group been covered. Assuming that the sample has been properly selected, the extent of the error depends on the size of the sample: the greater the accuracy desired, the larger the sample must be. Also, of course, the greater the number of sub-group comparisons to be made, the larger the sample must be.

It is surprising to many that the actual size of the total group from which a cross-section is to be taken has relatively little to do with the number of interviews required. Of more importance is the degree of homogeneity in the group being studied. Where there is little uniformity of opinion in the group, more interviews are necessary to achieve a

AT THE RIGHT are shown steps in tabulating attitude survey results. Top to bottom: "editing" and "coding" questionnaires; punching responses to questions on tabulating cards; sorting punched cards and counting responses given degree of accuracy than where people's opinions tend to be similar.

Getting the Information

THERE ARE various ways of obtaining attitude information from the public. Each has its advantages and disadvantages, and the procedure used for any specific survey would be the one which would provide the most reliable and useful results in connection with the problem at hand.

Face-to-Face Interviews have been used in conducting many Bell System surveys. While this method is relatively time-consuming, it has particular advantages where a new problem is being explored, where many questions are to be asked, where the questions are on subjects unfamiliar to the customer, or where it is necessary that the questions be answered in definite order.

Face-to-face interviews must be made, of course, where observation of the premises is necessary to get data on economic status or to observe telephone facilities; or where, as a part of an interview, it is desired to show advertisements or check lists, or to ask the customer to perform some operation such as to look up telephone numbers or to dial a call.

One of the more difficult aspects of the face-to-face interview is the proper recording of answers and comments without interfering with the conduct of the interview. No attempt is made to conceal the questionnaire form, and responses and comments are recorded as the interview proceeds. Experience has been that people not only do not mind having their answers written down but, as a matter of fact, seem to feel that it is the logical thing for the interviewer to do.

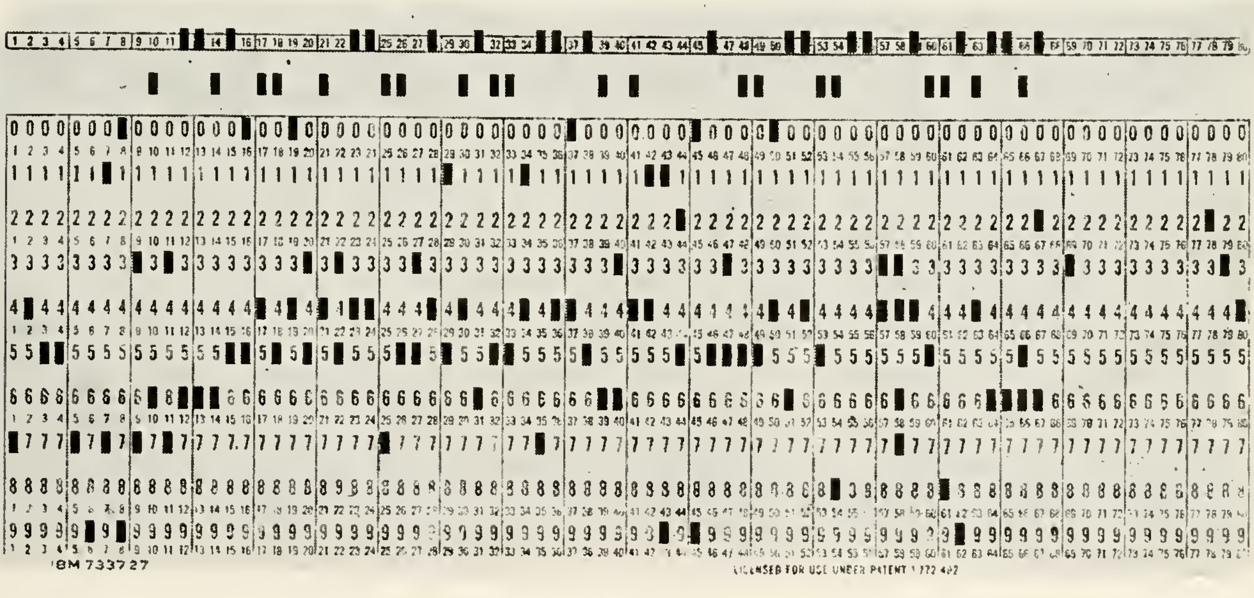
Telephone Interviews have been used extensively, particularly for studies of attitude toward telephone service. Customers seem to feel it is appropriate for the company to use the telephone in interviewing them about their service. Telephone interviews are less time-consuming and less expensive than premise interviews, and can be supervised much more closely. While the telephone interview has many of the advantages of the premise interview, it must be relatively short and the questions must be of a type which people can answer readily.

In surveys involving either face-to-face or telephone interviewing, proper handling of the interview is of crucial importance and requires training, skill, and experience. In the introduction to the interview, the purpose of the survey is explained to the person, and the company's interest in getting a frank expression of opinion is emphasized. Every precaution is taken to insure that answers will not be influenced in any way; naturally, interviewers refrain from expressing their own opinions, and questions raised by the person being interviewed are usually deferred for answer until the end of the interview.

IN CONTRAST to interviews where questionnaires are filled out by an interviewer, there are other procedures whereby customers fill out the questionnaires themselves. For example, questionnaires have been left at pay stations, and have been given out at business offices, at telephone company "open houses," at telephone exhibits and demonstrations. However, in most Bell System studies where the customer fills out the questionnaire, the practice is either to send it to him through the mails or to employ the "leave-and-pick-up" procedure.

Mailed Questionnaires have been used to advantage especially in connection with subjects which have previously been explored rather thoroughly in personal interviews. Studies conducted on this basis can be administered from a central point, and are particularly advantageous where people from whom information is wanted are widely scattered or where "family" expressions of opinion are desired.

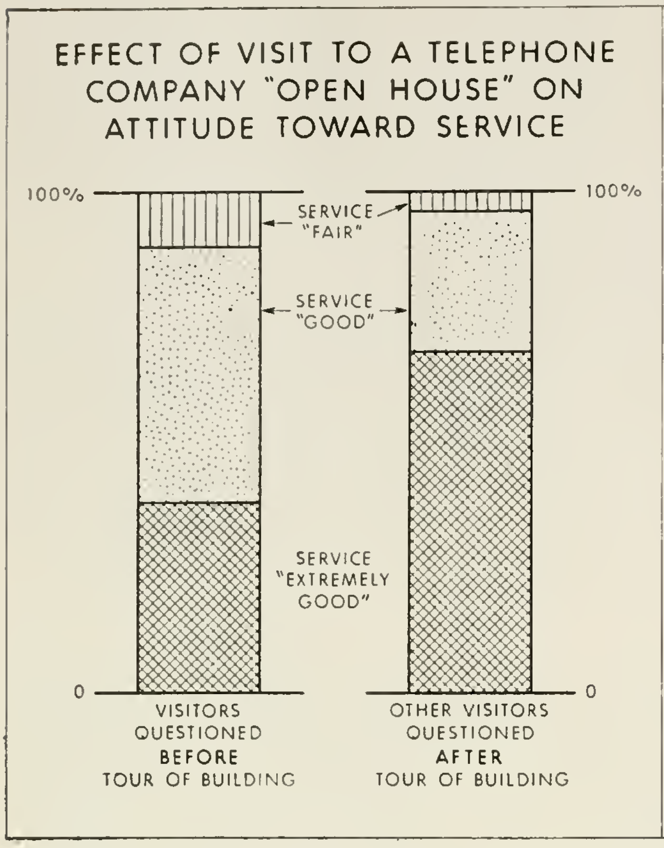
In using the mailed questionnaire method, the possibility must always be reckoned with that people who fill in and return questionnaires may differ from those who do not. Accordingly, in order to minimize any effect which such differences may have on the results, special effort is always directed toward getting a high return. If the subject is of interest, if the questions are not too difficult, and if the approach and follow-up are well planned, a satisfactory return of completed questionnaires can usually be obtained.

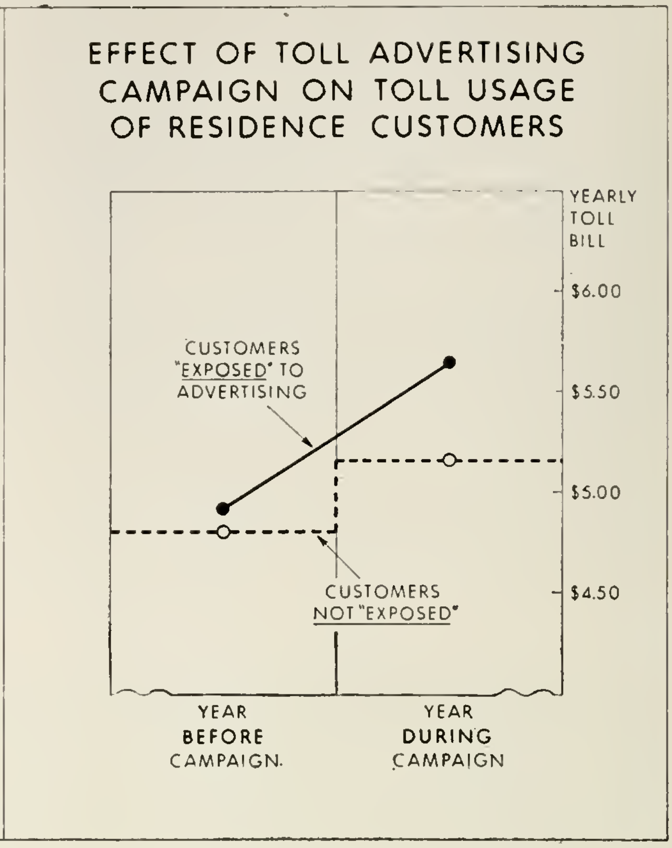


THE HOLES on this card record all the information given on one questionnaire

The "Leave-and-Pick-Up" Method is a relatively new development in System studies. In this procedure a questionnaire is left with the customer to fill out; and later on, the same day or the next morning, it is picked up. The method was first tried out in a survey in Rochester, Minnesota, early in 1943.

This method, as compared with face-to-face or telephone interviews, materially speeds up the field work, because the interviewer does not have to wait while the questions are being answered. Since the individual reads the questions himself and records his own responses, any influence which interviewers might have on results is largely eliminated. Moreover, it is





How SURVEYS were used to determine the effectiveness of two specific public relations activities. Left, people's opinion of the quality of their telephone service improved after a visit to a central office. Right, the toll bills of people "exposed" to advertising increased more than did the bills of people who had not seen the advertising

possible to conduct the surveys with a less skilled field force than where interviews are involved.

Little difficulty is experienced in getting people to fill in the questionnaires; and most of those who agree to fill them in, do so. The fact that the questionnaire is delivered by a representative of the company preserves some of the values of personal contact of the face-to-face interview. The customer can fill out the questionnaire at his convenience; and since it is left outside when completed, the person is called to the door but once. Help of other members of the family in filling out the questionnaire can be secured if necessary.

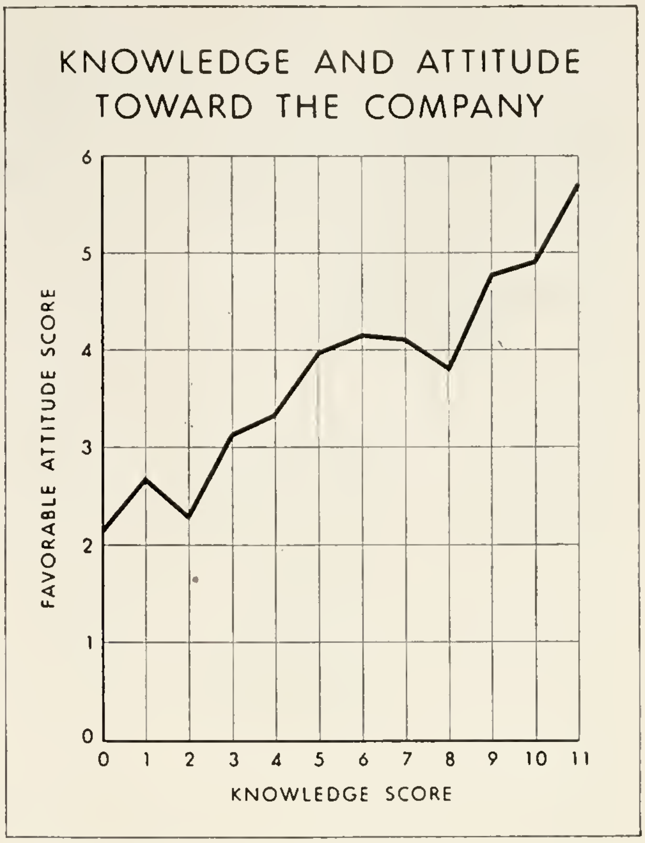
Analyzing Results

IN SUMMARIZING the results of a survey, machine tabulating methods are almost always used. This usually involves "coding" the questionnaires: that is, translating the responses to the questions into numerical codes. When coded, the questionnaires are given to a punch card operator who perforates tabulating cards according to the codes shown. A separate card is prepared for each questionnaire and the cards are then run through sorting or tabulating machines which provide a record of the responses to each question.

These responses, expressed in percentage form, are generally significant in themselves. They gain added meaning, however, when comparisons can be made, for example, between different groups—such as dial and manual customers, individual and party line customers, and so on. Or the results in some specific locality may be compared with other places, with "company" figures, or with "Bell System" totals. Particularly enlightening are trend comparisons, where results are compared with those of previous studies made in the same locality.

ANOTHER method of analyzing results is by studying the way in which answers to various questions are interrelated. To illustrate: in recent surveys in rural areas each customer interviewed was asked whether he would be interested in "semi-selective" ringing—an arrangement whereby each customer hears the rings of only one other party on the line. Elsewhere in the questionnaire he was asked whether he objected to others "listening in" on the line. By relating the answers to these two questions, it was found that people who objected to listening in were much more interested in the new ringing arrangement than those who did not. This provided a pretty clear indication that one reason for interest in this type of ringing was a feeling that less listening in would result.

Through this "indirect method" of analysis, it is often possible to obtain indications of the reasons which lie behind things people think or do. This is particularly important where reasons are of the type which people might tend to cover up if questioned about directly; or where motives are

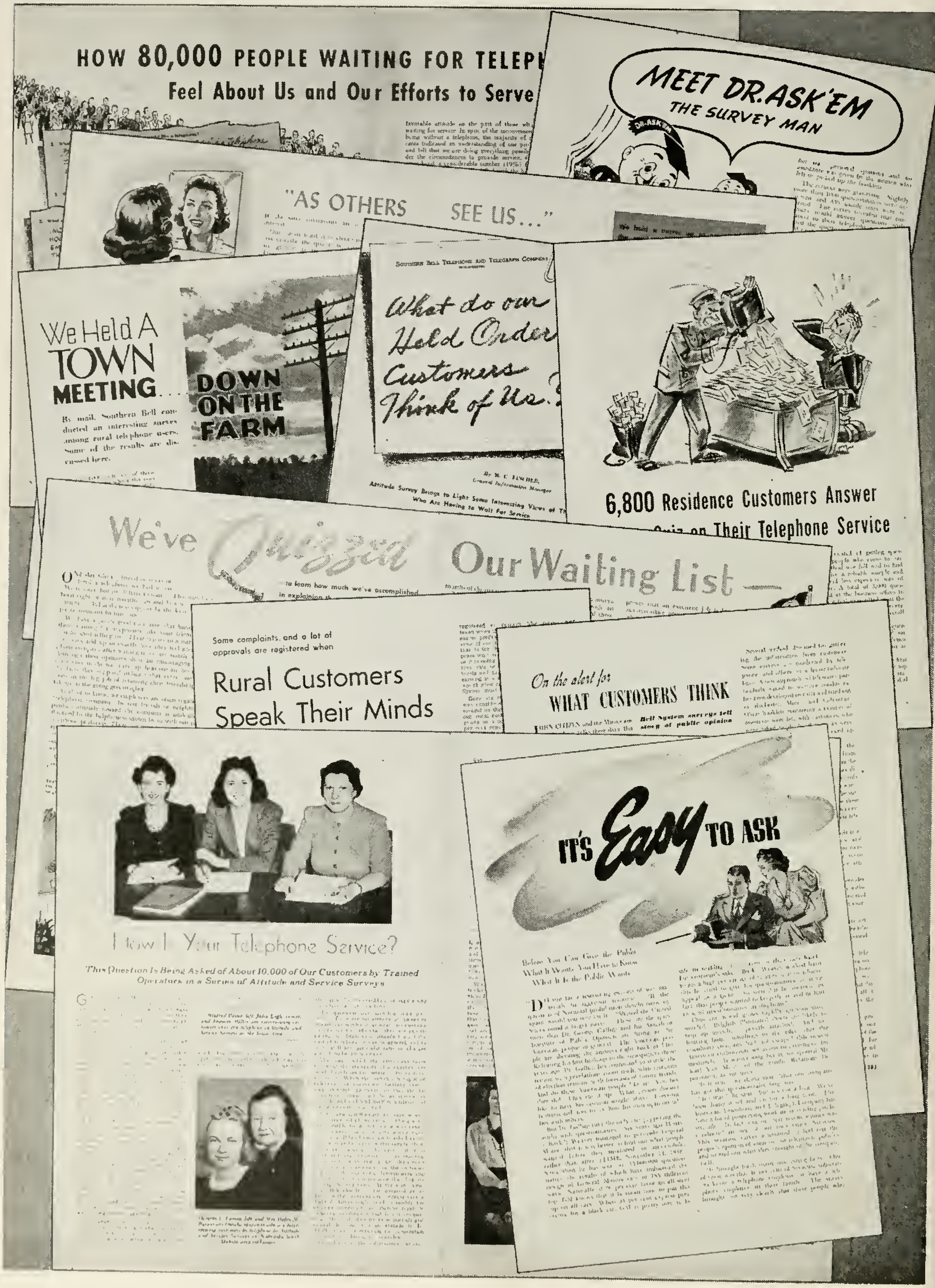


THE MORE people know about the business, the more favorable is their attitude toward it

involved which individuals may not be too well aware of themselves.

In addition to determining specific relationships, it is also frequently desired to investigate relationships of a more general character—and in these cases "scoring" procedures are usually employed.

In one survey, for example, it was desired to find out the extent to which people's knowledge of the business seemed to affect their attitude toward it. In this study, the extent of the individual's knowledge of the telephone business was determined by using a series, or "battery," of questions; and on the basis of responses to these questions, each individual was assigned a "knowledge" score. General attitude toward the company was measured by another battery of



TELLING EMPLOYEES about opinion surveys and the results obtained is an important part of attitude survey work. Here are some articles published in Associated Company employee magazines questions, and each individual received an "attitude" score. When knowledge scores were related to attitude scores, it was found that the higher the individual's knowledge rating, the higher his attitude rating tended to be; indicating that the more people know about the telephone company, the better they feel toward it.

Another use for the scoring technique is in determining the public relations significance of difficulties people may have with telephone service—such, for example, as slow dial tone or wrong numbers. In the case of each difficulty, it is essential to know at least two things: first, the number of people who have experienced it; and, second, how much difference it makes to the individual when it does occur. The first figure is simply a matter of counting people. The second is arrived at by comparing the attitudes of people who have and who have not had the difficulty, as measured by a score based on a battery of general service attitude questions. Where the attitude of the people experiencing the difficulty is substantially less favorable than the attitude of the group not affected, it seems reasonable to assume that the trouble is an irritating one; where the difference is small, not so irritating.

It is particularly important that the basic plan of analysis of each attitude survey be determined upon at the outset, for this affects every phase of the study:—the field to be covered by the questions, the exact form the questions are to take, the procedure to be followed in obtaining the answers, and the methods to be used in summarizing and analyzing results.

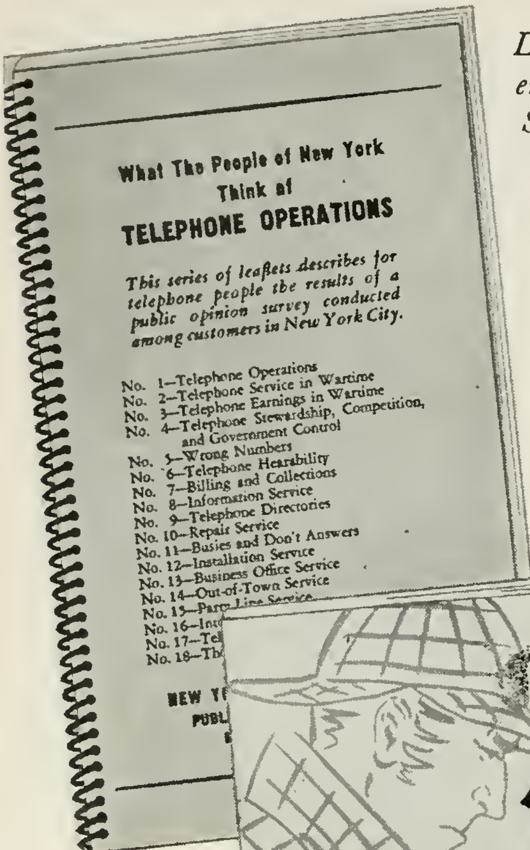
Looking Ahead

In recent years various studies have been undertaken on a System basis in which most of the companies have participated. During the war period, for example, surveys of the opinions of applicants who had to wait for service were made by almost all of the companies, and most of them also conducted opinion studies among rural telephone subscribers. Some of the companies are making surveys to determine the service needs of non-subscribers in rural areas. Others have inaugurated *continuing* studies of the attitudes of their customers toward telephone service.

These surveys and others have demonstrated the value of a coördinated research program. And it must be borne in mind that the success of such a program depends in large measure on the extent to which an effort is made by management and by supervisory people to determine how the findings of attitude surveys may be used to greatest advantage in helping to solve the problems of the business.

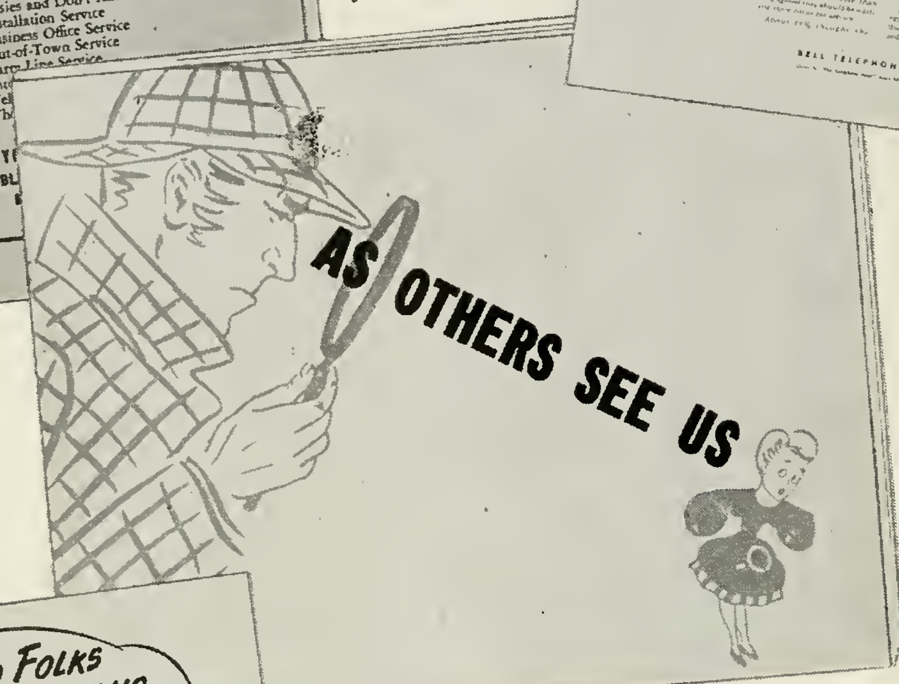
Research of the type described in this article can be of particular value at a time when new problems are arising and previously established precedents no longer seem to apply. Looking ahead, many changes in operating methods can be expected—changes which will affect directly millions of telephone users. Public opinion is in a constant state of flux; changes in opinion seem to be occurring at an accelerated rate, and this may be expected to create many new customer and public-relations problems.

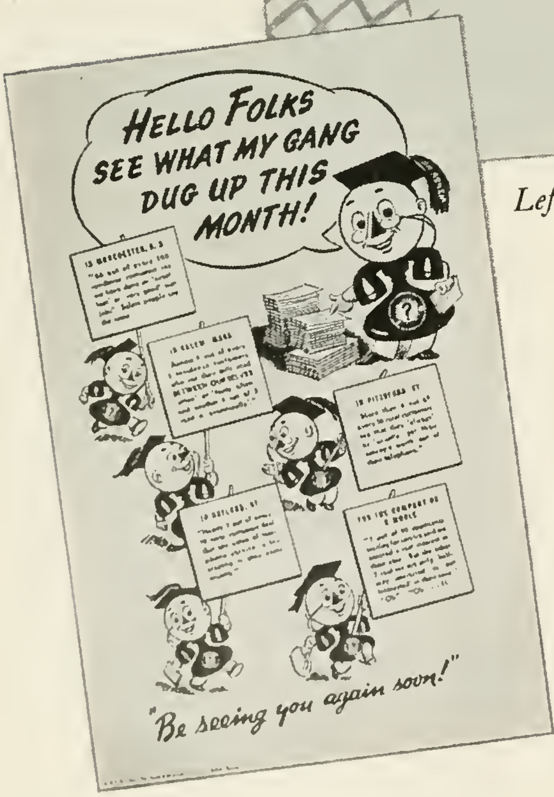
The fact that the Bell System is entrusted with supplying telephone



Left: Booklet for supervisors. Right: Bell System magazine advertisement.

Below: Booklet for employees





Left: Poster for employee bulletin boards

Frame from an employee informative film

VARIOUS MEANS are used to publicize the results of opinion surveys service to the great majority of the people in this country places large responsibilities on its Associated Companies. Since telephone service is an essential service, the public has an important stake in the welfare of the telephone business, and should be interested in many of its problems. For example, the public is directly concerned with the adequacy of telephone company earnings if the service is to continue to expand and improve.

In promoting mutual understanding, a continuous inward flow of information from the public seems essential. In order that the System may be assured of keeping abreast of changes in public thinking, a project has recently been inaugurated which calls for periodic soundings, on a nation-wide basis, of public opinion toward the telephone business.

Equally important, of course, is the outward flow of information from the company to the public. Every year the Bell System devotes a considerable amount of effort and money to keeping the public informed about the telephone business. Many different methods are employed to reach the public with our messages. If our informative activities are to be along the most productive lines, we need information regarding the public's reaction to them, and all the evidence obtainable as to their effectiveness.

The reputation of the telephone company as a business organization is determined primarily by the quality of its service and by the skill and understanding used in its day-to-day contacts with the public. If the telephone companies are to provide good service, they must know what the user expects in the way of service, and what he likes and does not like about the service he is getting. One of the most important functions of the research activity should be to supplement the present internal measurements and indexes by providing continuing measurements of the quality of service from the public's point of view.

In dealing with the many problems of human relations which characterize the telephone business, there is obviously no substitute for sound judgment on the part of management. But the more facts management can command, the better that judgment will be.

There is probably no business in the country more adequately equipped than ours with accounting, statistical, and engineering records on which to base operations. There is probably no business where progress has been more dependent upon factual knowledge developed through technological research. And there is every reason to believe that facts regarding the many human—and hence intangible—aspects of our business can be made available through the application of the research technique; the same systematic, painstaking method of inquiry which has brought the physical facilities for telephone communication to their present high state of development.

Special Efforts and Arrangements by the A. T. & T. Long Lines Department Have Enabled Thousands of Members of Our Armed Forces Overseas to Telephone Home

Three-Minute Furloughs

Harold A. White

AT 2:20 P.M. on Thursday, February 21, 1946, a nervous G.I. stepped into a telephone booth in Titania Palast, Berlin, and picked up the receiver. Three minutes later, flushed and jubilant, he came out, the first soldier to call the United States from the German capital. He had talked to his folks back home in Philadelphia. "Nothing to it," he said, "but, brother, it's amazing. Clear as a bell. Talked to my wife, mother, father, sister. Recognized all their voices."

A few weeks previously, on the opposite side of the world, an American soldier had emerged from a telephone booth in Tokyo greatly reassured. First to call from there since the war, he had talked to his wife, who had been ill, in Wichita, Kansas.

Those calls were two among thousands that our men have placed from foreign lands. "Three Minute Furlough" is the name that *Stars and Stripes* * gave to these brief but precious contacts with home which overseas radio telephone service has made available to the men and women in the services. Those two calls were notable because they marked the climax of the job of restoring overseas telephone service to war-torn areas.

For the war had disrupted overseas service to many foreign points.

In 1939, when the United Kingdom and France went to war against Germany, calls to and from the United States were limited to government business. In 1940 France fell, and the New York–Paris circuit went silent.

After the Jap attack on Pearl Harbor, the circuit to Japan was turned down when an operator in Tokyo said that she could accept no further calls—in the circumstances, rather an understatement. Service with Germany and Italy was suspended when war was declared.

Early in 1942, as the Japs were approaching Manila, the Manila station reported that the privacy device,

* Available evidence indicates that the phrase may have been first used in *The Caribbean Breeze,* publication of the Sixth Air Force.

which might have been valuable to the Japs, was out of order for an indefinite period and a less modern device was being substituted for it. Code words were established daily for contact, to be sure that service was with our own people and not the enemy. Then, with the fall of Manila, another circuit became silent. The loyal Filipinos had smashed the privacy equipment and dumped it into Manila Bay.

Thus, while service with South America and the Caribbean remained available to the public, in Europe only Switzerland, Spain, and Portugal maintained commercial service; and in the Pacific, only Hawaii. All calls to and from the United States were subject to censorship after the attack on Pearl Harbor. Meanwhile, much of our equipment on these shores went to war as a fundamental part of the Army's world-wide communications network and for use in short-wave broadcasts by the O.W.I.

The American Theater

WHILE our service men were in the States, assigned to military stations throughout the country, many of them eased the transition from peacetime pursuits to the business of war by telephoning home.* When they reached points beyond the continental United States, their desire to call home was increased rather than diminished. And here the Bell System overseas service brought to many an American a means of doing just that. For example, after that disastrous December 7 of 1941, the Hawaiian Islands developed rapidly into a concentration center as troops massed there for the push toward Japan. Recognizing the need for telephone facilities for service people, the Mutual Telephone Company of Hawaii promptly established a telephone center for overseas calls and, in coöperation with A. T. & T.'s Long Lines Department, increased the number of

AFTER FOUR YEARS: a former prisoner of war talks by radio telephone with members of his family for the first time

radio telephone circuits between the Islands and the States. Over these circuits thousands of soldiers and sailors were able to get that brief "furlough" home.

This service was in many cases not only the "last chance" for those headed out but also the first contact for those on the way back. Early last Fall hundreds of liberated prisoners who had spent four years in the filth and despair of Japanese prison

* See MAGAZINE: "Service for Service Men," Feb. 1943; "'I Knew Then I Was Home,'" Autumn 1944; "That First Call Home," Autumn 1945.

camps made their first contact with home by calling from Hawaii, an experience that they and their loved ones alone could fully understand and appreciate.

In Panama, the troops and naval personnel guarding the Canal Zone showed a similar eagerness to call home. The Tropical Radio Telegraph Company, too, set up a telephone center in Panama City to accommodate service men, and this center became an oasis for Americans whose hearts were, after all, in the U.S.A. Prospective callers arrived from outlying military centers by the truckload, and "the trucks are in" from the Panama operator to the New York operators was the warning of a flood of calls to all parts of the United States. Similarly, from Puerto Rico, and in South America on the air route to Europe via Africa —from Curacao, Paramaribo, Recife and Rio—Americans in increasing numbers talked with home.

To the thousands of service people stationed in Alaska, telephone service was available by means of radio facilities operated by the United States Army Communications System. The circuits terminate at Seattle, where they are interconnected with Bell System wire facilities for the completion of calls throughout the United States. Service men stationed at Nome, Adak, Anchorage and other Alaskan points have found this conversational link with the States of great value. Some

OUTPOST OF HOME: HAWAII. There many men released from Japanese prison camps had their first voice contacts with their loved ones. Here several are waiting to talk home

2500 calls a month, most of them personal calls by G.I.s, have been completed from Alaskan points via the Army's radio system.

The European Theater

In the winter of 1944, as the prospects of victory in Europe became daily more encouraging, the Bell System began to plan not only to restore the overseas services that had been disrupted but also to create an overseas system which would meet the needs of the post-war world. From the growth of traffic among those services still operating, it was apparent that the future needs of the world for international telephone service would be many times greater than they have ever been; that America had new responsibilities, and would assume a new place, in the world. And—of most immediate importance—at the close of the war many Americans would be in foreign lands, eager for the sound of voices from home.

As to conditions in enemy-occupied territories, nothing was known concerning the state of the radio telephone equipments nor the land-line systems; but it was a safe assumption that much had been or would be smashed to bits in the path of the retreating enemy.

Men by the truckload poured into Panama City to place calls to the United States

At about the time that the Germans were retreating north of Rome and were being forced back on the Rhine, a representative of Long Lines began arrangements in London with the governments of Norway, Belgium, and Holland, then in exile, for the resumption of the war-interrupted service to their countries. He also visited Rome and Paris, hardly yet cleared of the enemy, to lay the foundation for restoration of telephone service with the United States. For both the Army and A. T. & T. recognized that it would be most important to the morale of American occupation forces to provide them with a means of telephoning home.

Arrangements with Great Britain

To these ends, plans went forward, looking toward both the immediate needs of the G.I. and the ultimate communications needs of a world at peace.

Shortly after V–E Day, arrangements were made with the British General Post Office to make the overseas service, which had been limited to official calls, available for public uses.

At that time the British communications system was still greatly overloaded because of bomb damage, war-time shortages, and post-war readjustment needs. It was at first thought that, because of this serious congestion, the system could not take the added burden of G.I. calls from all parts of the United Kingdom and therefore overseas calls should be limited initially to those originating at a telephone center in London. However, General Post Office officials said that they wanted to give all American fighting men in Britain an equal opportunity; that the British people were grateful to them and anxious to accommodate them. They

The British set up a radio telephone center near London's *Rainbow Corner* therefore willingly assumed this additional burden, and public telephone service between all of Great Britain and the United States became available on June 23, 1945.

The response of men and women in uniform to this offering was immediate and heavy. Additional circuits were quickly added between New York and London, but bookings ran days in advance. A Long Lines traffic representative thereupon flew to London to work out, in coöperation with traffic experts there, procedures which would speed the flow of messages; and representatives of the GPO came to New York for the same purpose.

The GPO established a telephone center on Shaftesbury Avenue in London, near Picadilly Circus and the famous *Rainbow Corner* Red Cross Club. The center fortunately adjoined a pub, and it became the custom for G.I.s to be paged at the pub when their calls were ready.

In certain parts of Britain, it is common for public telephones to be mounted out of doors, as are fire boxes in this country. One sergeant placed a call from one of these boxes and then took his blanket roll to the box and slept beside it until his call was completed. A number of soldiers on leave on the Continent hitchhiked to Britain on Army planes to get in a call home.

THE London-New York circuits were swamped at first

Some 9,000 calls a month were completed, most of them for men and women of the American services.

When in Rome

WHEN the Allied Command took over in Rome, it found the telephone

THE RED CROSS decorated the room in Rome where members of the American services waited for their calls back home to come through

system of the city in a deplorable state. Nobody could place a call with any certainty of completing it. Transmission was poor and cut-offs frequent. However, the Germans, in retreating, had sent non-technical troops to destroy the radio transmitting equipment. At the station they found some massive but obsolete long-wave transmitters which they thoroughly destroyed—fortunately leaving the smaller, modern short-wave equipment virtually intact. At the direction of the Allied Commission, and with the assistance of the U. S. Army Signal Corps, Italcable Company conditioned the equipment and established contact with the United States.

Because the telephone system in Italy was in such poor shape, it was decided that overseas service for both G.I.s and all other users in Italy would be confined to a single booth location near the Pincio Gardens in Rome. Here, beginning on July 1, 1945, calls were booked, scheduled, and completed to the United States. The demand was so great that it was necessary at first to limit all calls to three minutes, in order that as many as possible might enjoy the privilege. The Allied Commission found that G.I.s, impatient to complete their calls, became restless when inevitable delays occurred. At such times, a loudspeaker was switched on in the waiting room and the voices of the operators working on their calls could be heard. Such evidence of activity on the circuit, and the sound of American voices naming American towns and cities, relieved the tension considerably.

This efficiently run unit, which handled as many as 3500 calls a month, became a model for terminals which were later set up in other war-torn areas. When long distance lines became available to northern Italy, overseas telephone centers were also established at Udine and Leghorn.

At Pontoise, near Paris, the retreating Germans made a determined effort to destroy radio equipment, and particularly that formerly used for service to America. This they smashed into pieces no bigger than a man's hand. They imprisoned the staff, blew up one end of the building, set it afire, and withdrew.

The French freed themselves, and saved part of the building; but it was necessary for the Ministry of Posts, Telegraphs, and Telephones to obtain new equipment from the Western Electric Company in the United States before service could be restored. A Long Lines representative spent several months assisting the French Telecommunications Admin-

AN AMERICAN SOLDIER and his French bride, in Paris, talk with the former's parents in the U. S.—the Parisienne reading a typed statement in English as her contribution to international good will istration to install and test it. He encountered many difficulties while working in buildings which were without adequate heat and light. Power was rationed, and subject to frequent interruption, and little items, such as bolts and screws, which can be obtained in any hardware store here, were major supply problems in Paris. U. S. Army personnel gave informal but able assistance to the project.

Overseas service with France was re-opened to the public on November 7, 1945, and again Americans eagerly crowded to telephones. Despite the many handicaps resulting from enemy invasion and occupation, the French telephone system had been sufficiently restored to permit interconnection to the overseas system, thus making the service available to users throughout France. A telephone center was opened on the Champs Elysees for American soldiers, and men on leave in Paris flocked to it in such numbers that it was found impossible, with the limited facilities available, to handle the rush.

SOLDIERS visiting Switzerland on leave find it easy to make calls to their homes in this country

"SIG-CIRCUS," originally the Army Signal Corps's mobile overseas radio telegraph station, located near Frankfurt, Germany, was leased by A. T. & T.'s Long Lines Department and modified to handle telephone conversations

MEMBERS OF THE U. S. Forces may make telephone calls to the United States from eight cities in Germany. In this booking office in Frankfurt—as is the rule everywhere—people take their turns regardless of rank

It was necessary, therefore, to close this center temporarily, and calls were completed instead through public and private phones.

Switzerland, surrounded by combatants, maintained service with the United States throughout the war—although with difficulty. Improvisations were necessary to make up for wartime scarcities, and vital parts, such as vacuum tubes, were several times flown into the country via Portugal. Soldiers began to visit there after V–E Day, first in small numbers and later in larger groups under an organized leave program sponsored by the Army and the Red Cross. The Swiss Administration of Posts and Telegraphs, one of the most competent communication agencies in Europe, promptly made plans to meet the natural urge for soldiers there to call the United States. A second radio circuit was added with Berne, and soon 4000 soldiers a month were pouring their greetings across the Atlantic to the folks at home.

For G.I.s in Germany

In Germany, the U. S. Army quickly recognized the advantages to the welfare of the occupation troops of having radio telephone service available to the States. But Germany was smashed — politically, economically, and physically. There was no equipment available, no constituted authority to operate it, no organization remaining upon which a nucleus of a public telephone system could be built. So the Army asked the Long Lines Department to establish service by operating both the German and American ends of a radio telephone system. This was an unprecedented step. It was tackled, nevertheless, in the interest of the G.I.s' needs.

Army radio equipment which could be modified for telephone service was available in Frankfurt, and the Army agreed to lease it to Long Lines for this purpose. Known in the Signal Corps as the "Sig-circus", it was a multi-channel single-sideband telegraph system mounted on trucks, complete with power supply, and was used from advanced areas in Europe to establish direct communication with Washington.

In early December, 1945, fifteen Long Lines men and a couple of tons of special Western Electric Company equipment were flown by Army plane to Frankfurt to establish the service. It was a pretty tough job, and this little group was very much on its own. All about them lay the vast ruins of a nation prostrated by war. Communication, transportation, supply were virtually non-existent—excepting as they had been restored by the Army for Army purposes.

To get service going took a lot of doing. The radio equipment had to be modified for telephone use, conditioned, and tested. Arrangements had to be made with the Army for the establishment of suitable telephone centers in eight cities in the American Zone, and land lines connecting the other seven with Frankfurt had to be established and tested. Meanwhile, there were the tasks of staffing the centers; working out details for the booking and handling of calls and the handling of funds; establishing a switchboard at Frankfurt; and arranging a coördinated schedule for operating it. In fact, these Long Lines men had to put their hand to almost all the jobs which have to be done to make a telephone system work.

They had minor adventures, too. Though armed with credentials, two Long Liners, travelling from Berlin through the Russian occupied zone, found that cigarettes were the best passport. They finally were stopped by a Russian who apparently didn't smoke, and so spent the night in the guardhouse.

The U. S. Army gave the fullest assistance in every phase of the undertaking, and provided our men with living quarters, transportation, and supplies. Army-approved German civilians were recruited to assist in both the technical and operating phases of the work. During time off from their duties, G.I.s were glad to help out as operators or as assistants in the calling centers.

On January 10, 1946, preliminary work was completed and service was opened to the United States from Frankfurt and Munich. On successive weeks Heidelburg, Nuremburg, Bremen, Kassel, and Stuttgart were linked on; and by February 21 the network was completed with the opening at Berlin.

Only calls placed from Germany could be handled, because of the difficulty and delay which would have resulted from trying to locate soldiers to receive calls placed by their families or friends in the United States. The response to the service was, to the telephone men, a gratifying reward for their efforts.

The service was originally established with two transatlantic telephone circuits and a teletype order circuit over which booking information and call reports were passed. Soon a third telephone circuit had to be added; and with this arrangement, calls have been completed at the rate of some 7,000 a month.

A FRIENDLY SPIRIT pervaded the telephone centers, and the soldiers cooperated splendidly in following the calling procedure. Usually each caller emerged from the booth wreathed in smiles and pretty well set up—although emergency calls, which were given priority when certified by the Red Cross and a unit chaplain, sometimes brought distressing news from home.

Calls were booked in advance; and at booking hours the men counted off in the line the number of calls allotted for that day—as shown by a placard in the office window—and the rest went away, to come back and try again the next time. One morning at 3:00 o'clock a pair of weary Long Lines men were closing up the center in Nuremburg when they were approached by a soldier wrapped in a blanket. "Where does the line form?" he asked.

At Bremen one morning a G.I. came in to call his mother in Brooklyn. When he heard her voice he jumped up and down in his excitement until he crashed through the floor of the booth into a hole that happened to be beneath it. He completed the call, with his head just visible through the window, bellowing up to the transmitter. He climbed out of the booth, said he had had a fine talk, made no other comment, and walked out smiling. Stout planks were installed in the booth, and service was continued.

A boy from Oklahoma called home from Kassel one stormy day and walked out of the center in a dream. Five minutes later he came back, drenched to the skin, and said, "Reckon I'd better take my hat and coat along."

The Pacific Theater

OUR FORCES in the Pacific gots lots of service too. Service with Australia was re-opened to the public on September 15, 1945, and immediately carried capacity traffic, many calls being made by G.I.s stationed there. A direct U. S.–New Zealand circuit was established for the first time on October 25, 1945, offering another link to American soldiers and sailors "down under."

The Supreme Command for the Allied Powers in Japan likewise wanted service to the States for service men, and asked the Bell System to send a representative there to assist in establishing it. Arriving in Tokyo in November, 1945, he found the destruction and disorder characteristic of conquered territory. However, unlike Germany, Japan was not completely disorganized, since the structure of the Japanese Imperial Government had been maintained.

The Board of Communications of Japan was still to some extent a going concern under military direction, and it was attempting to restore communications to meet the Army's needs. The radio equipment and the essential units of the control equipment were found to have escaped the B-29s and were intact, although in very poor condition. Here also the land-line system was in too sorry a state to permit connections with the overseas circuit. At the direction of the Army, and under the guidance of the Long Lines representative, the Japs prepared the equipment for service and established and organized a telephone center for overseas calls.

The Long Lines man, in commenting on the attitude of the Japanese who worked on the project, said, "I had to give up thinking out loud, because what I thought were just ideas the Japs took as orders for execution pronto." For example, looking at a littered corner of the room which was to become the telephone center, he had remarked wryly, "This ought to be OK when we get it painted and pictures on the wall and flowers around." On opening day several oil paintings graced the walls and a small vase held a single orchid.

On January 10, 1946, everything was in readiness. English-speaking Japanese operators, trained by an Army lieutenant who had studied Japanese in college, covered the switchboard, Jap technicians manned the equipment, and the first call was completed. At first, because of the great demand, only calls involving emergencies at home were accepted, but as the kinks were ironed out service was made available to all G.I.s and other accredited personnel in Japan.

IN JAPAN, the details of calls to this country are handled by the Army, but Japanese operators set up the connections

MEANWHILE, Manila was struggling toward rehabilitation after enemy occupation and the ruin created by the bitter fighting when the city was re-taken. The main building of the Philippines Long Distance Telephone Company in downtown Manila had been reduced to rubble, but an office building nearby which could be used was still standing. It was shell-splattered and surrounded by wreckage, but needed repairs were soon made. The radio equipment had been completely destroyed, however.

New equipment to replace it had been ordered prior to V–J Day, and installation was started—under difficulty—as soon at it arrived.

Filipinos who had survived the enemy occupation returned to their old jobs. One of them, a Philippine Army lieutenant, had lost his fingernails under Japanese torture. Some of the technicians and operators returned with small but valuable items of equipment which they had taken home before the enemy arrived and had hidden during the occupation.

Service with Manila opened in January, 1946. By that time the Manila exchange area had been sufficiently restored to permit direct overseas connections to a limited number of telephones in the city and at military and naval establishments nearby. A telephone center of the familiar pattern was set up in the downtown area.

Booking of calls from this center began immediately, and was for a time considerably in excess of the capacity of the two Manila-San Fran-

TWO-WAY telephone service between Manila and this country was restored last January. Here Americans in the war-torn Philippine city are booking calls and waiting to talk

NEW EQUIPMENT, ordered from Western Electric before V-J Day, had to be installed in Manila before telephone service with the United States could be resumed

cisco circuits as G.I.s eagerly placed calls to all parts of the United States. Through the efforts of the Philippines Company, arrangements were made whereby, despite the limited facilities available, people in the United States could call men stationed in the Manila area, and many people in this country have availed themselves of the opportunity. Because many of the men called could not be located, the Philippines Company hit upon the scheme of publishing daily lists of "men wanted" in the Army paper "Pacifican"—which often drew them to the center. Here too some 2400 G.I.s each month have been able to gain that priceless "three minute furlough."

WHILE AMERICANS have grown to accept the telephone instrument and the job it does as a commonplace in this country, to many members of the Armed Forces in the strange surroundings of foreign countries this familiar service has taken on a special worth. Since V–E Day more than a quarter of a million calls by Americans in uniform have been completed from far-distant points by means of the overseas services. The Bell System is proud that, with the coöperation of telephone administrations abroad, it has made possible this host of conversations which have contributed so greatly to the morale, the happiness, of the American men and women stationed around the globe.

TRAFFIC COP OF INVASION: the Laboratories' "beachmaster" adaptation of a Bell System public address loudspeaker (above). Truck-mounted rocket launchers (below) in action using a fire-control device developed by the Laboratories

The Special Knowledge, Skills, and Form of Organization Of the Bell System's Research Unit Contributed in Many Ways to the Prosecution of the War

Bell Laboratories' Rôle in Victory

Philip C. Jones

I. Telephones at War

THE WAR-TIME CONTRIBUTIONS of the Laboratories were by no means limited to direct instrumentalities of war.* Both the Army and Navy required also many types of communication systems, and their development was undertaken by the Laboratories as a matter of course.

Military telephone instruments—microphones, headsets, and loud-speakers—should be designed to pick up and deliver messages and orders with high intelligibility under the noise of battle. They should be convenient and easy to use with a wide variety of equipment. They should withstand the rough and varied usage of modern warfare.

Noise is one of the chief obstacles which has to be overcome in devising instruments suitable for the Armed Forces. Another consideration is that of varying climatic conditions. Still another is the occurrence of rapid temperature and pressure changes—as with a plane rising or descending sharply. Instruments must be designed, therefore, to operate over an extremely wide range of conditions.

An important requirement is that all instruments must be designed to fit into the paraphernalia used by the Armed Forces. Microphones, for example, have to fit into and become an integral part of oxygen masks, and to be used with noise shields, under gas masks, and other similar equipment. Receivers are used in tank helmets, aviators' helmets, and under those of the Signal Corps men.

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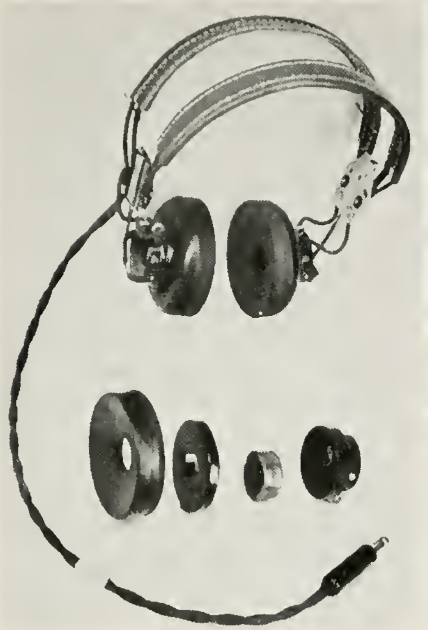
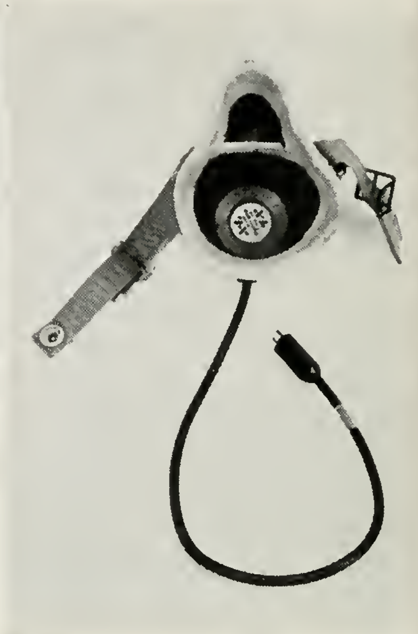
* See MAGAZINE: "Electric Brain," Winter 1943–44; "Bell Laboratories in the War," Winter 1944–45; "Radar and Bell Laboratories," Winter 1945–46.





Left to right: ANB standard receiver, lip microphone, transmitter with noise shield

With all these instrument demands, it is highly important from the manufacturing and supply standpoints to employ a few basic transmitter and receiver units which can be adapted to all of the military uses.

Receivers and Microphones

A HEAD RECEIVER UNIT which largely overcame extraneous noise by both its electrical design and its use of soft-rubber ear pads was designed by the Laboratories and designated by the Joint Radio Board as an ANB (Army, Navy, British) standard. The receiver unit was equipped with a molded phenol-plastic case having stepped contours to fit the various headbands of the Armed Forces. The headset is used by ground forces, bomber crews, and wherever protective helmets are not required. The same receiver without a headband is placed in aviators' helmets.

A small headset was required to fit under the steel helmet of the service men; and for this, receivers of the audiphone type were employed. These are only seven-eighths of an inch in diameter and are equipped with soft-rubber ear plugs. A wire headband attached to them can be bent to fit the user's head and lie snugly under the steel helmet.

Microphones must exclude from the telephone line or radio transmitter as much as possible of the noise that is present. Three methods have been used to obtain this exclusion.

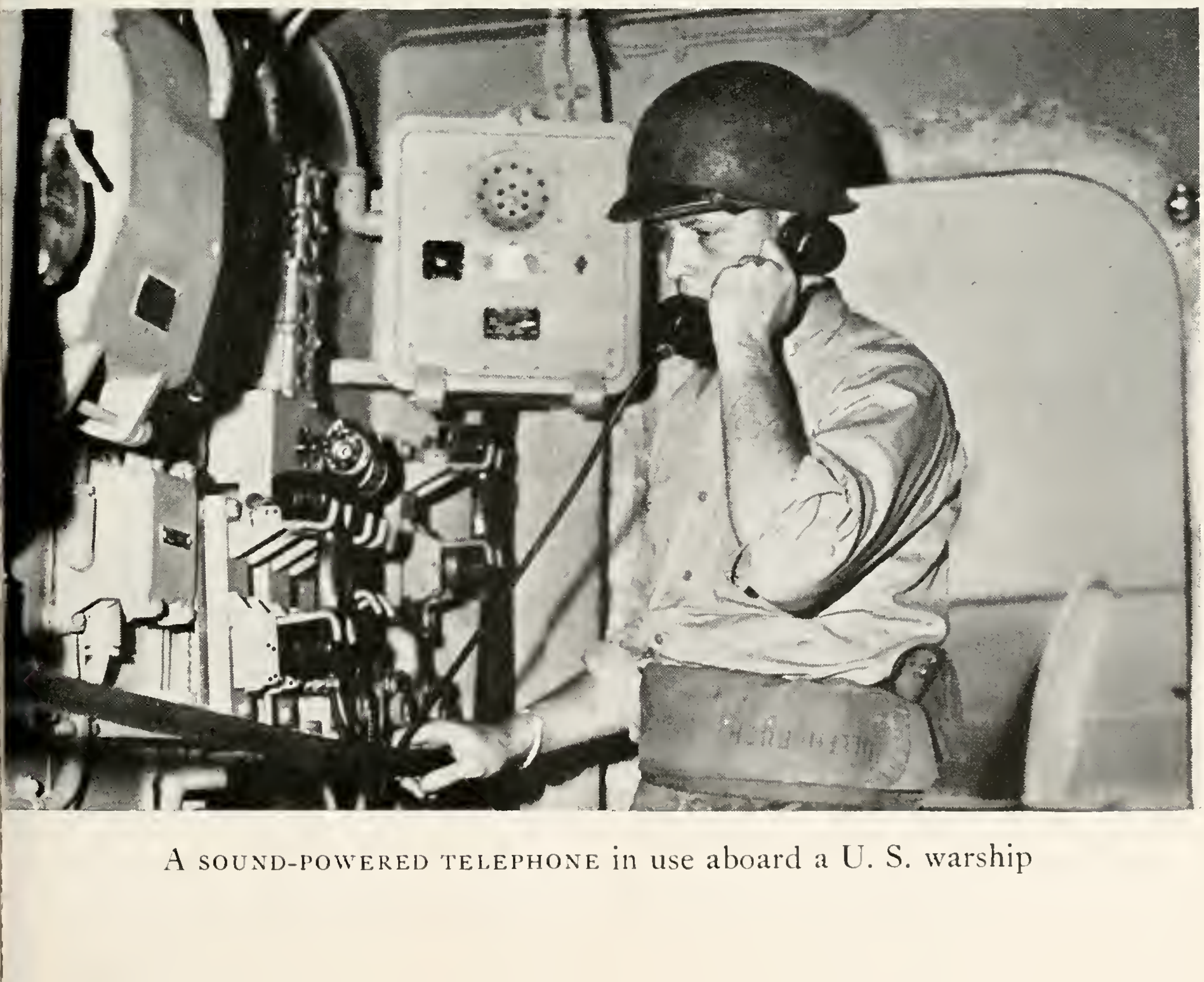
One method is to make the instrument relatively insensitive to noise. The throat microphone does this. It consists of two transmitter units worn high up on the neck with a unit pressing against each side of the throat. Speech vibrations are transmitted to the microphone through the neck tissues; and inasmuch as the microphone is designed to pick up mechanical vibrations of the throat rather than the acoustical vibrations in the air, a fair degree of discrimination between noise and speech is attained. The over-all response of the throat microphone, however, is not all that is to be desired, because chiefly the low-frequency throat sounds are transmitted; the high-frequency sounds which are formed in the oral and nasal passages are not included in the proper proportion.

Another way of excluding noise in the microphone is illustrated by the noise shield. This unit has a granular-carbon microphone unit built into it, and is worn over the mouth and nose. A good degree of noise exclusion is obtained, and at the same time the speech transmitted is of a high order of intelligibility because sounds from both the nose and mouth reach the microphone.

The aviator's oxygen mask is similarly a noise shield, and actually forms the mouthpiece for the microphone. The microphone design was coördinated with the design of the oxygen mask, and the unit—of either the granular-carbon or magnetic type—was standardized for the Army, Navy, and British oxygen masks.

The third method of restricting noise from the microphone, and one which provides a good degree of discrimination between speech and noise, is by the use of the lip microphone. The principle of this microphone is very simple. If a diaphragm is open on both sides, noise will reach it with substantially the same intensity and phase at each side, and therefore will tend to cancel out. Then when one talks very close to one side of the diaphragm, the speech will actuate the diaphragm principally from that one side, and hence the ratio of speech to noise transmitted will be high.

This microphone is equipped with a harness so that it can be worn on



A SOUND-POWERED TELEPHONE in use aboard a U. S. warship the lip, making the speech path to one side of the diaphragm very short. It can also be used with many of the devices provided by the military services, and has been standardized for Army and Navy use.

Sound-powered Telephones

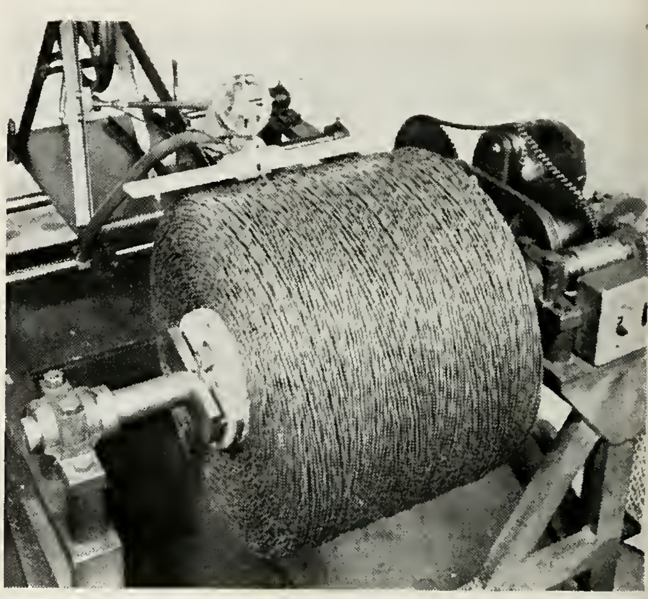
ANOTHER GROUP of military telephone instruments includes the sound-powered telephones. A sound-powered instrument is one which is dependent solely on the voice as its source of energy. No battery or other external power supply is used. The sound-powered transmitter is a generator which creates the voice-modulated currents transmitted over the line. At the receiving end there is a similar instrument in which the transmitted frequencies are reconverted into speech. Bell's original telephone was a sound-powered instrument.

Although the principle of sound-power is not new, the instruments of the type used in the recent war have been improved by the use of high-grade magnetic alloys, which have permitted good efficiency with a substantial reduction in size of instruments.

Sound-powered instruments are built in a variety of forms, such as handsets, headsets, and chest sets. Used extensively aboard ship for fire control and other command purposes, they replaced speaking tubes, which in the old days ran from one end of the ship to othe other. Being entirely independent of an external power source, sound-powered instruments supply effective emergency communication even though the ship's power has been entirely crippled.

Another use of sound-powered instruments, which is rapidly gaining favor, is in portable field telephone sets for use where dry cells, with which most of these sets were then equipped, either did not operate effectively or had a very short life. With Army field wire lying on the ground but in good condition, sound-powered instruments operate satisfactorily up to eight or ten miles.

Flying Telephone Wire



IN ORDER that it may pay out rapidly and smoothly from an airplane in flight, the field wire is wound on a special machine into criss-cross coils

EARLY IN 1944 the Air Technical Service Command requested the Laboratories to study the possibilities of laying telephone wire from the air—and to do it on a rush basis. It was specified that standard Army field wire be used, a flying speed of 150 miles per hour was designated, and the maximum length of wire to be laid in a single flight was put at 15 miles.

An outdoor laboratory was set up at Murray Hill, N. J., including a 40-

foot tower near the top of which experimental packs of wire might be placed. In a building several hundred feet away, a motor-driven drum was located by means of which wire could be drawn at speeds up to 200 miles per hour from the coils or packs in which it was wound. At this laboratory the performance of various types of coils and packs was studied with the aid of high-speed cameras and electrical devices.

Sixteen miles of field wire are coiled within the boxes fastened securely in this plane, the outside end of each coil spliced to the inside end of the next coil

Flight testing was also speeded by establishing a field laboratory in a building provided by the Air Technical Service Command at Fort Dix Air Base and assigning to it a Laboratories flight testing team. A total of well over 200 test flights were made—in which the performance of the various types of coils and packs, as well as inter-coil splicing methods, were thoroughly studied.

In the standardized system two wires, twisted together as manufactured, are wound on a specially designed machine into "criss-cross" or "universal" coils, similar in form to the balls of lacing twine used by the telephone installer. Each coil contains one or two miles of wire, depending upon the type, and each is encased in a square wooden box with a hole in each side about one-half the outside diameter of the coil.

When a mission is to be flown, the number of boxes required are loaded into a C-47 plane, lined up in echelon from the open doorway to the forward end of the cargo space, and secured to the floor. The outside end of each coil is carefully spliced to the inside end of the following coil. The inside end of the first coil is led outside the plane through a pipe about six inches in diameter and brought back into the cargo space, where it is attached to a weighted parachute. After taking off, the pilot flies over the starting point of the line as identified by landmarks or panels on the ground, and a member of the crew throws out the parachute. As the wire thrums out from the pipe at speeds up to 250 feet a second, it settles to the ground with the parachute. Eventually the other end of the wire pulls free of the plane and is picked up by the second ground party.

Success was soon attained in one-mile flights. Gradually, the number of successful runs increased, and the test lengths mounted from one mile to two miles, and then to four and six. Finally a successful 15-mile run, the specified maximum, was made over the flat, woody terrain of Fort Dix.

As finally turned over to the Army Air Forces, the system may be used with C-47 cargo planes to lay either a new plastic-insulated (polyethylene) wire or the heavier present standard field wires used by the United States and Great Britain.

The Spiral-4 System

Another communication system, for an entirely different service, is the Spiral-4 cable system. It employs a four-conductor cable developed by Bell Laboratories in coöperation with the Signal Corps. The cable can be buried, laid on the ground, or suspended in the air. The system provides three telephone channels, including both voice and carrier frequencies, and four telegraph circuits. Voice frequencies are heard satisfactorily up to forty miles without amplification. All the channels can be amplified by a single compact repeater. These are spaced twenty-five miles apart and extend the range to two hundred miles.

The cable is made in quarter-mile lengths with quick coupling connectors at each end to permit extending a circuit to any desired distance. In each connector, one of the pairs of conductors is loaded with small coils also developed by the Laboratories.

Copper strands, individually insulated, are twisted together to form "spiral four" conductor. Strength is provided by enclosing the cable in a braid of small high-strength steel wires. A tough rubber jacket completes the four-conductor cable.

This system extends the distance over which telephone communication can be quickly established by our field forces.

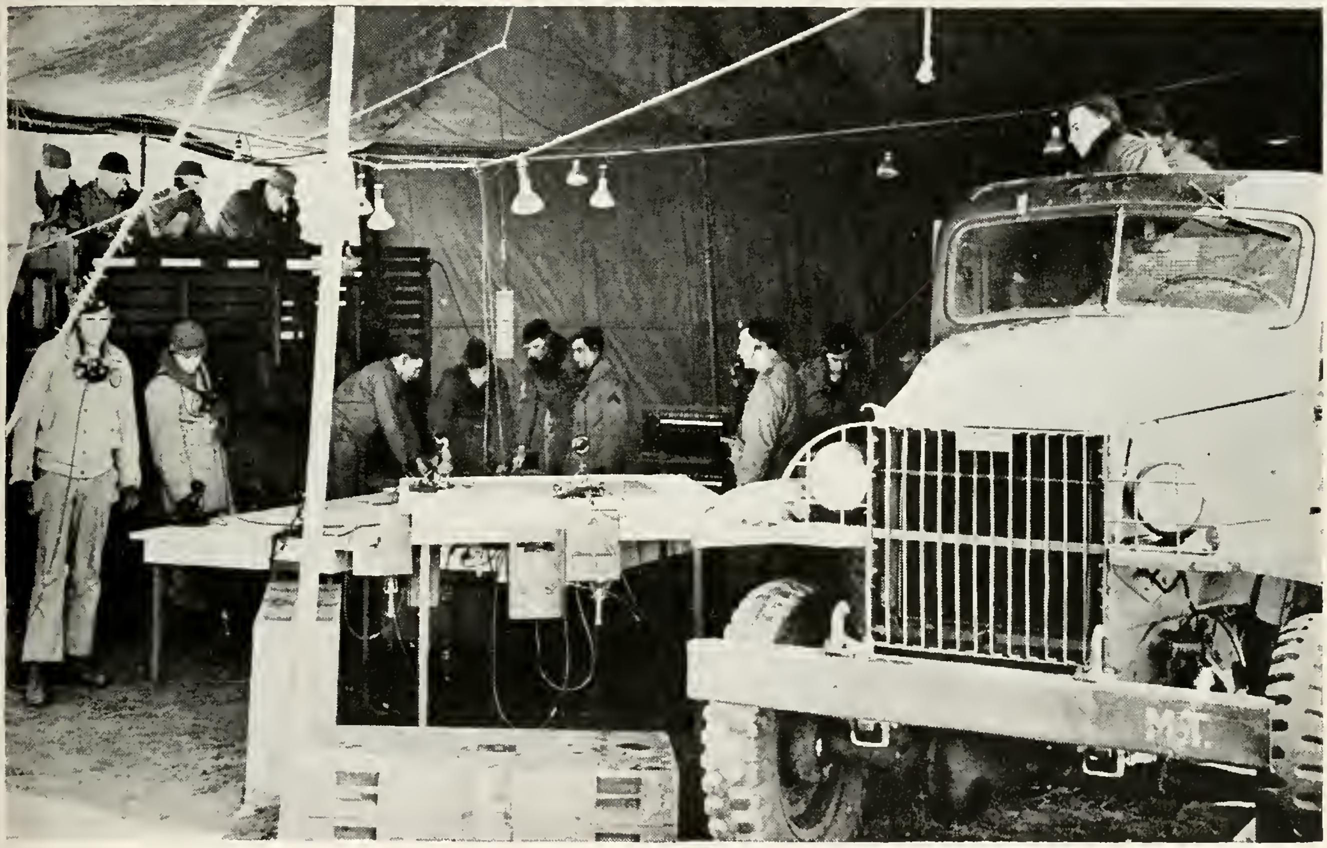
Air Warning Systems

Before the Pearl Harbor attack, an elaborate communications network with permanently located "filtering" and "information" centers had been established along our seaboard to combat possible air raids. Thousands of airplane spotters located at scattered points reported to the filter centers all planes observed. Here the various reports were checked against each other, the positions of the planes were indicated on large maps, and suitable instructions would be issued —if required—to the various fighter commands, other Services, and Civilian Defense authorities.*

The Army Air Force, which had been responsible for the development of the coastal system, recognized that similar systems and centers would be required in the overseas theaters to control our tactical air forces. As a result, the Laboratories undertook the design of portable equipment along similar lines but modified to meet conditions on the fighting fronts.

In coöperation with the Laboratories' engineers, the Army Air Force set up the requirements, and during the early development stages, discussions were also held with the Navy and Marine Corps to insure that the equipment developed could be used by all the Armed Forces.

The development of the new portable operations center, called the AN/TTQ–1, had two main objectives: a reduction in size and weight to achieve greater portability and less effort in setting up or dismantling; and a simplification of the equipment to facilitate operation and maintenance. Since the equipment might have to be transported by cargo plane and set up in buildings with narrow doors and stairways, it was specified



An AN/TTQ1 portable operations center installed in a tent

* See "Telephone Lines and Air Defense," Magazine, February, 1942.

that no package should weigh more than 250 pounds nor be greater than 4 feet in any dimension, nor more than 2 feet in at least one dimension. To facilitate the stacking of the packages for shipment no dimensions other than 1, 2, or 4 feet were to be used at all.

Operations Center AN/TTQ–1 consists of communications equipment needed to receive and evaluate military information on aircraft for a geographical area, and to direct the action required by the information received. Information on all friendly and enemy aircraft in the area involved is received by telephone or radio and plotted on a large table map. Platforms carrying a bench and table are placed around the large map table for use of Air Force personnel, who can watch the activities indicated on the table maps, pass information to other interested military agencies, and order the proper action to be taken. Since such procedures involve fighter planes, radio contact must be maintained from the Center to planes in flight.

In addition to air warning and fighter-control functions, the Marine Corps and Army Ground Forces have found this equipment useful in antiaircraft artillery control. In a great many cases, the equipment would be located in a building or under a tent, and it was therefore arranged to mount the platform positions and cabinets in 2½-ton Army trucks for use as mobile centers.

The equipment as shipped from the Western Electric Company is complete in every detail, and needs only gasoline and oil for the engine alternator, a shelter, and personnel for its operation.

II. Giant Voices

THROUGH ALL the turmoil, noise, and apparent confusion of an invasion beachhead, strict control of the movements of troops and material must be maintained by the beachmaster who—acting as traffic cop and dispatcher—directs the incessant flow of foot and mechanized power. His indispensable assistant in the latter phases of the war was the Western Electric beachmaster announcing system, technically known as the Navy PAB–1 Public Address Set. (See picture on page 36.)

But for this equipment, the voices of those in authority would be drowned out by the noise from the very machines and men they were endeavoring to keep in efficient order and deployment. With its help, however, commands are instantly heard by all to whom they are directed, and there is no loss of time in relaying messages through a chain of command.

Growing from experimental, small-scale use of loudspeaking equipment in early amphibious moves, the PAB–1 became available to the Navy early in 1944. It was used for the landing at Iwo Jima, and played its part in most of the rest of the Pacific landings. Thousands of these equipments were delivered to the Navy for use in the Pacific Theater before the end of the war, and their applications reached far beyond original expectations.

A close relative of the PAB–1 set is the ship-mounted landing-craft announcing system, whose major components are interchangeable with those of the former. Direct two-way speech communication is thus made possible between ships and shore.

Classed by the Navy as semi-portable equipment, the PAB–1 Public Address Set consists of a loudspeaker, an amplifier, a gas-engine-driven alternator, and accessories and spare parts. The complete system is packaged as six individual units in rugged water-tight reinforced steel carrying cases with detachable covers. Each case is designed for its particular component and has ample buoyancy so that, if the occasion requires, it may be dumped overboard and floated ashore.

The loudspeaker is a 3 × 3 assembly of nine receivers coupled to nine horns and mounted on a yoke and tripod. The useful range of the PAB–1 naturally depends on local conditions, and will vary in different locations. When a greater area of coverage than that of a single system is needed, it is possible to operate two amplifiers and loud speakers from one engine alternator and one microphone. Similarly, when still greater coverage is needed, one microphone may be used to operate four amplifiers and loud speakers powered by two engine alternators.

After these Public Address Sets have done their part in helping to establish the beachhead, they may move on with the advancing troops or may remain to direct the continuing flow of supplies, machines, and troops. At forward command posts they have been used for surrender demands, and for conveying essential information to the troops when other means are either lacking or too hazardous to use.

The Voice of Ship Command

IT IS NOT ONLY on invasion beaches, however, that high volume public address systems are required to override the noise of battle. Consider, for example, a battleship plowing silently along at night in enemy waters.

A BOS'N pipes the crew to attention over the ship's announcing system. A typical system installed on a battleship includes eight transmitting stations, 294 loudspeakers, seven local announcing circuits, and 31,000 feet of cable

The shrill scream of the bosn's pipe startles a sailor from slumber. A few seconds later, wide awake, he hears a "Bong! Bong! Bong!"—the repeated bell-tone of General Alarm. This means an emergency. He listens carefully to the announcement which follows, telling him the cause of the emergency. It might be a fire, a call to battle stations, or any other serious condition, and he goes quickly to the station he has been trained to man in such an emergency.

These alarms and instructions come through the Battle Announcing System, with which all of the two or three thousand men aboard a large warship are informed of trouble and given any necessary special instructions.

THIS IS one of the more spectacular but less usual uses of the announcing system. Every few minutes during the day the equipment is used for the more prosaic job of calling together a group for a work detail, paging an officer, or summoning the men to mess. It is the means by which all general commands are transmitted to the crew, members of which may be in any of the hundreds of separate compartments on the vessel. As many as two hundred or more loud-speakers are distributed throughout the ship.

Announcing equipment on shipboard is divided into several separate but interrelated systems. The general system might well be termed the commanding officer's system. Announcements on this system are usually made from the point of ship control: the bridge while under way; the quarter deck while at anchor; or the central station, deep in the most protected part of the ship, during special conditions.

The engineer's system is primarily intended for use by the Chief Engineer in giving instructions to machinery spaces. On aircraft carriers, the aviators' system provides for instructions to hangar and flight deck. These systems are tied in with the general system, however, so that alarms and general orders can be sent to all spaces.

Each turret on cruisers and battleships, incorporating a maze of compartments and intricate machinery, has a special two-way announcing system over which the turret officer gives orders for operating the turret and the loading, aiming, and firing of the guns.

The larger anti-aircraft guns are under the control of an officer at an anti-aircraft director station, located high up in the ship's superstructure. Loud-speakers at the guns transmit verbal orders from this officer, and also special tone signals to begin and cease firing.

One of the more interesting uses of announcing systems is on the flight deck of aircraft carriers. Several super-power loud-speakers are located on the island structure, and pointed so that the entire flight deck is covered. These loud-speakers form part of the system over which the Air Officer, located at the control station above the flight deck, can give orders to pilots and deck crews during flight operations and while the airplane engines are being warmed up. This system is also used for transmitting warning signals in flight deck emergencies.

INTERESTING design problems arise because of special requirements for service on naval vessels. Short circuits on loud-speakers must not interfere with operation over other loud-speakers. Short circuits or trouble grounds on microphone circuits or

A NAVY PB4Y-Z which carried the "Polly Project" public address equipment to hail the Japs from an altitude of 10,000 feet

control wiring at microphone locations must not prevent the system from being used from any other microphone location.

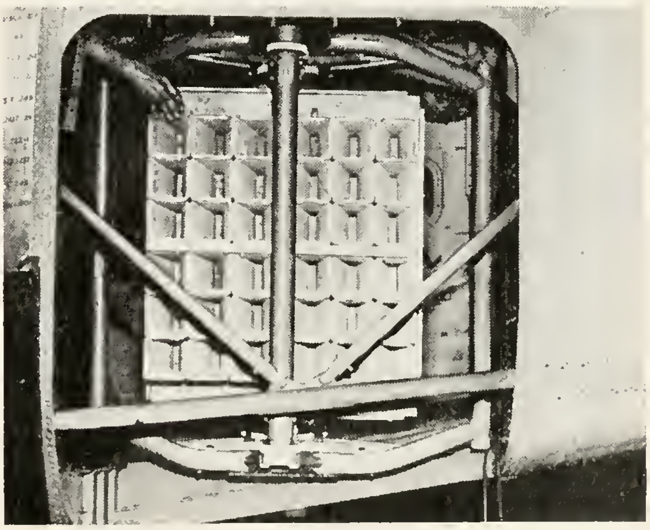
Mechanically, the design problems become even more interesting. Great strength is required, and protection against shock, because equipment must not be rendered inoperative by the ship's own gunfire or the shock of torpedoes or near misses by aerial bombs. Vibration over long periods, caused by the ship's engines, must cause no damage. Loud-speaker and microphone diaphragms must be designed to withstand the blast from nearby gun muzzles.

All equipment located on weather decks must be protected from corrosion by salt water. This includes microphones, control boxes, and loudspeakers. In some cases, equipment is made watertight so that no water can enter. In others, equipment is designed with the expectation that water will enter, and drain holes are provided. Under these latter conditions, all internal parts must be made immune to the corrosive effect of sea water.

Voices from the Sky

THERE ARE still other situations which demand the use of powerful loudspeakers.

After V–J day, voices two miles up in the sky blasted the news of unconditional surrender to isolated Japs still holding out in jungles, caves, and swamps on remote islands of their extensive stolen empire. This new air-borne public address equipment was rushed to Japan to assist in the enormous task of disarming Jap fight-



THE 36 horns of the new "Polly Project" loudspeaker as installed in the plane ing men and in directing civilian movements.

In May of 1945, the Navy ordered this air-borne public address system, known as the "Polly Project," and requested that it be delivered within one hundred days for installation in three four-engine PB4Y–2S. Bell Laboratories completed the design and the Western Electric Company manufactured the equipments and made them ready for shipment within the short time of eighty-four days. They were capable of being heard and understood on the ground from a height of 10,000 feet.

The Navy order was a direct tribute to an older "Polly" equipment delivered in the early part of 1944. This latter system had a 5000-foot ceiling, and was used successfully for battering down the Jap will to resist on Wotje, Saipan, Iwo Jima, and Okinawa in the last stages of the war. Flying at 2700 feet above Wotje Atoll for instance—within machine gun range—a twin-engine Ventura PV–1 slowly circled the atoll and then sounded off, saying: "Attention, Japanese soldier of Wotje Atoll, attention!" A short news broadcast followed, then a selection of Japanese popular music, a short propaganda talk, and finally more news. The whole program took about fifteen minutes, and was given twice.

These sky programs emphasized straight news broadcasts to isolated Japs completely ignorant of the war's progress. Promises of good food, medical aid, and fair treatment helped coax the Nips into surrendering. On islands occupied by our forces, the Japs were ordered to report to a certain location. On by-passed islands they were told to wait for a landing craft.

After Wotje, "Polly" moved on to Saipan and Iwo Jima. Every day the flack grew thicker, a testimony to the threat of "Polly" to Jap morale, as verified by questioning of Jap prisoners. "Polly" landed on Okinawa one month after the invasion. By that time the plane was so badly battered, it soon had to be abandoned after first removing the equipment.

As a result of these experiences, the Navy specified that the new "Polly" should be capable of operating at a height of 10,000 feet so that the plane would be out of range of machine gunfire. This meant that a completely new system had to be designed.

In it, microphones are provided for direct broadcasting, and in addition, two magnetic-wire recorders are provided to permit continuous broadcasting of previously prepared messages or the recording of information broadcast from the microphones. Two control panels are supplied to give the flexibility needed for switching from live to prepared broadcasts, and for connecting to the intercommunication system on the plane.

Bell Laboratories' engineers supervised the building of the equipments at the Western Electric Company, and later coöperated in installing and testing the equipment in all three planes at the Naval Aircraft Modification Unit at Johnsville, Pa. Each plane took off for Guam and points west as soon as the tests were completed.

III. The Rockets' Red Glare

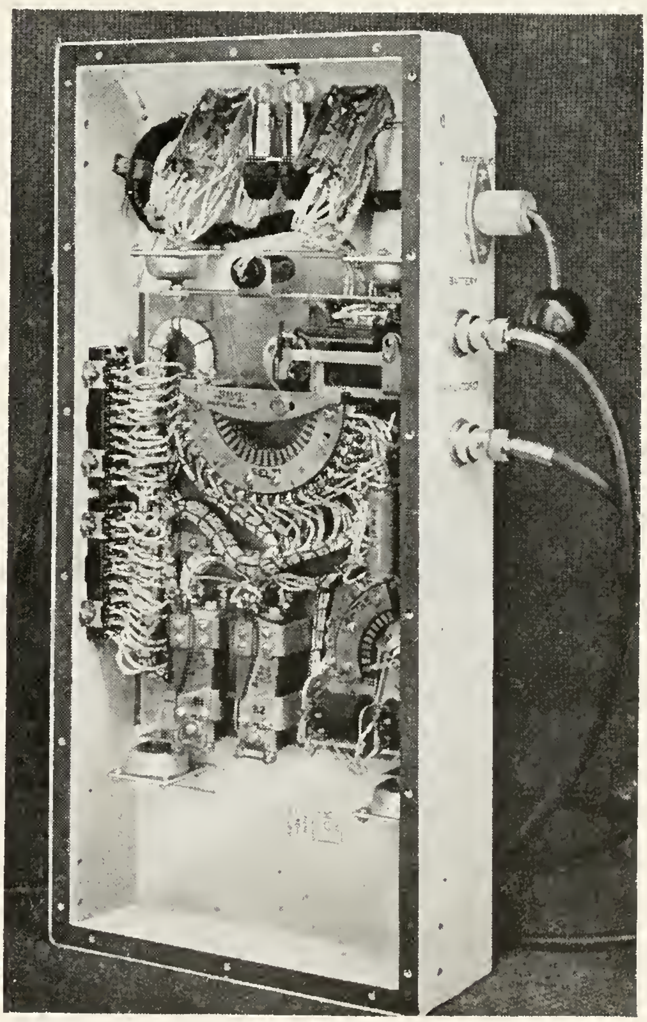
Coöperation accounted for much of the difference between success and failure in the late war. Practically all information was pooled to make it available where it could best be applied; and tools, plants, and personnel were used for the best over-all good. It was in this spirit of coöperation that the Laboratories lent one of its engineers to the National Defense Research Committee. During the first World War, he had had some experience with the experimental development of rockets as military projectiles. More than 20 years later, with the outbreak of the second World War, he suggested that rockets had a number of military applications. By the end of July 1940, he had been sworn in as chief of a section of the National Defense Research Committee.

Of the long series of rocket developments carried on under this engineer's direction, the one to see earliest combat use was the 2.36-inch bazooka, which became known around the world because of its novelty and effectiveness—even against the giant German tiger tanks.

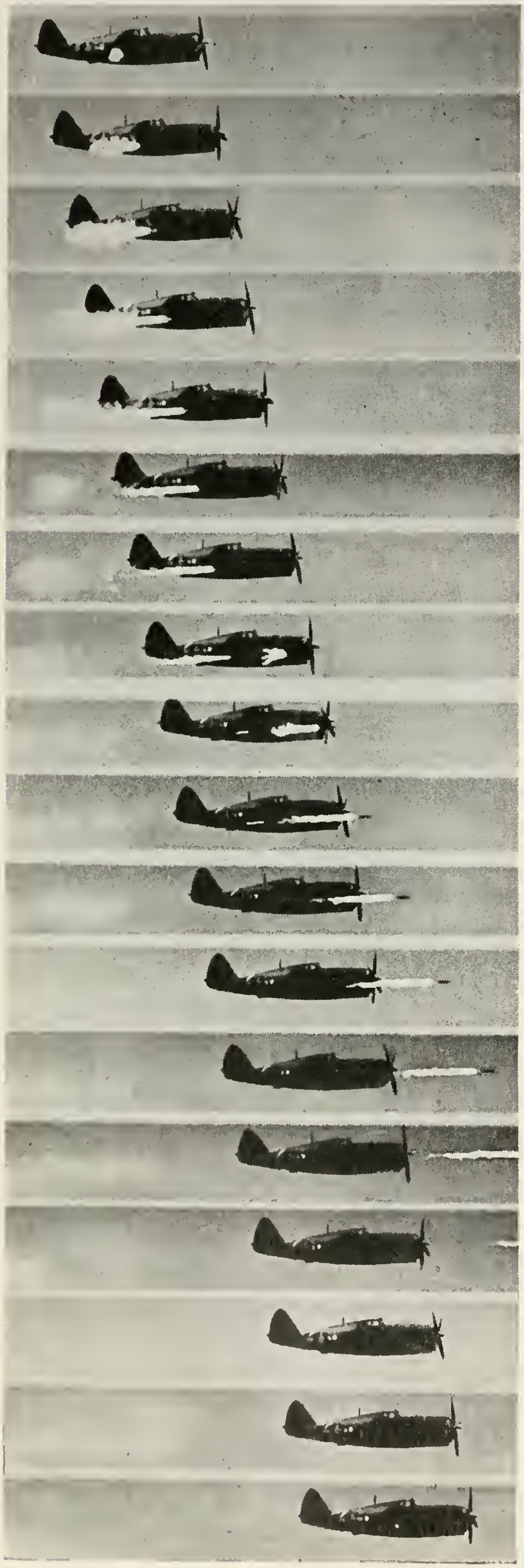
To understand why the rocket is so useful a weapon under certain conditions, one must remember that a projectile weighing several pounds requires a considerable push to accelerate it to several hundred feet per second. When this push is exerted by a cannon, its recoil is heavy—and in proportion to the force of the propelling change. A rocket, however, reacts against the mass of its own gases, and there is no appreciable recoil. The launching tube is not subject to high pressure, but merely serves as a guide, and thus can be light and inexpensive.

Launching "by Telephone"

One of the many applications of communication techniques to rocket problems was the fire-control mechanisms developed for releasing rockets from multiple-tube launchers. The Army was working on an arrangement to launch 7.2-inch rockets from a large truck. An electrical firing cir-



The "innards" of the fire-control unit of a multiple rocket launcher, showing the dial-type selector and other standard telephone apparatus (see photograph on page 36).



cuit was needed to set off the rockets in succession under control of a selecting mechanism connected to the truck by a long cable. The problem was to obtain a timed selecting arrangement that would discharge the rockets in as rapid succession as possible without having them collide in the air or having the blast from one rocket affect the trajectory of the succeeding one.

The Laboratories designed a fire-control arrangement around a dial telephone selector with an associated relay timing circuit that enabled the rockets to be discharged in succession as required. Within a week a model was in the hands of the Army, and the Western Electric Company was commissioned soon thereafter to build nearly a hundred of these devices for further field experiments.

This first "ripple" fire-control mechanism attracted attention to similar problems on rocket launchers for tanks and other mobile mounts. On a rush basis, the Laboratories designed fire-control devices for tanks carrying 60-tube launchers, for demolition tanks which threw twenty 7.2-inch missiles for breaking up heavy defenses, and for 8-tube launchers on truck and trailer mounts. All of these fire controls, built around telephone switches and relays, were found to provide greater reliability of firing than earlier designs, and Western

Development of a ribbon frame camera, which takes pictures at a speed of from 1/10,000 to 6/10,000 of a second, was an important contribution of the Laboratories to rocket research. This series shows the launching of a rocket from an airplane

Electric was placed under contract to build several hundred of each kind of launcher controls for equipment to be sent overseas.

Spinning to the Target

ROCKETS are ordinarily stabilized with fins, and if the propelling charge is completely burned before the rocket leaves the launching tube, the dispersion, or deviation from the desired trajectory, is very small. If the propelling charge burns after the rocket has left the launcher, however, the dispersion may be large unless there is perfect alignment of the nozzle and the center of gravity of the rocket. When this alignment is not perfect, the line of force of the burning gas discharging through the nozzle does not pass through the center of gravity, and a tilting moment is developed which causes the rocket to deviate more and more from its original direction of travel. Such conditions are common with very high speed rockets where the burning cannot be completed before the rocket leaves the launching tube.

Spinning had been suggested to decrease the dispersion under such conditions, but preliminary studies had indicated that a high spin would be required to bring about a worth-while improvement.

To find out just how much spin was needed, a rocket launching tube was mounted in large ball bearings

HERE ARE three groups of exposures of the launching of a rocket from a stationary structure, taken with a wide-angle Fastax camera, developed by the Laboratories during the war

A ROCKET starts its journey, its accuracy increased by the spin imparted in launching

within an outer stationary tube attached to a tripod. Provisions were made for arming the assembly, and a motor was provided to rotate the launching tube at speeds of 900, 1,800, and 2,700 rpm.

With this arrangement, an extensive series of tests was carried out to determine the effect of spin on dispersion. It was found that a considerable decrease in dispersion was obtained with very moderate spins, and that the speed was not critical—essentially the same improvement was obtained over a wide range. Without spin, the dispersion for the standardized rocket was 39 mils: that is, the rocket would deviate 39 feet in 1000 feet of travel, while with spins of 800, 1,400 and 2,400 rpm the dispersion was reduced to 13, 11, and 9 mils, respectively.

The improvement in dispersion obtained in these and other tests resulted in intensive research programs both here and abroad to reduce dispersions by giving the rocket, at the time of launching, a moderate spin.

Other Projects

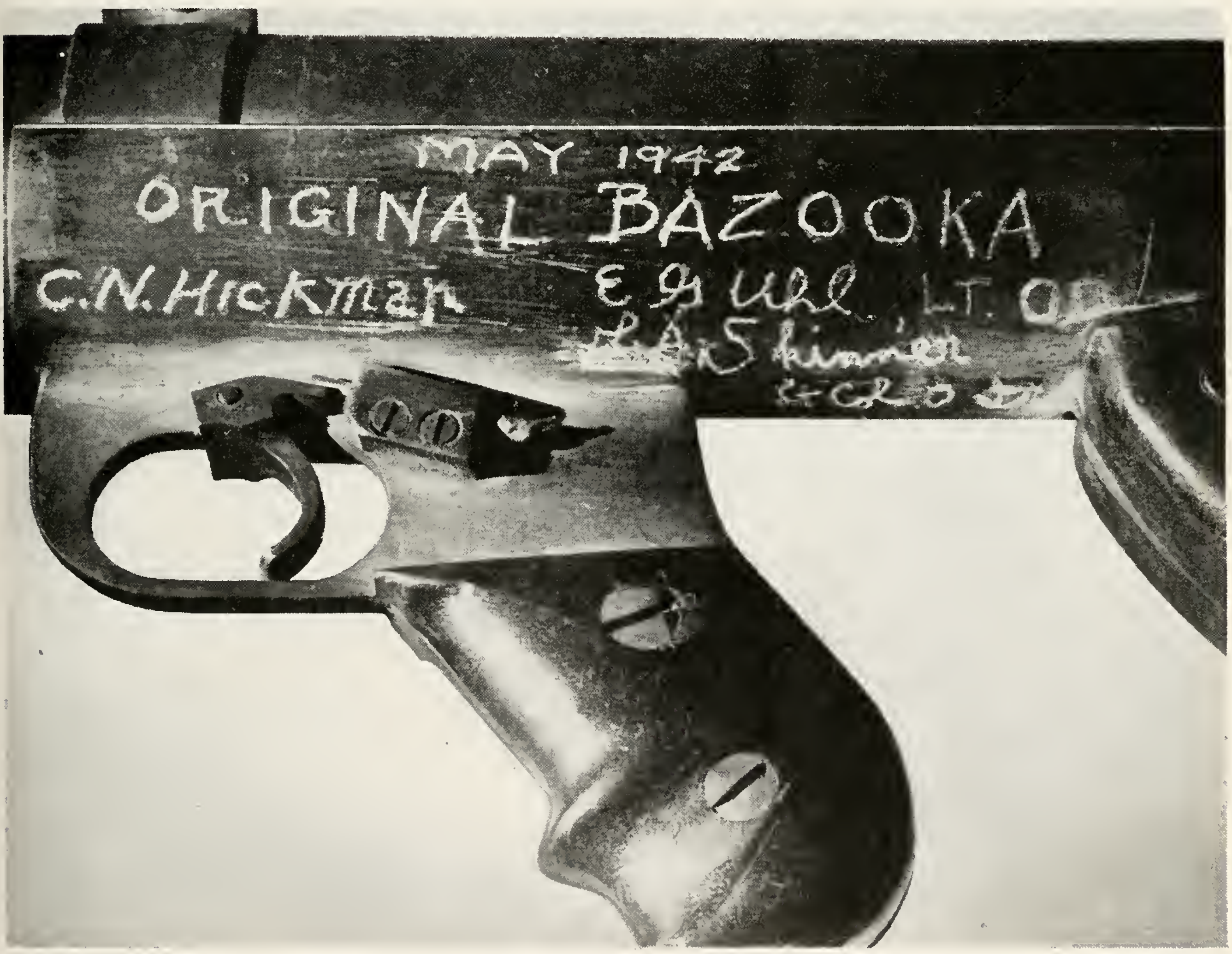
OF MANY supplementary projects undertaken in connection with rocket research, two are particularly interesting.

The use of copper balls instead of cylinders for measuring pressure in the explosion chambers of rockets and mortars not only proved of inestimable value in ordnance studies, but brought savings several times greater than the total amount the Laboratories spent on all its rocket developments. Copper balls of the required diameter were obtained from ball-bearing manufacturers, but the work of annealing and calibrating them was carried out by the Laboratories, not only during the development stages but on a production basis until nearly the end of the war.

One of the important tools used in most of the studies of rockets was a high-speed "ribbon frame" camera, especially developed to obtain knowledge of the behavior of rockets during the early part of their flight.

It was by the use of special apparatus and tools of this sort, and through an intensive application of native genius, that American jet propulsion, which was almost non-existent at the beginning of the war, became one of the important factors in our final victory.

THE WAR DEVELOPMENTS here recounted are only a few of those actually carried out. The original design and development were undertaken by the Bell Laboratories, and manufacturing was done for the most part by the Western Electric Company. But every branch of the Bell System made its contribution of trained personnel: either on loan directly to the Laboratories, or on military leave with those branches of the Armed Forces which installed and maintained all sorts of communications equipment under all conditions and all over the world.



Field Engineers of the Bell System's Manufacturing Arm Accompanied Our Army and Navy in All Theaters to Help Keep Electronic Devices at Peak Performance

Western Electric Experts With the Armed Forces

J. Stedman Ward

Out on Midway Island early in 1945 a Navy radar technician aboard a U. S. submarine reported having had a brush with a trouble-maker named "Little Joe." He didn't say a word about it to the Intelligence Officer, or to the Shore Patrol either; they wouldn't have been interested. Trouble of this kind was in the province of a fellow who wasn't really in the Navy at all; yet he was certainly *of* the Navy, for the Bureau of Ships had requested that he come to Midway, required that he wear a Navy uniform, and arranged that he be accorded all the privileges of a naval officer.

The man to whom the "Little Joe" trouble was reported was a Western Electric field engineer.

The field engineer had seen Joe, under one guise or another, often enough in the past, and knew him for an old and troublesome offender. Joe was, in fact, a false echo, a little man who wasn't there. For every once in a while the oscilloscope screen of a radar equipment would indicate the presence of an object at short range when, in sober truth, the seas were clear for miles around.

There were four or five standard possible explanations for Joe's presence. None of them fitted this particular case at Midway. Then the engineer remembered an item in a recent number of the weekly *Technical Newsletter* sent to him by the Field Engineering Force headquarters in New York. He checked back, found that one of his five-hundred-odd far-flung colleagues had scotched "Little Joe" on the same equipment by the use of an FE-1088 Oscillator. Within a short hour Joe had left Midway.

Joe had not always been viewed with such nonchalance, nor had he always been so easy to eliminate. In the early years of the war, he had been a real menace. When the seas were teeming with Japs and Germans, it was disconcerting, to say the least, to have such a will-o'-the-wisp target bob up every so often. It is even possible that an occasional torpedo was fired at Little Joe. In any case, Joe, in concert with a number of his brother gremlins, threatened to undermine the confidence of Navy crews in the radar equipment which had so recently been given them.

A Western Electric field engineer on duty in the Pacific changes from one warship to another by breeches buoy to answer a call for expert radar assistance

Joe's departure was important, and the fact that it was a *hurried* departure was even more important; but the incident hardly provides more than a hint of the reason for the field engineer being with the military services. In itself, it cannot explain why the Navy requested Western Electric to hire this young man, a former police radio engineer, school him in the new science of radar, send him to the Norfolk Navy Yard for months of additional training and experience, and then ship him out to Midway among the submarines and the gooney birds.

In the five days immediately following that fateful Sunday morning of late 1941 at Pearl Harbor, one of the first Western Electric field engineers, a former ERPI * man, worked 85 hours repairing damaged radar and making new installations.

In October and November of 1945, a field engineer accompanied the 7th

* ERPI, signifying Electrical Research Products, Inc., a former subsidiary of Western Electric Company which introduced and distributed Western Electric sound motion picture equipment.

Amphibious Corps of the Marines as these troops occupied Northern China to accept the surrender of the Japanese for Generalissimo Chiang Kai-shek. In the engineer's words, it was "more of a social call than an occupation," but the Marines wanted him there as a source of information on their radar equipment.

strong Headquarters staff of technical and clerical people in New York.

Why this growth, and what did the field engineers do at home and in strange lands around the world? It is an interesting and, for industry, a rather exceptional tale. The Bell System had a major share in translating radar from a scientific concept to an accomplished fact.* Here, now, is the evidence that the System also accepted a share of the responsibility for putting this fact across to the enemy.

A MEMBER of the F. E. F., somewhere in the Pacific, goes aloft to get something done. Radar didn't work by decree; it sometimes took a lot of doing

Between these two assignments, so significant in their contrast, lies the growth of the Field Engineering Force from a group of twelve engineers, recruited in 1941, to an organization of more than five hundred field engineers by V-J day, serving our armed forces and our allies on five continents and backed up by a

THE MAIN JOB of the field engineer was to bring about the best possible

* See "Radar," MAGAZINE, Winter 1945–46.

standards of radar operation in the field. He helped to translate Bell System quality of design and manufacture into high quality field performance. This meant the instruction of officers and enlisted men in the techniques of proper installation, adjustment, maintenance, and operation of radar and, for that matter, sonar, other special electronic devices, and communication systems developed by Bell Laboratories and produced by Western for the Army and Navy.

The insistence upon a high standard of performance meant frequent need for on-the-scene field modifications and readjustment of radar systems and other electronic equipment to incorporate improvements meeting the always advancing technical and operational requirements. This objective involved extensive coöperation with Bell Telephone Laboratories.

Not infrequently, it was the very fact of the engineer's civilian status, his easy mobility in terms of official channels, which made him invaluable. He was able to go directly and immediately to the proper level of command to present suggestions and get the approvals necessary for action.

Specialists in the high-altitude bombing radar equipment carried by the B-29s. These six field engineers, pictured somewhere in the China-Burma-India Theater, were commended by Major General Curtis LeMay for their contribution to the success of the missions of the 20th Air Force over Japan

The field engineer functioned also as a coördinator and expediter. He established a reliable and close technical liaison with the designers and factories of his company at home. His presence throughout the armed services proved a considerable factor in building up confidence in radar and other new electronic devices for combat.

It is not an easy thing to summarize the activities of even one of these men. Their work was as varied as the use of radar itself—which, as we know, was employed for scores of purposes, from area bombing of the enemy home-land to zenith search against kamikazes. But actions speak louder than definitions: the pattern of their contribution should emerge from the retelling of several characteristic incidents.

Field Engineers in the Field

Field Engineering Force "branches" served the various armed forces thus—

Bureau of Ships branch—*covered seaborne radar, sonar, and special radio communications for the United States Fleet and the Marine Corps.*

Bureau of Aeronautics (USN) branch—*first for airborne radar and later for electronic flight trainers.*

Bureau of Ordnance (USN) branch—*for radar controlled airborne missiles and later for fire-control radar.*

Army Air Forces branch—*for airborne radar.*

Army Ground Forces branch—*for ground-based radar and wire and radio communications.*

Office of Scientific Research and Development—*for various radars and special equipment.*

Engineers trained and assigned to the work of one branch ordinarily specialized in its activities and remained within its scope.

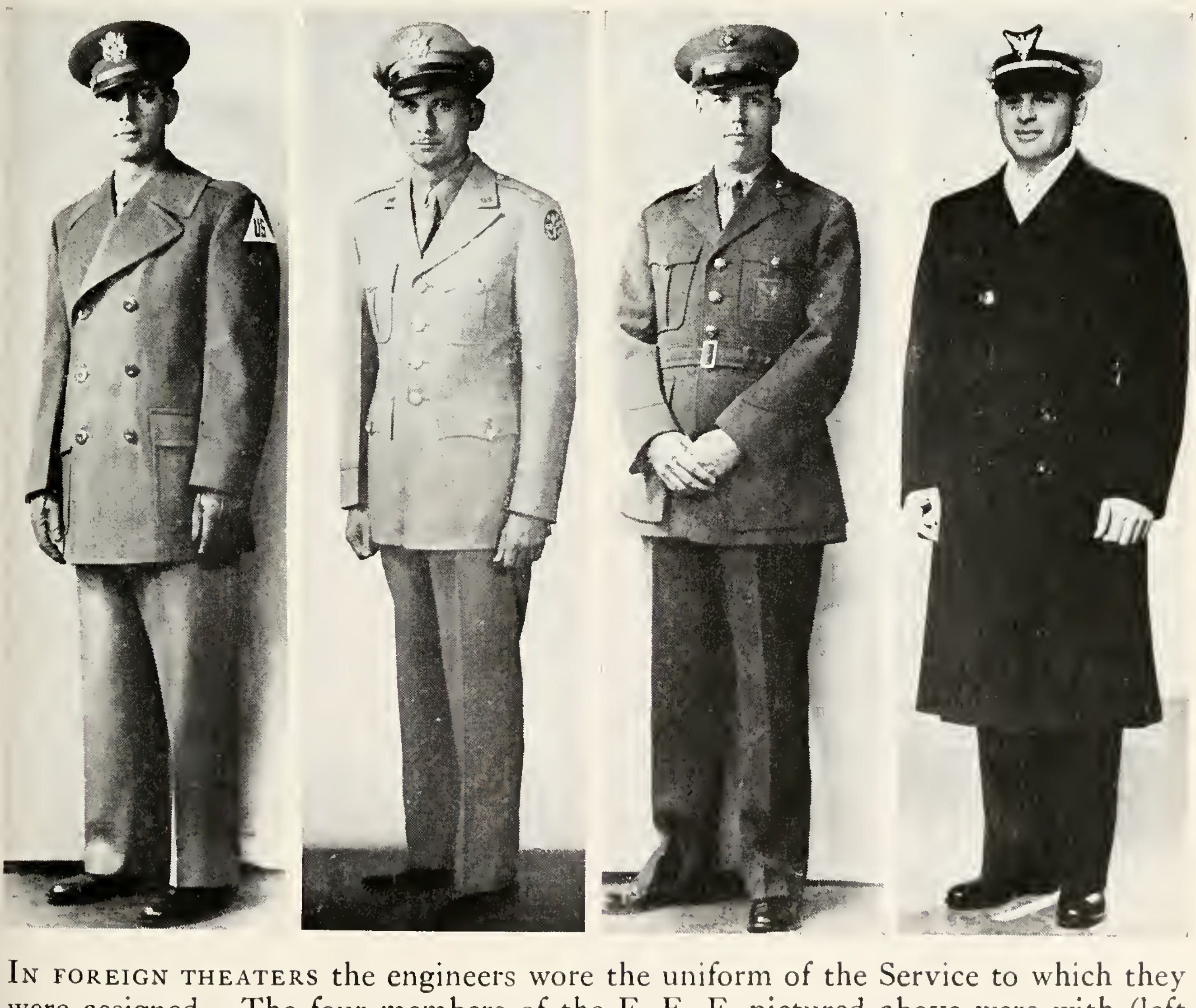
During the early years of the war, aircraft crews were at first inclined to question the value of radar—which, because of added weight, meant less fuel supply and lower speed. A field engineer—a man of 17 years' service with the Illinois Bell Telephone Company—helped to demonstrate what radar, understood and rightly used, could do.

This man spent several months in 1942 and '43 with the B-24 Squadrons' crews of the 480th Air Forces Group, coaching them in their use of radar against submarines. Careful instruction and painstaking trials both in this country and in England had brought no results over the North Atlantic; but by the time the squadrons were transferred to the Mediterranean, things were looking up. In the latter area, during the first two weeks of July 1943, those squadrons sank 13 Axis submarines —a not inconsiderable contribution to the freedom of the seas. Of those 13, nine were spotted and the bombs sent away through the use of radar alone.

That proof of the usefulness of radar *in* airplanes was matched by another field engineer's demonstration of its value *against* airplanes. This man, attached to the 108th A.A.A. Battalion, whose gun directors were controlled by SCR-545A radar equipment, spent long and dangerous hours at Anzio. He helped these artillerymen to locate their equipment to best advantage and taught them how to track their targets steadfastly through the enemy jamming and "window" (tinfoil dropped by enemy planes as they approached). The 108th, which was the first anti-aircraft battalion to be so fitted out, shot down seven enemy planes during their initial radar night action, firing with an effectiveness 2½ times greater than the other two Anzio battalions together.

A colleague in Italy, assigned to the 12th Air Force, briefed the radar officers, navigators, and pilots of the C-47 planes which carried paratroopers from the Galleria Air Field, near Rome, in the August 1944 invasion of southern France. The drop zones, although completely covered by overcast, were discernible to skillful radar interpretation. The troops landed just two minutes behind schedule.

In 1944 and '45, field engineers



IN FOREIGN THEATERS the engineers wore the uniform of the Service to which they were assigned. The four members of the F. E. F. pictured above were with (left to right) the Army Ground Forces, the Army Air Forces, the Marine Corps, and the Navy

In his capacious black bag (center), the field engineer carried his specialized tools and instruments, his Company papers, and as many of the equipment bulletins (rear) as applied to the equipment with which he was concerned

worked with the British branch of the M. I. T. Radiation Laboratory, in England and on the Continent, on problems connected with radars for fast night fighter planes. Some of these men, making their observations and tests right up where the shooting war was happening, discovered an important fact: the planes they were using were so fast that in the dark of night they whizzed right over slow-flying German supply planes almost before their own planes' radars had indicated the enemy's presence. So an engineer devised an answer to that one, involving the use of micro-wave early-warning radars. Thereafter the night-time deliveries of German supplies by that method dwindled.

In Alaska, field engineers were assisting the cold-weather program of tests on Air Forces' radar equipment at the same time that another engineer, a former Michigan Bell Telephone Company man, was sweating it out in Brazil, learning Portuguese and helping the Brazilian Navy with the installation and operation of ship-borne radar equipment. Between these extremes of North and South in the Western Hemisphere, many field engineers saw service at numerous locations outside the continental United States, including the Canal Zone.

One of the first field engineers to go abroad won't forget the time he inspected and checked the radar aboard the submarine Peto as she rode the seas in the Pacific 40 miles off the Zone. He was taken out to

Best available statistics indicate that Western Electric engineers travelled collectively 11,200,000 miles at least in their globe-girdling operations. They worked 2,200,000 man-hours, and filled 138,000 assignments.

meet her in a PC boat and—the last half mile—in a native dugout canoe!

This same engineer, while stationed in the Zone, witnessed the growing confidence Navy men displayed in their radar equipment as more and more ships followed one another through the Canal in 1942 and 1943 enroute to the fighting fronts. In contrast to the skepticism displayed by many Navy crews handling the earlier radar installations, all concerned with it were by then showing the greatest interest in developing high efficiency in the operation of their equipment.

The advantages of radar, demonstrated in battles won and very effectively circulated via the reliable scuttlebut route, brought about this respect, and created the desire on the part of personnel manning fighting vessels to utilize the equipment to its utmost capacity.

In the Pacific, the center of naval activities was of course Pearl Harbor, where eventually two-score and more Western Electric engineers in Navy uniforms handled radar, sonar, and other electronics problems brought in by a steady stream of ships from all parts of the Pacific. But Pearl Harbor served another function too. It was the jumping off place for field engineers heading south to Australia, north to Okinawa, and all stops in between: New Caledonia, Espiritu Santo, Guadalcanal, Munda, Kolombangara, Bougainville, New Georgia, Manus, Ulithi, Eniwetok, Kwajalein, Funafuti, Majuro, Palau, and others.

Engineers were stationed ashore at bases; they lived afloat on tenders, repair vessels, and flagships; and they rode combat ships of all types, traveling hither and yon—wherever the need for their services might take them. More than once they witnessed engagements at sea, and shore bombardments in preparation for landing operations; and they sometimes went ashore with attacking troops.

At Ulithi lagoon another engineer, on loan from the Illinois Bell Telephone Company, worked back-breaking hours checking and tuning radars among the 624 ships gathered there in preparation for the Okinawa invasion. He was so busy that the Navy asked him not to answer a request for assistance unless it was repeated.

A succession of field engineers assigned to the 7th Fleet Submarine Base at Freemantle, Australia, set up a model system and routine for

In addition to conventional automobiles, railroads, surface ships, and aircraft, field engineers rode in or on jeeps, command cars, motorcycles, tractors, tanks, landing craft of all kinds, native canoes, amphibious "ducks," submarines, rickshas, catapult planes, gliders—and probably other vehicles not yet reported.

checking, servicing, and tuning the radars of the big "pig boats." One of these engineers was flown to Milne Bay, New Guinea, where he worked eighteen hours a day for five days on the radar gear of ships destined to take part in the Arawe invasion. When he finished, he himself sailed aboard one of them—the destroyer FLUSSER, which covered the operation and bombarded enemy installations ashore.

Western Electric was one of eight companies manufacturing radar and other electronic apparatus whose field engineers accompanied the Armed Forces. Most of these specialists served with the fleet, and Western Electric supplied the largest single group: 325 out of 1,300. While each engineer was on hand primarily to look out for the equipment made by his own company, many a helping hand disregarded that technicality on occasion, and in an emergency there was no thought of distinguishing among different companies' products

Field engineers working with the Army Air Forces in the Pacific area, by their advisory engineering assistance on radar equipment and problems relating to its use, contributed heavily to the success of our bombing of enemy ships and cities.

Perhaps one of the most impressive evidences of their success in this line was provided by two engineers who accompanied a B-24 Squadron to Guadalcanal in mid-1943. This squadron was the first to be equipped with a radar bombsight designed in a big hurry for low altitude bombing at night. The bombsight was so new that half of the available equipments were pre-production models, and one of the field engineers was borrowed from the Bell Laboratories group which had developed the equipment. The planes went to work and sank everything *not* in sight—even canoes.

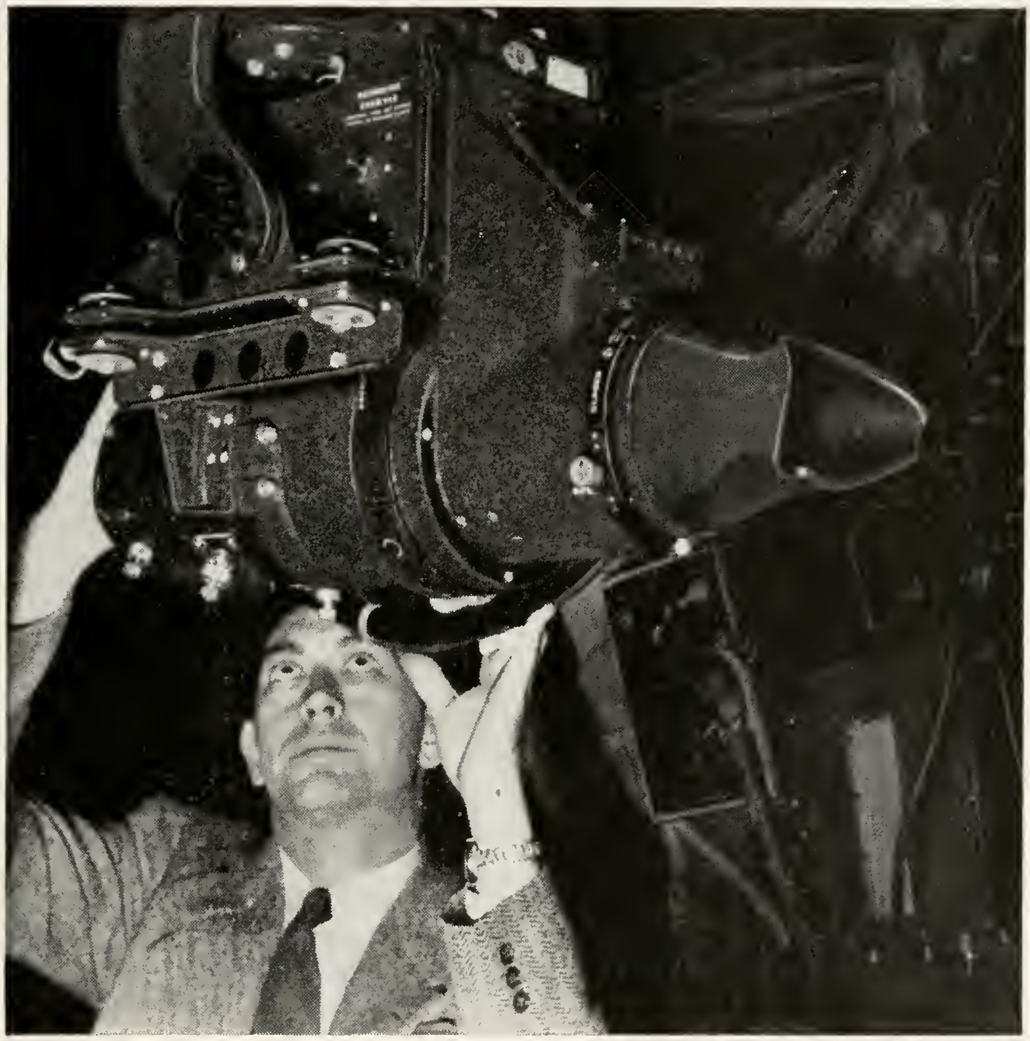
The telegram from General H. H. Arnold, Commanding General of the Army Air Forces, to C. G. Stoll, president of the Western Electric Company, commenting on the outcome of these operations, said in part:

I WISH TO EXPRESS MY OWN APPRECIATION AND THAT OF THE ARMY AIR FORCES FOR THE INVALUABLE ASSISTANCE GIVEN BY TWO OF YOUR ENGINEERS . . . WHO WORKING IN THE FIELD UNDER MOST DIFFICULT CONDITIONS MADE IT POSSIBLE FOR THE ARMY AIR FORCES TO TAKE THE OFFENSIVE WITH TELLING EFFECT AGAINST JAPANESE SHIPPING IN THE SOUTH AND SOUTHWEST PACIFIC AREAS UNDER CONDITIONS WHICH WOULD NORMALLY HAVE MADE SUCH OPERATIONS IMPOSSIBLE. . . .

These two were followed in 1944 by many other field engineers who worked with the China and India-based B-24 Squadrons, and with the big new B-29s of the XX Bomber Command in the China-Burma-India theatre and of the XXI Bomber Command in the Mariannas on Saipan, Tinian and Guam. Of these men, and of many other Western Electric field engineers doing similar work, Major-General O. P. Echols wrote to President Stoll, "The Army

Air Forces regard these men as an indispensable element in the All-American team of fliers."

A MOST EFFECTIVE WAY of showing the field engineer at work would be by montage movie photography.



IT SERVED over Bikini. A Western Electric field engineer is making final adjustments on the radar "scope" camera aboard a B-29 which took part in the atomic-bomb test on June 30

While one field engineer was improving the pressurizing system of high-altitude bombing radar equipment in India, another was on leave with a National Defense Research Committee project down in Panama recording authentic jungle sounds to improve training for jungle combat.

A field engineer on board the battleship INDIANA at an advance base in the Pacific teamed up with the ship's boatswain and, by working out an ingenious rigging system for replacing a faulty Mark 8 antenna which weighed about one ton and was mounted high up on its upper works, they saved the ship a long trip to an Australian port. Incidentally, their success won $10,000 for their supporters among the crew, who had wagered enthusiastically on whether such an exchange could be effected without resort to the large navy-yard cranes customarily used for such a heavy job.

At about the same time, one of this engineer's colleagues, in association with naval personnel, conceived a rearrangement of one of the fire control radar systems which greatly improved distribution of the target information for gunnery purposes.

One field engineer, under front-line conditions on Okinawa, used a piece of gas mask hose to conduct warm air from the magnetron of a search radar equipment to the transmission line, in which moisture condensation had been causing arcing trouble.

Two other field engineers on that disputed island were assigned to work with one of the Navy's most super-secret weapons, the radar controlled flying bomb, known as the Bat. In the words of a rear admiral, they showed a "willingness to tackle all jobs on all types and models of electronic equipment." They actually tackled 56 such jobs in their first 72 hours on Okinawa.

All the subject-matter worked on by the F. E. F. represented military secrets, most of them highly classified. The field engineer carried a constant burden of knowledge of great value to the enemy, which it was his duty to protect unremittingly.

Letters of commendation and appreciation numbering several hundred have reached the Western Electric Company, during the war and since, from many Commands, expressing their satisfaction with and congratulations upon the efforts of Western Electric field engineers assigned to assist them. Included are commendations from the Royal Navy, the Royal Air Force, the British Air Commission, and the Office of Scientific Research and Development.

In late 1944, two field engineers accompanied the first radio-link communication equipment sent to France. This very-high-frequency apparatus, basically the same sort of equipment as that recently placed in service on the West Coast to connect with Catalina and now being installed between the Massachusetts mainland and Nantucket Island, was used for communication between the 12th Army Group Headquarters and the 15th Army in Europe.

One of the cardinal points about radar was that it didn't work by decree. It took a lot of doing. When asked what he considered his assignment to mean, the Western Electric field engineer usually replied, "to go out there and make the radar work." He was by no means alone in this effort; but it is acknowledged that he was instrumental in creating faith in this new, versatile, and critically indispensable equipment.

These men did not get back home without having heard some angry shooting and having undergone a few hardships. "Hardships" is a calculated understatement for air raids, buzz bombings, mortar fire, sniping, torpedoes, plane crashes, bad food, and spider bites—not to mention occasional climatic inroads on health.

One field engineer (from the Michigan Bell company) logged 193,775 miles in the course of a scant year on a Navy assignment. He covered 6,000 miles by submarine and spent 816 hours in air travel. During his first 24 hours on an island naval base, he led a rather precarious existence: 1). The plane in which he arrived made a belly landing. 2). He then was assigned to a vessel scheduled to sail that afternoon, but was prevented from boarding her by the merest chance—and she was never heard from again. 3). That night he left his tent two minutes ahead of the bomb that demolished it.

Three Western Electric field engineers lost their lives in the line of duty—all in accidents involving airplanes. The first death, at Marietta, Georgia, in late 1943, occurred during the initial tests, in one of the first B-29 airplanes, of the high altitude bombing type radar which was to be used in China-based raids against Japan. The second engineer to lose his life died in September of 1944 with eight others aboard a B-24 plane that crashed as it came in to land at Alamogordo, New Mexico. Early in 1945 another field engineer was killed in the crash of a transport plane which had just taken off from Australia enroute to a Philippine port, where he was to supervise the installation of a new radar system in submarines.

Most field engineers were inclined, none-the-less, to take a rather lighthearted view of the hazards of their profession. Indeed some of these hazards had their comedy aspects—at least in retrospect. One man will always remember the predicament of an Army nurse who stepped off a transport plane at Bougainville just as the Japs began to bomb the airfield. The nurse and the field engineer by chance made for the same fox hole, where their number was increased seconds later by six husky and very naked Marines who had been in swimming.

Recruiting and Training the F.E.F.

It was not an easy task during the war years to find more than 600 engineers (counting a small turnover) who were willing and able to undertake this potentially dangerous but vital work. They had to be mature yet rugged and in A-1 health. They had to have technical skill and an imaginative engineering attitude. They not only had to satisfy the exacting employment requirements of Western Electric but to undergo a searching security investigation by the Army and Navy. It was necessary that they be adaptable in high degree yet thoroughly stable. Moreover, they could not be rough diamonds; the job called for men who were articulate and agreeable. On the whole, becoming a field engineer was hardly a matter of following the line of least resistance for these men, most of them family heads in their 30s and early 40s.

Into this rather high-voltage occupation came 132 men directly from within the Bell System—22 per cent of the total group. Only the radio industry contributed a slightly larger number. There were, of course, men from the Bell Laboratories, from Long Lines, and from various parts of the Western itself; but the bulk of the Bell people came from 15 associated telephone companies.

The Bell System could not begin to supply the full requirements, however. The burden of this man-hunting job fell upon the "Bird-Dog" Department, as the Force's personnel organization became popularly known. Led by a former general plant employment supervisor of a mid-west telephone company who had himself been a field engineer, a group of ten former field engineers spent their time hunting out prospects in every section of the United States for the expansion of the Force. They found their recruits in 39 states, and even a handful from Canada and the British West Indies.

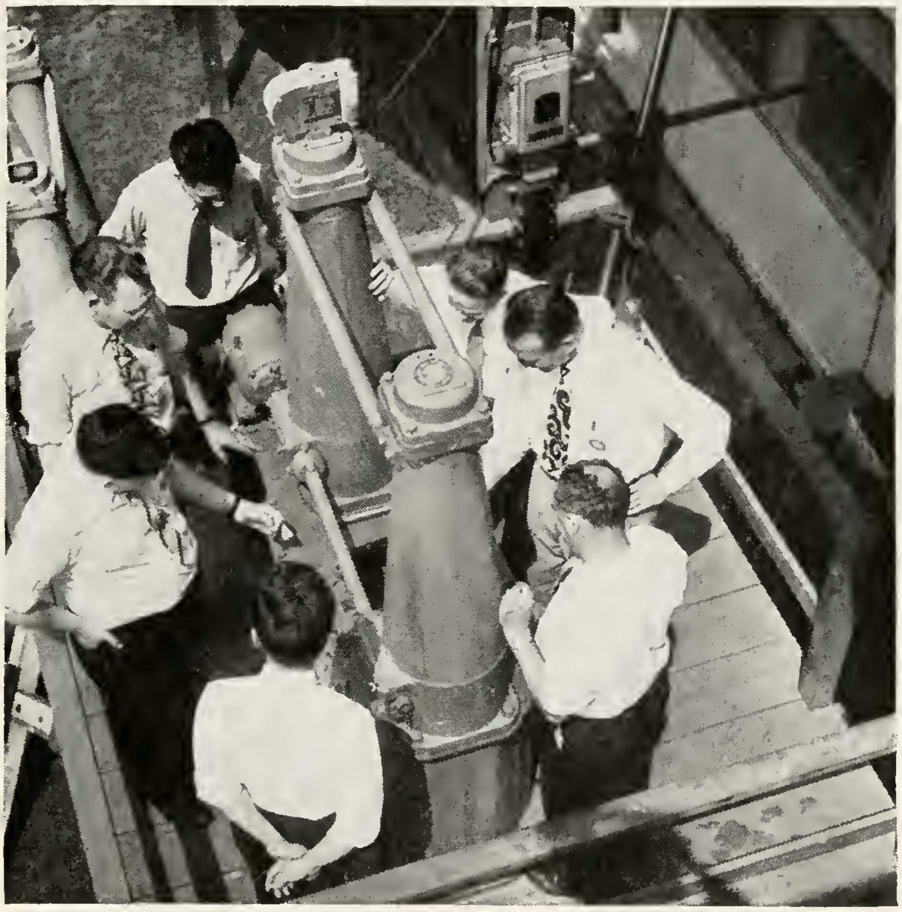
At the Whippany radio laboratory of Bell Laboratories, where Western Electric maintained one section of its F. E. F. training schools, a student engineer works with the antenna of a Naval radar

Some companies were better able than others to spare their valuable engineers and specialists during the manpower shortage. All of them, however, were glad to coöperate in every way possible with the Field Engineering Force search for additional field engineers to meet the increasing demands of the Army and Navy.

The roster saw virtually every

major American technical school, college and university represented in the membership. Naturally, electrical engineering degrees predominated although several other scientific degrees were to be found, including a number of Ph.Ds.

A MAJOR contribution to the development and management of the Force arose out of the experience of Electrical Research Products, Incorporated, in the sound motion picture equipment business, commencing in 1927. ERPI's extensive operating experience in the installation and servicing of sound equipment, in both the nation's picture-making studios and its theaters, provided a useful background. Several top supervisory positions were occupied by former ERPI men, all of whom had joined the Field Engineering Force in its early days. Still another pertinent and valuable asset was the experience, gained over many years, of the field engineering group maintained by Bell Telephone Laboratories for the assistance of the broadcasting industry in the installation and use of Western Electric radio transmitters.



AN F. E. F. instructor (left center) at the Whippany training school lectures on the features of the train and hoist mechanism to his class of sonar specialists

Every Western field engineer has in his possession a certificate which testifies that he has received some four to eight or more weeks of intensified F.E.F. training in the theory

Western Electric's field engineers were selected through nationwide recruiting from more than 200 vocations. To employ 606 engineers, 4,515 men were interviewed out of 14,100 considered in all. The cumulative growth was:

1941	*18*
1942	*134*
1943	*289*
1944	*486*
1945 (to V-J Day)	*606*

and operation of shipborne, airborne, or ground radar systems.

The Company's Radar Training School was the first step for every new field engineer. In 1941 and early 1942, it was conducted by Bell Laboratories engineers; but soon the fast-growing equipment development program took all of their time and the school passed to Field Engineering Force supervision and instructors, even though continuing to use space and facilities at Laboratories locations. The first Field Force head of the school was a university professor who, in 1942, had interrupted a lecture tour in upstate New York in order to become a field engineer.

Most engineers came back periodically to the Schools of the Force for refresher courses, advanced courses, or courses on new equipment, and always after service in foreign theaters. Their training really never stopped, however, as they carried on their jobs in the domestic Navy Yards and at Army Airfields.

Here they wore no uniforms and had few thrilling adventures—unless it can be called "thrilling" to have a worker paint your hair with a spray gun or another burn the soles of your feet with an acetylene torch from the deck below. Here was a solid, if unspectacular, contribution of the Field Engineering Force in some 20 naval establishments from Casco Bay in Maine right around the coast line to Puget Sound in Washington, as well as at numerous fields of the Army and Navy Air Forces, airplane factories, and AAF modification centers throughout the United States. While these were the principal military activities served in volume, the Force also assisted several other branches of the Army and Navy and O.S.R.D.

It was not always so unspectacular, either. Our Navy needed its ships on the firing line; the "availability" of a ship was often cruelly short.

There was the case of the battleship Massachusetts, which arrived in Boston to prepare, as it later developed, for the bombardment at Casablanca. She wanted two fire control equipments replaced with radar of a later and improved design. But since she was under 12-hour sailing orders, no work could be started that might take longer than that to complete. Ordinarily, it took several days to complete a single installation of the new fire control equipment. The captain decided to replace, if possible, at least one of his old equipments. When this job, in the opinion of the Western Electric field engineer, was within 12 hours of completion (this point came at 2 A.M.), the captain gave orders to start the dismantling of the second outmoded equipment. Had the field engineer

FUTURE field engineers at a Western Electric radar training school in New York. The men shown here were studying Navy fire-control radar equipment

been wrong in his estimate of the time needed to complete the first new installation, and had the battleship then received her sailing orders, she would have had to sail for Casablanca with *no* radar fire control.

P.S.: It took 10 hours to finish the first installation—and the MASSACHUSETTS had her second new equipment operating, too, before she sailed.

THE "BIBLE" of the field engineer working far from his company headquarters, and possibly far even from any brother engineers, was his collection of engineering notes or "Equipment Bulletins." Because of the diversified and difficult nature of his responsibilities, the field engineer relied on their comprehensive coverage, in concise, accurate terms, of a great variety of apparatus, systems, and theory.

Containing circuit and assembly drawings as well as illustrations describing 67 different equipments and systems, they form a complete reference in miniature to the apparatus and its proper operation and maintenance, prepared with a special regard for the particular needs of the engineer in the field.

Throughout the war, these bulletins were kept up-to-the-minute, reflecting all changes and modifications in existing equipments immediately and keeping abreast of the initial appearances of new equipment and systems as they were introduced.

By early 1945, there were nearly 30 experienced field engineers assigned to the writing, editing, and

More than half of the working time of the Western Electric field engineers was occupied in the instruction of Armed Forces personnel detailed to radar duty.

STANDING in front of the jeep is one of the 18 Bell System engineers who worked on military communications in the European Theater as members of the Western Electric field engineering force

modifying of the technical bulletins and miscellaneous manuals which field engineers and Service personnel alike found invaluable in their work. Embracing 20,500 pages of a special small size compiled into neatly bound loose-leaf volumes, each from two to three inches thick, more than a score of these have been published for the guidance of the Field Engineering Force. Perhaps in no other respect was the experience of ERPI so strikingly apparent as in the conception and preparation of these bulletins, which served at once as authoritative instruction manuals and as reference works.

SOMEWHERE between the glamour and diversity of the overseas field engineering assignment and the steady basic work in domestic locations come the activities of the field test group.

The group was organized in 1942, at the suggestion of the Bell Laboratories. There were naturally some "bugs" in new radar systems which could not be anticipated in the design stages and which could be eliminated only by actual field testing. For this work, several of the most experienced field engineers were organized into a field test group; by 1945, 17 men were engaged in this work.

This story of a typical field test contribution should also provide a valid and accurate picture of what field engineering was all about:—

In February of 1944, one of these field engineers went down to Dam Neck, Virginia, to the Bureau of Ordnance Anti-Aircraft Training and Test Center. He was to participate in various tests involving new Western Electric radar equipment for antiaircraft fire control. The assignment was the beginning of an interesting chain of events.

To the operator of such a piece of radar equipment, the target plane appeared as a small bright dot on the fluorescent screen of the oscilloscope. His job was to keep the cross-hairs of the gun sight centered on that dot; in this position the gun should be properly trained on the target. And this was so when the plane was coming in directly towards the battery. However, when the plane turned and flew to one side or the other there was a somewhat irregular and disturbing phenomenon. The little dot on the screen was a fraction of a second slow to react and to simulate the plane's movement, *and it never did catch up.* The dot floated across the screen in a position actually some distance behind the real position of the plane. Thus, when the operator kept his cross-hairs on the dot, he still was not actually "on target."

This trouble was caused, it turned out, by a rather lengthy "time constant"—the steady interval of time which elapsed between the reception of a radar "echo" from the target and the conversion of this tiny pulse of energy into a visual signal. Radar energy travels with the speed of light—but to throw a meaningful signal on a fluorescent screen takes just a bit more time than that.

The field test man was able to suggest circuit changes on the spot—changes which reduced the "time constant" to only one-fifth of its former infinitesimal split-second length and brought the radar signal and the actual target virtually into conjunction. This circuit modification was then reported to the Bell Laboratories engineers, who incorporated it in their design for all subsequent radars of this type.

After conferences at New York, the engineer proceeded to Hawthorne to observe the first of these equipments in their final acceptance tests. From Hawthorne, he accompanied the first five systems to the Navy Yard at Mare Island, California, where he supervised their installation aboard four destroyers and a heavy cruiser. He then prepared a lengthy installation report which was submitted to Bell Laboratories and to Navy Ordnance Planning.

Now came two weeks of maneuvers and tests aboard the destroyer MAHAN. The field engineer assisted the Fire Control Officers in training their personnel on this new system. He assisted them to such good effect that the radar fire-control performance of the ship improved by 67 percent in this period, to the obvious satisfaction of the Squadron Commander and the ComDesPac Gunnery Officer, who were acting as observers.

A later report from the MAHAN stated that in 1,547 hours of radar operation, zero hours were lost due to failures.

THE SAGA of the part the F.E.F. played in the rehabilitation of telephone communications in France, Belgium and Germany from the time of the Normandy beachhead until well after V-E day—that is a field engineering contribution which cannot adequately be reported here. The eighteen engineers engaged in this program, most of them on loan from Bell Laboratories or from associated telephone companies, exhibited courage and resourcefulness of high order in cutting over damaged and disrupted enemy communications to the uses of the Allied forces. Not the least remarkable part of their accomplishment was their coördination of American, English, French, and German telephone and carrier equipment into smoothly functioning systems.

The End of the Story

WITH THE ARRIVAL of V-J Day, some of the contractual services performed by the Field Engineering Force for the Army and Navy were terminated immediately. Right up until the week preceding total victory, Western Electric had been hiring and training field engineers to meet the ever-expanding demands from the armed forces. Then came the sudden reversal of direction and the necessity for reducing the enrollment drastically. Since then, the remaining activities have been tapered down to a small fraction of the going rate at the war's end—enough only upon a temporary basis to facilitate an orderly transition to peacetime operations.

One field engineer, a veteran of two overseas assignments with the American Air Forces, left on his third not long ago—this time to the Bikini Islands for radar work with the bombers on Operation Crossroads.

Three others from the Bureau of Ships branch, all specialists on naval fire-control radar, likewise were members of the joint Army and Navy task force which conducted the atom bomb tests.

Several of the former field engineers have transferred to other parts of the Western Electric Company, to the Bell Laboratories, or to Associated Companies, and are applying their war-won knowledge toward the achievement of peacetime projects, such as mobile telephone service, point-to-point communication, and various other pursuits.

But most of the Field Engineering Force technical staff have gone back to their families and friends in their home states and the occupations, generally speaking, from which they came. The telephone men have returned, with few exceptions, to their companies. The radio men have gone back to radio—some of them as chief broadcast engineers. The teachers have gone back to teach—with a lot of valuable practical experience to bolster their theory. A number of men have started their own engineering, radio, or other businesses.

Despite this scattering to the winds, these field engineers still feel the pride and satisfaction which was theirs as members of this effective Bell System war-time organization. They feel that, during the war, they made the contribution most in line with their training and abilities, and that their hard work and varied experiences will enable them to play fuller roles in American life and industry.

ume XXV ❧ Number Two Summer 194

Bell Telephone MAGAZINE

Putting Disabled Veterans Back to Work • LAWRENCE L. ARMANTROUT

Twenty Years of 'Talking Movies': an Anniversary
FRANK H. LOVETTE and STANLEY WATKINS

Command Circuits • ELDON NICHOLS

Bell Laboratories' Rôle in Victory—Part II

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Bell Telephone Magazine

Summer 1946

"*The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost.*"

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *Pres.;* Carroll O. Bickelhaupt, *Sec.;* Donald R. Belcher, *Treas.*

Who's Who & What's What

in This Issue

"The veteran who has a physical disability will be placed (and trained where necessary) on a job *which fits his particular qualifications*, not merely on a job he can do." So wrote Lawrence L. Armantrout in "Welcoming Bell System Veterans Back to Work," which was published in the issue of this Magazine for Spring 1945. That was the promise, made while this country was fighting enemies on two fronts. Now those wars are over, and he can measure the performance against the promise—as he does here. The facts which he sets forth speak for themselves.

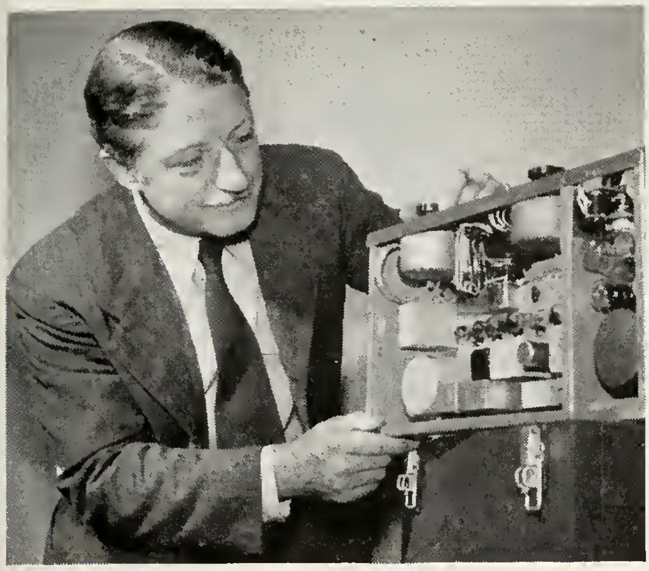
Mr. Armantrout joined the Traffic Department of the Michigan Bell Telephone Company in 1925, and in the next dozen years held various assignments involving manual, dial, and toll operation. In 1937 he moved over to the company's Personnel Department, and in 1943 he transferred to the A. T. and T. Company's Personnel Relations Department. Since going to New York, he has been largely occupied with personnel matters arising out of necessary adjustments to military service and readjustments to peaceful employment.

Lawrence L. Armantrout

A whole generation exists today which knows nothing of silent movies. To these people, motion pictures naturally have dialogue, music, appropriate noise—just as automobiles have self-starters and radios have loud speakers. To them the change from silent motion pictures to today's inadequately nicknamed "talkies" is simply an accomplished fact. This younger generation is still outnumbered, however, by people who *experienced* the change, marveled at it, and appreciate how great is the advance, in artistry and interest, which came about two decades ago. The leading part which the Bell System played in the change is told in this issue's second article.

Frank H. Lovette

The entirely different backgrounds of the two authors have fitted well together to give their story historical authenticity. Before joining the Western Electric Company in 1943, Frank H. Lovette had been—among other things—publisher of a daily newspaper, executive officer of the old Federal Radio Commission, secretary to a member of Congress, and the author of three books. His present post is that of Historian, and his preparations for the article included much research in old records, patents, and similar documents. To this Magazine for Winter 1944–45 he con-



Stanley Watkins

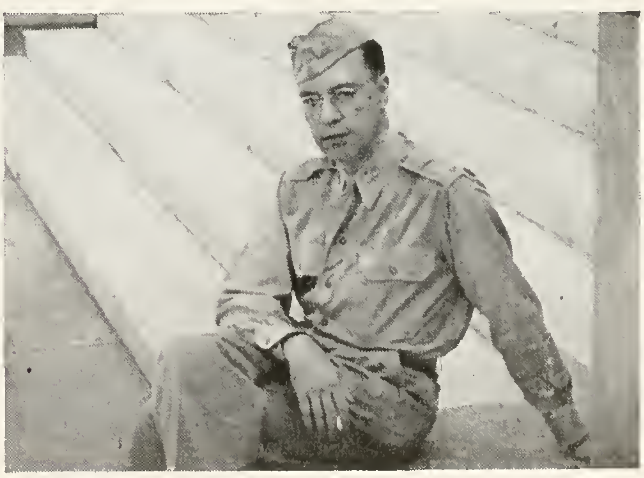
tributed "Western Electric's First 75 Years: A Chronology."

Stanley Watkins joined the Bell Laboratories (then Western Electric Company's Engineering Department) in 1911, and his various activities there have included several years of active participation in the development of sound motion pictures, beginning in 1922. In 1925 he had charge of the Laboratories' group which installed and operated the first commercial sound picture recording system in the Vitaphone studios in Brooklyn; he was then for a year Vitaphone's chief engineer; and from 1927 to 1936 he was director of recording engineering and European technical director for ERPI. Since returning to the Laboratories in 1937, he has worked on a variety of projects; and his wide background and long experience are now being employed in the Laboratories' Publication Department.

Some of the places pictured in "Command Circuits" are doubly familiar to Eldon Nichols, for he saw them twice: once, under fire, as an officer in the Army Signal Corps; and, again, as a civilian expert sent out by the Long Lines Department to help reëstablish overseas telephone service with the United States. Probably even more familiar to him are the radio teletypewriter circuits he describes, for he looked at them from two sides: first as staff representative (overseas service) in Long Lines, where he took part in early work on radio teletypewriters; and again as Officer in Charge of Communications Facilities Engineering Section, Office of the Chief Signal Officer. Mr. Nichols assisted in the installation of the first chain of single-channel radio teletypewriter circuits through the Caribbean, South America, and Africa, and in communications planning in the Pacific Ocean and Southwest Pacific areas.

Mr. Nichols joined Long Lines in Boston in 1922, and three years later transferred to New York. There he filled several assignments in the Plant Department prior to the staff post (already mentioned) he held when he entered the Army, in 1942, as Captain. At the time of his release in November 1945 he was a Lieutenant Colonel. He was awarded the Legion of Merit for his work with the Chief Signal Officer, and received the Bronze Star Medal for feats performed during his tour of duty in the Pacific under General MacArthur. He returned from his civilian expedition to Manila and Tokyo last April, and is now circuit layout engineer at Long Lines' New York headquarters.

The account of the many ways in which the Bell Telephone Laboratories contributed to Allied victory, which was begun in the preceding (Winter) issue, is concluded with the article beginning on page 116. Since these paragraphs are largely a compilation "from the record," their author may be identified most conveniently as that prolific and frequently quoted authority, Anonymous. The Editors



Eldon Nichols

Utility in a setting of peace and beauty: one of the joint Army-Navy radio stations on Guam. *See "Command Circuits," beginning on page 101*

Nearly 1,500 Former Employees and 700 Other Veterans With Service-incurred Disabilities Are on the Job with Bell System Telephone Companies

Putting Disabled Veterans Back to Work

Lawrence L. Armantrout

LET'S TAKE three instances, by way of illustration:—

The Kraut artillery had the range, and when the American tank started to cross the bridge they blew it off and into the water, where it lay partly submerged. Because it was under fire, the crew could not be rescued until darkness fell. Wounds and exposure caused injury to the tank captain's leg muscles which Army doctors rated, when he was discharged, as a fifty percent impairment of use of the legs.

A shell-burst got the infantryman before he could make the foxhole, and messed up his right leg. It had to come off, finally—below the knee. Now he wears an artificial leg.

Jap gunfire never got to a certain Marine during all his service in the Pacific, but malaria did. It was the recurring type, and with it came headaches which at the time of his discharge were rated as incapacitating.

Those three men were Bell System employees serving their country on military leave of absence. Now they are back on the job again, doing good and useful work and happy in the doing of it.

They are cited here because they bring out an important point in connection with the reëstablishment of disabled veterans on the job. That is, the wide variety of situations the telephone companies run into as they work with their returning employees to find the right job for every individual.

Matching disabled veterans and suitable jobs is only one part of the Bell System's general program for placing all returning employees in the right assignment *; but it is a highly important part. Specifically, its major objective is to put the veteran on a job *for which his particular qualifications fit him*—and not merely on a job he may be able to do.

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* See "Welcoming Bell System Veterans Back to Work," MAGAZINE, Spring 1945.

Nearly 1,500 Have Some Degree of Disability

THAT'S THE TARGET. How close to the bull's-eye are we shooting?

Suppose we add up the score so far, and look at the figures.

Up to July 1 of this year, more than 32,000 employees had returned from the Armed Forces to the operating telephone companies of the Bell System. Those who incurred some degree of physical disability while in the service are of course a relatively small proportion of the total: 1,488, or about four percent.

Of that figure, 16 represent amputations; 118, impaired sight or hearing; 421, disabilities involving some restriction of movement; and 933, almost two-thirds of the group, disabilities such as tropical diseases, conditions of the heart or nerves, arthritis, and other ills which, while incurred in the service, are not caused directly by wounds.

That isn't the total reckoning, however. For in addition to welcoming back the 1,488 men just enumerated, the telephone companies have been proud to hire another 689 veterans, not previously employed, who have some degree of disability. Of this group of new employees, 14 have had amputations, and nearly a quarter of them have a disability which causes some restriction of motion.

Statistically, those figures total 2,177. But the statistics are significant only as a measure of the opportunity. What *is* important is 2,177 men, individuals: each with his own problems, his own hopes; each to be placed on the job he can do best.

It wasn't all new to the System—this business of placing disabled employees on work they are equipped to do. The System has been operating for a good many years, and has gained some experience both with men whose disabilities developed in the course of their employment and with men who were employed with some physical impairment.

That experience was sound and helpful; but, the telephone companies realized, it wasn't enough. So, within the general program for welcoming the returning veterans, they set up a special program for the veterans who would return bearing in some form the scars of war.

THAT SPECIAL PROGRAM fell naturally into three sections: *planning, doing,* and *checking.* Let us see what is involved in each.

Planning. The first step was to review past experience in placing employees with physical limitations, to see what could be learned there for future application.

Then came a re-analysis, thorough and detailed, of the physical requirements of the various occupations of the business.

From this could be derived the relationship between various kinds of physical limitations and the kinds of work that could be done with—or in spite of—those limitations.

Then, to corroborate theory, one company fashioned an adjustable device which, when strapped to the body, could produce the effect of physical restriction on various parts of the body. The actual effect of different kinds of simulated limitations was observed on the performance of various types of work operations, and the results of this study were made known throughout the System.

Whatever information was available outside the business was freely consulted. The reports and studies of the Armed Forces, the Veterans Administration, and the War Manpower Commission were found particularly helpful.

Doing. The facts about job requirements developed during the planning phase have been of the greatest practical value to the people who have the actual responsibility for making the assignment of the veteran to the specific job.

No less important has it been to find out the disabled employee's physical capacities, his interests, and the range of his present and potential capabilities.

The employee's *physical capacity to do* can thus be matched against the *physical requirements of several specific jobs,* and the *selection of the particular job* made on the basis of *his particular interests and capabilities.*

Such hand-and-glove fitting is by no means an automatic process. Since we are dealing with human beings—individuals, personalities—and not objects nor statistics, it calls for the closest kind of coöperation between people who do the job assigning, the Medical Department, and people in other supervisory positions.

Out of it comes not just assignment to a job which the employee can do with safety to himself and others, but to a job where he can have the satisfaction of using fully his particular qualifications and of making his most effective contribution to the success of the business.

Checking. Since the process is human and not automatic, the program includes regular follow-up of each man and his job, to see that things go along smoothly: that the adjustment to civilian life and productive employment is made easier for him; that if he needs training, it is made available to him.

This follow-up is the responsibility of supervisors within each department. If a specific problem arises, the solution is found and constructive action taken—with the coöperation, as required, of those responsible for placement and the Medical Department.

Most Men Return to Their Old Jobs

Those are generalizations. It is possible to be quite specific in describing the kinds of jobs in which veterans with disabilities have been placed.

Such matters as this determine whether the program is a success—whether the reality lives up to the intent.

Let's see what the record shows.

Of the 1,488 employees who came back with some degree of disability, more than 1,000 have been returned to the jobs they held before entering the Service, without the need for making any change in the scope of the job or the functions it includes.

In 72 instances, it has been necessary to revise some of the functions of the job or to limit the employee to doing only certain parts of the job. For example, certain disabilities prevent former installers from climbing, although they are entirely competent at every other function of the installer's work. In many instances it has been possible to assign these men to areas where climbing isn't necessary.

New jobs have been found for 314 disabled employees. Most but not all of these re-assignments were necessitated by the inability of the men to do their former work competently and safely. In 90 percent of these instances, the employee's maximum wage rate for the new occupation is the same as or higher than for his old job. In the remaining 10 percent, which have a lower ultimate wage, the companies are making every effort, through special training, to fit the men for assignments which will compare with their old jobs. Up-grading has already been possible in more than half of these instances.

Twenty-four employees have disabilities which have rendered them at least temporarily unemployable. They have been reinstated and placed on disability under the companies' Benefit and Pension Plans. There is expectation that before long some will be able to do productive work.

Adapting the Man and the Job

Assignment to new jobs has been most necessary, generally speaking, in those occupations which require outdoor activity and muscular effort or a good deal of mobility. To a lesser extent, inability to do certain operations requiring manual dexterity has been a factor.

Of the 16 employees who underwent amputations, seven are doing effective work on their old jobs. One man is back at his old job, somewhat revised, at the same rate of pay. Eight have been placed in new occupations, at the same rate or better. Of that last number, here are some examples:

A combination-man lost a leg and wears an artificial one. He was trained and is functioning as a central office repair man.

An installer who lost his left hand was trained and then placed as a plant assigner.

Another installer suffered the loss of the four fingers of his right hand—although the thumb remains useful. He was given special training to develop the necessary dexterity in his left hand, and is now performing all the functions of the installer's job, including climbing, without apparent handicap.

Of the 421 employees whose disability involved restriction of motion of some part of the body, about one-third have been placed on different jobs. Examples of this type of shift:

An installer suffered loss of strength and muscle balance in both legs. For a while he was placed on disability, and subsequently was given facilities assigning work. But his physical improvement was such that within six months he could resume all the functions of his old job—and did.

A house service man's leg was so severely injured that it became immobile. He was given training for and then assigned to a clerical job.

An installer whose back injury brought about restricted bodily motion was first placed in sedentary work as a general clerk; but improvement in his condition made it possible to place him as a line assigner, and there is good prospect of still another job—as a central office repairman.

A construction groundman's injury

resulted in partial paralysis of the right arm. He was re-trained as, and now is, a central office repairman.

A sales manager had his foot badly crushed. But that injury did not affect his ability to do his old job.

Of the 118 employees who returned with impaired sight or hearing, all but 16 have been placed in their old jobs. There were no cases of total blindness and only two of total deafness—and the latter are able to handle their old jobs satisfactorily.

In the largest group—933—whose disabilities included tropical diseases, conditions of the heart or nerves, arthritis, and similar ills, assignment to different jobs was necessary for less than 20 percent. In most instances these involved a necessary change from installation or construction work to jobs requiring less physical exertion.

The 689 newly employed veterans with some degree of disability have all been placed on jobs in which their disabilities present no insuperable handicaps, and so they may look forward to contributing successfully to the progress of the business and themselves.

THE STORY of placing disabled veterans where they will do the very best jobs they can for themselves and their companies is necessarily told here in terms of generalities and a few anonymous instances.

There are other contributing factors to the accomplishment of the program which must not be overlooked.

The attitude of "supervision," from foreman to president, has been constructive and helpful.

All of those who have had the important responsibility for bringing the right man and the right job together have exercised imagination and ingenuity not only in doing that part of the job but in developing special kinds of training when needed.

Fellow employees have contributed immeasurably in understanding and encouragement—both those who have returned sound and whole to their old jobs and those who, because they played their parts on the home front, feel forever indebted to the men who laid down their tools to take up arms.

But the greatest contribution comes from the men themselves. By their eager coöperation in finding the right assignment, their indomitable will to rise above whatever physical limitations they may have, they give the rest of us convincing demonstration that "disability" is not necessarily synonymous with "handicap."

The Sciences and Techniques Which Have Contributed to the Constant Progress of Telephony Had By-products which Culminated in 1926 in Sound Motion Pictures

Twenty Years of 'Talking Movies': an Anniversary

Frank H. Lovette and Stanley Watkins

TWENTY years have now passed since the night of August 6, 1926, when Western Electric and Bell Telephone Laboratories, in collaboration with Warner Brothers Pictures Inc. and the Vitaphone Corporation, gave to the world that by-product of telephone research which has often been called *the living voice of the silver screen.*

That memorable occasion, which the Bell System joins Warner Brothers in observing, was the premiere of the world's first successful commercial sound picture, *Don Juan,* featuring the noted actor John Barrymore. It was preceded by short film presentations of opera stars and musicians—the first time a theater audience had heard the natural tones of music and the human voice from a motion picture screen.

There were distinguished guests in Warner Brothers' New York theater that night—among them a score or more of the scientists and engineers of Western Electric and Bell Telephone Laboratories who had labored for years to perfect the devices which were combined in the apparatus about to receive its first public demonstration. If some of them were anxious, it was understandable: the crucial test was at hand.

Then, as the theater lights were dimmed, symphonic music burst from the screen while the first of the short preliminary features appeared on it: the New York Philharmonic Orchestra playing the overture from Wagner's *Tannhäuser.* Next came Mischa Elman, playing *Humoresque* upon his violin. Roy Smeck, Marion Talley, Zimbalist, and Bauer performed in succession. With a full orchestral accompaniment the noted Metropolitan Opera artist Giovanni Martinelli sang

The big night: August 6, 1926. The first public performance of the first successful sound motion picture on Broadway was an event, as this crowd indicated

the aria from *Pagliacci*. Anna Case, singing in an elaborate Spanish fiesta set, climaxed the prelude.

Before the applause could die away, the dramatic sequences of Don Juan unfolded against their synchronized musical background. Scientists, public officials, prominent figures from many walks of life sat in amazement until the last crescendo and finale of this scientific marvel. The men who brought it into being by their refinement of existing arts were hailed as having made possible "the greatest invention of the twentieth century." And Dr. Michael I. Pupin was led to exclaim that "no closer approach to resurrection has ever been made by science." The pioneers of Western Electric and Bell Telephone Laboratories and their collaborators of Warner Brothers and Vitaphone experienced that night a measure of accomplishment which few men of science ever live to taste or see.

That was the climax, the culmination. The purpose here is to recall the state of the arts as they existed when Western Electric undertook development of sound pictures, and to review the steps by which they were brought to commercial acceptance.

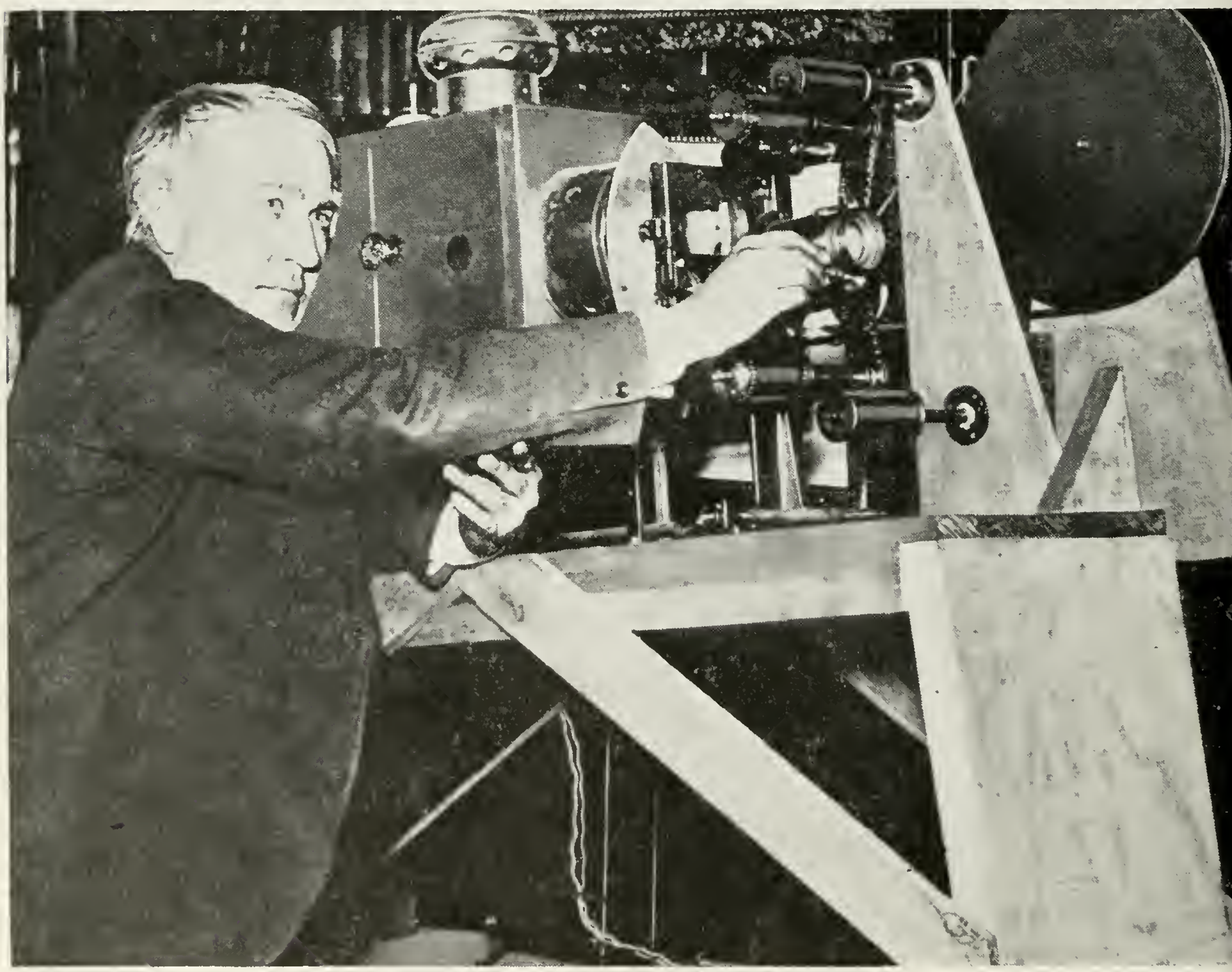
The achievement of a satisfactory technique for recording and reproducing sound synchronized with motion pictures had been a cherished ambition of science for more than fifty years.

Distinguished inventors, engineers, physicists and chemists, men proficient in photography and the mechanical arts, as well as a veritable army of tinkerers, had followed the gleam of that rainbow, but none had found its end. They could not; for, however great may have been the contributions of these earlier experimenters to the advancement of the silent film, they completely lacked five essential elements of the modern talking picture:

1. A high-quality microphone capable of transmitting a wide range of sound frequencies without distortion and of being used at a distance from the performer.
2. A non-distortive amplifier.
3. An electrical recorder and reproducer.
4. A loud-speaker of high quality and adequate capacity.
5. A synchronizing system free from speed variation.

As late as 1912, the science of modern electro-accoustics was yet unborn, and no efficient instrument for the measurement of sound was available.

It was in October of that year that Lee deForest, a former Western Electric engineer who had left the company to pursue a career as an independent inventor in the field of "wireless," submitted to Dr. Frank B. Jewett—then assistant to Western's



Irving Underhill

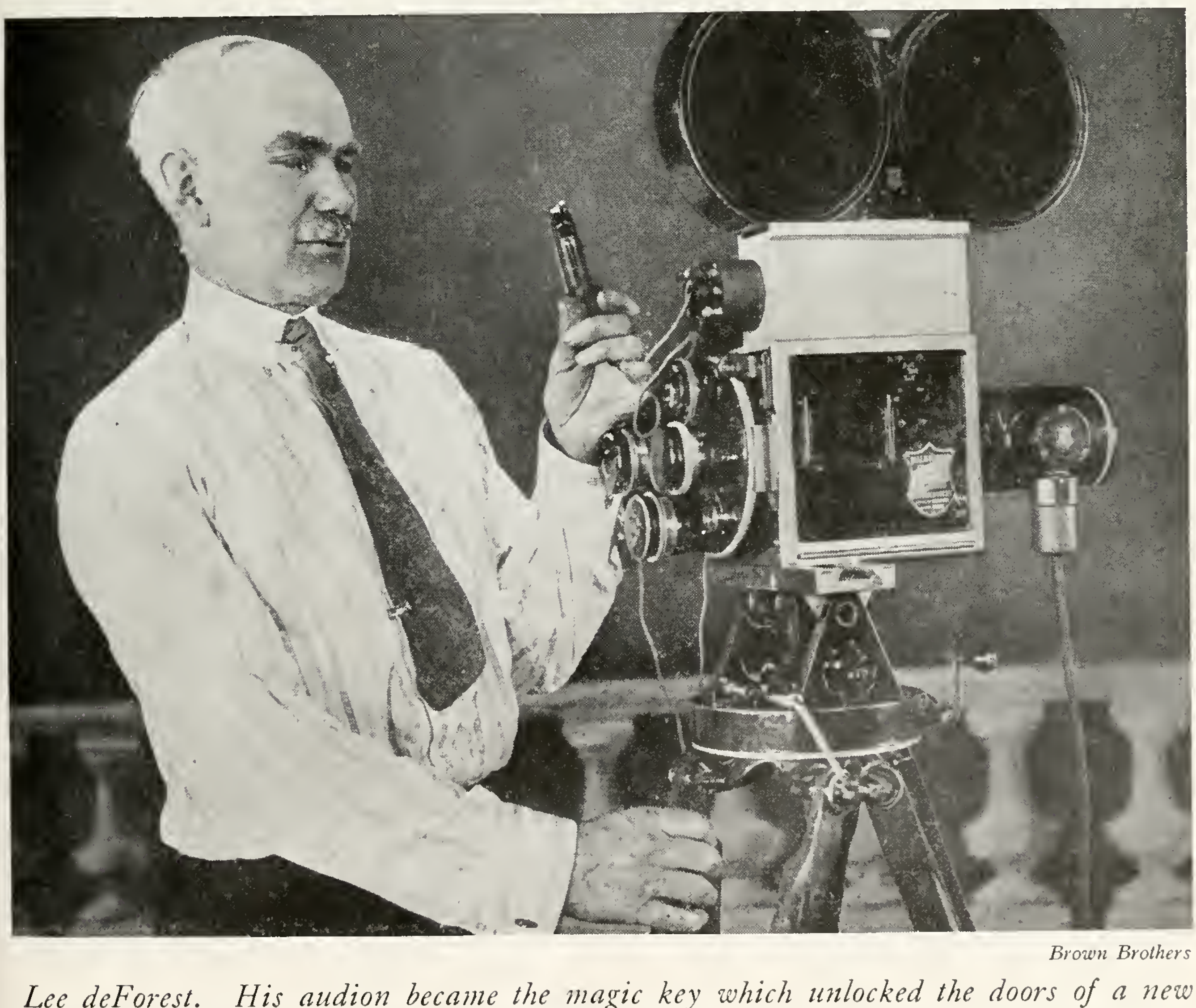
Thomas A. Edison working in his West Orange laboratory in 1905 on the problem of synchronizing sound and pictures

Chief Engineer, Charles E. Scribner—a little device which was to be of momentous importance to the Bell System. It was the "audion," which was ultimately to provide the solution to the System's problem of finding a practicable "repeater" for its long distance circuits.

The development of a satisfactory repeater was a primary objective of telephone engineers in this country and throughout the world. Out of it would come the telephone's final conquest of distance on this earth. So there were hours of intense discussion among deForest, Jewett, and E. H. Colpitts about such things as the audion's capabilities, the tests to which it had already been submitted, its adaptability to commercial manufacture, the proprietary interests of certain others in it, and similar preliminaries.

Finally, it was agreed that the audion should be tested by Bell System engineers. If it performed in accordance with the high hopes of all, Jewett assured deForest that he would recommend its purchase on the basis of terms the inventor had tentatively suggested.

Late that afternoon when deForest said goodbye to his friends at 463 West Street, he left his audion behind him. He did not dream that he had also left the magic key with which a



Brown Brothers

Lee deForest. His audion became the magic key which unlocked the doors of a new scientific age little group of telephone engineers would unlock the doors of a new scientific age.

Jewett had a great ambition to achieve transcontinental telephony, to which an effective repeater would be essential, and one of the young engineers on his staff, H. D. Arnold, was working on the problem.

Soon after deForest left his audion to be tested, Jewett summoned Arnold and showed him the device. The young engineer silently and critically examined the audion while his chief explained its background.

Finally Arnold declared, "It will do it."

He hastened to point out what steps he thought would have to be taken to increase the audion's efficiency. Both the outer circuit leading into the tube and the inner circuit would have to be redesigned. It was weak in output because the chamber had not been completely evacuated, and the higher vacuum could be obtained only with a pump superior to the one deForest had used. Needless to say, Arnold got the assignment to refine and develop the audion.

Although his analysis proved accurate and his 1912 conception had to be altered but slightly, he could not build a high vacuum tube until 1913, when he obtained a satisfactory vacuum pump from Europe. In the spring of that year, the Bell System purchased the audion.

Testing the Audion

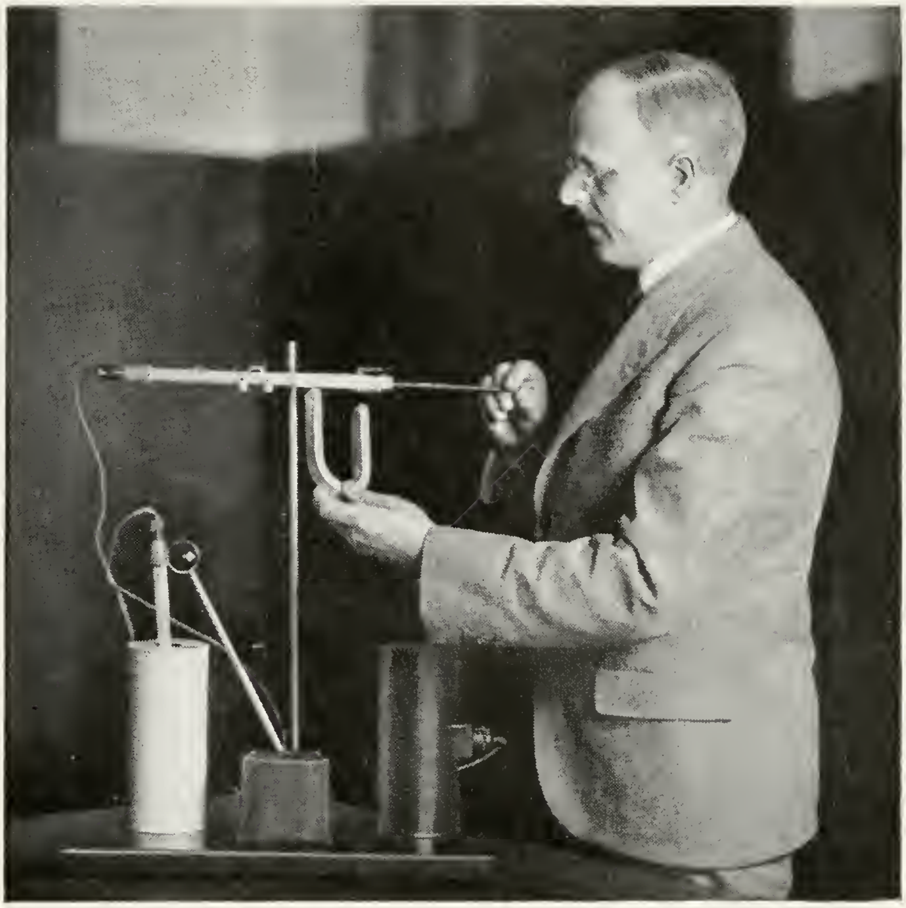
Coincident with the acceptance of the audion came the need for qualified young scientists to augment the existing research staff; for it was evident that the audion was potentially capable of revolutionizing the art of communication, and that its capabilities had to be explored extensively as well as intensively.

The vacuum tube—as the audion had now become—had to be tested on long lines and short lines. Its components had to undergo scores of laboratory tests. Research had to be conducted in more than one hundred particulars.

During those exciting and busy months in the Western Electric Engineering Department, Jewett, Colpitts, E. B. Craft, Arnold, I. B. Crandall and their associates decided to record sound for its use as a laboratory tool. Transcontinental telephony would require much more than just a first-class repeater. Higher quality transmitters and a wide variety of associated apparatus had to be designed. Much of it might be tested and compared by use of acoustical recordings. The recordings would also serve to help appraise successive developments of the vacuum tube and demonstrate its performance as an amplifier.

This new approach to achievement of improved transmission, together with these original and fundamental studies of sound, marked the beginning of the science of electronic amplification.

Talking pictures were not contemplated by the engineers initiating these fundamental studies of sound. However, they believed it imperative to obtain recordings of higher quality than those available by the commercial processes of the contemporary phonograph industry. They decided, therefore, to experiment with the recording of sound upon film (an old but non-commercial laboratory art) while simultaneously seeking to im-



Harold D. Arnold. His development of deForest's audion into the high-vacuum tube met the Bell System's pressing need for a practicable repeater for its long distance circuits

prove the wax disc method of recording.

The broad scientific attack projected by this program contained a great variety of complex elements. After the fashion of a modern military invasion, the generals and their subordinates had to divide and sub-divide their respective responsibilities.

While Arnold attacked the audion, other Western Electric engineers, using an improved microphone and a Duddell Oscillograph, recorded sound upon film in the winter of 1912-13. These first recordings were of the variable area type.

Early in 1913, H. A. Frederick began work upon instruments for transmission of music, and soon thereafter the engineers Crandall and Kranz began construction of an electro-magnetic phonograph reproducer. Experiments were continued with both film and disc. Most of these engineers pursued uncharted pathways. Their original notebooks, still preserved, reveal the minutely detailed and frequently dramatic results of this research.

Improving the Microphone

Meanwhile, a number of young engineers had been welcomed into Western Electric's Engineering Department: alert, ambitious youngsters, eager to put their university-acquired knowledge to practical use. Among these newcomers was Edward C. Wente, who arrived in 1914.

When young Wente had been there a few months, he was given a microphone by Arnold and Crandall. It was the highest quality electro-magnetic transmitter known to telephone engineers; it represented the cumulative

DeForest's audion as submitted to Dr. Jewett in 1912 (left), and the high-vacuum tube developed in 1913 for the first telephone repeater

effort expended in this field since Bell's invention of the telephone. His superiors explained to Wente the nature and extent of his first major assignment. The microphone had to be made capable of transmitting music, and this required its development to a hitherto unattempted quality. The frequency range of music was wider and its loudness range much greater than that of speech. One obstacle to constructing such a microphone was the lack of any available means of accurately measuring its performance.

About the time Wente was ready to consult Arnold and Crandall concerning the feasibility of a device he had conceived for microphone calibration, he found them too busy to help him. It was late in 1914, and 463 West Street was suddenly plunged into a whirl of activity and excitement. The vacuum tube repeaters were working on the long lines to Denver. Soon came the tests between New York and San Francisco. The new repeaters worked with equal effectiveness!

The high-vacuum tube was just getting started on its triumphs. On September 29, 1915, Bell System engineers provided a world sensation by transmitting human speech between Arlington and Honolulu. Less than one month later, on October 20, 1915, this feat was duplicated between Arlington and the Eiffel Tower in Paris. Telephone engineers had registered a scientific achievement which was hailed as one of the most important in history.

The New Repeater Succeeds

THE AUDION had started the whole program, and no one concerned was more elated than deForest. In a paper afterward for the Franklin Institute, he referred to the Western Electric engineers as follows:

The developments by the engineering staff of the Western Electric Company of the audion amplifier as a telephone repeater, since my first demonstration to them of its possibilities in that field, are beyond all praise. The zeal and rare understanding of the elements of the problem with which this staff of trained men developed *the amplifier and applied it to the long-sought trans-continental telephone line stand unique in the annals of brilliant achievement in electrical engineering.*

THE TRANSCONTINENTAL and transoceanic conquests accelerated telephone research in all its subdivided fields. When Wente presented his case for the need of a microphone-calibrating instrument to Arnold and Crandall, they aided him in the design and construction of it. This instrument, called the thermophone, permitted accurate measurement of microphone performance for the first time.

Until then, the microphone had been the source of power, and therefore it had to be designed for the highest possible efficiency. The power from the microphone had to be sufficient to provide electrical impulses of enough strength to produce the required volume when the electric current was translated into sound at the receiver.

Arnold's high-vacuum tube amplifier made it possible to sacrifice efficiency for the sake of quality. Accordingly, Wente concentrated upon a microphone which would give uniform response at the various pitches in the audible range. His thermophone permitted quantitative measurements at each individual pitch. By 1916 he had developed the condenser microphone. It gave uniform response up to more than 15,000 cycles, and left little to be desired from the standpoint of quality. Both his thermophone and condenser microphone were adopted as standard by the International Reference System for Telephony located in Paris. For his condenser microphone he received the John Price Wetherell medal of the Franklin Institute. In an

E. C. Wente. His condenser microphone was one of the foundation stones on which sound motion pictures were built article published in the *Physical Review* in 1917, Wente pointed out the advantages of his condenser microphone for recording sound upon film.

Accomplishments of Four Years

DURING Wente's early research, the recording of sound was receiving a fresh impetus from the success and future possibilities of the high-vacuum tube.

In June 1915, Arnold suggested making phonograph records with a high-quality transmitter and amplifier, pointing out the exceptional results which had been obtained by use of the Frederick transmitter in conjunction with a vacuum-tube amplifier during transmission tests between Denver and New York. Crandall and Kranz had used their electrical reproducer experimentally in 1914. By 1915, superior electrical reproducers were in use with phonograph records, but the records themselves had not been made electrically; in other words, not by a method employing a high-quality wide-frequency-range microphone and amplifier.

On June 24, 1916, Crandall reported to Colpitts that one of the engineers in his group had made recordings of sound on film by the variable density method. They were of such surprising quality, he concluded in his written report: "I see no reason why a method for producing talking pictures of fair quality cannot be developed."

Thus, by 1916, Western Electric engineers had:

1. Refined the audion into the high-vacuum tube. (1913)
2. Given the vacuum tube its first commercial application by opening transcontinental telephone service. (1915)
3. Demonstrated trans-Atlantic radio telephony between Arlington and the Eiffel Tower. (1915)
4. Recorded sound on film by the variable area method. (1912-13)
5. Recorded sound on film by the variable density method. (1916)
6. Constructed improved electrical reproducers for the wax-disc phonograph. (1914-15)
7. Developed the condenser microphone. (1916)

In less than four years of coöperative research, Bell System scientists had produced this impressive array of engineering achievements. Modern talking pictures beckoned at the threshold. The prospect was tempting to those who had journeyed so far in that direction. But the crossing of that threshold suddenly was made quite impossible because the awful specter of World War I hung darkly over American shores. In that same year, 1916, the Bell System was called upon to arrange a vast mobilization of the nation's major communications facilities. The military preparedness program began. Not until the war was over was it possible to devote further research to the electrical recording and reproduction of sound.

Post-War Projects

WHEN THE Western Electric engineers were able to return to telephone research, their fundamental studies of sound were resumed under Dr. Jewett's guidance.

Arnold and his assistants inaugurated a score of projects involving the vacuum tube — which, incidentally, had come a long way during the years of war. Wente resumed his work upon the condenser microphone and, together with Crandall and others, conducted a new experiment in the recording of sound on film. At this same time another group, headed by J. P. Maxfield, undertook improvement of the technique of recording on wax discs.

E. B. Craft had been associated with development work since coming to Western Electric in 1902. Now that he had become one of Dr. Jewett's assistant chief engineers, he proved a stimulating factor in expediting and coördinating the various research projects. A high-quality public address system became one of his first objectives. The condenser microphone and vacuum-tube amplifiers and receivers, already devised by Western's engineers, needed little more than proper adaptation and redesign for commercial purposes to make such a public address system possible. The so called "loud speakers" were in reality loudspeaking telephone receivers.

Developments in Loud Speakers and Recording Sound

Within a few months after the return of peace, a public address system was a laboratory reality. But the system of 1919 was not sufficiently free from distortion. By 1920 it was greatly improved; and in March 1921, 125,000 persons clearly heard every word of President Harding's inaugural address through the Western Electric public address system.

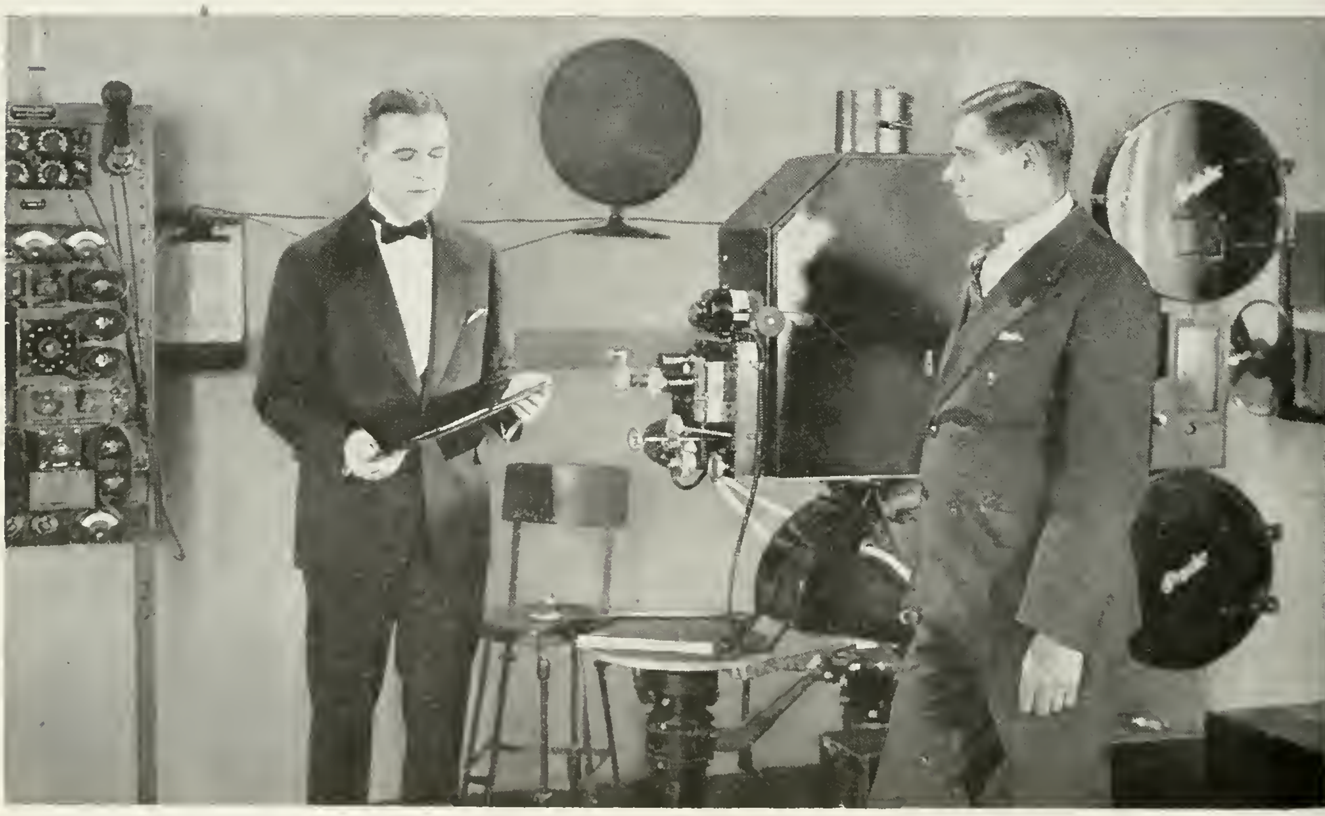
Eight months of improvement and experimentation made possible the

J. P. Maxfield (center), whose group developed electrical sound-on-disc recording which was used in the musical scoring of Don Juan, and is still used throughout the phonograph industry. With him are H. C. Harrison and D. G. Blattner use of the public address system in connection with long distance wires. President Harding's address of November 11, 1921, at the burial of the Unknown Soldier at Arlington, epitomized one of the most significant ceremonies in American history. His words were transmitted through the public address systems at Arlington and—via long distance circuits—to audiences at Madison Square Garden and the adjoining park in New York and the Civic Auditorium and Plaza at San Francisco. More than 150,000 heard the address: the greatest audience that had ever listened to a single speaker.

Another great stride toward sound pictures had been accomplished.

During the previous year Wente had been working on the recording of sound upon film by the variable density method. The 1912-13 recordings upon film had been by the *variable area* method. Those of 1919 were made by the *variable density* method. The two methods have been briefly summarized as follows:

"In *variable density* recordings, the motion picture film is moved at right angles to a narrow slit, mechanical or optical, through which over its whole length there falls upon the film a light varying in intensity with the sound pressure to be recorded. In *variable area* recording, there is a like slit, but what varies with the sound pressure is the length of the part of the slit through which a constant light reaches the film. When completed, the *variable density* record viewed lengthwise looks like a ladder with rungs spaced according to the pitch and darkened according to the loudness of the recorded sound. The



E. B. Craft (left) making a sound picture for demonstration, at the Vitaphone Studios in the Manhattan Opera House in 1926. He exhibited the first electrically recorded sound picture in 1922 *variable area* record, viewed from the edge of the film, looks like a hedge with uneven trimming, having peaks and pits corresponding in height to the loudness and in spacing to the pitch of the sound recorded."

Upon first undertaking the variable density method, Wente considered various devices which had been proposed. It appeared to him that the method being used in that year, 1920, by Professor Rankine of England, for speech transmission over a light beam might provide the most correct film exposure. He made certain modifications of the device and constructed an instrument of similar type. The quality of his recordings compared favorably with that of the commercial phonograph records, but that did not satisfy Wente or Arnold. Wente finally concluded that the method did not permit correct film exposure. His next step was to devise the new and improved light valve in 1921-22. The device gave ample exposure even at high camera speeds, and removed the biggest single stumbling block to the successful recording of sound on film by the variable density method.

Since the war, Wente had devoted a part of his time to improvement of his condenser microphone. By 1923 it was about 100 times more sensitive than his first condenser microphone of 1916; and either the condenser microphone, or a high-quality carbon microphone employing a method of damping of the diaphragm discovered in the development of the condenser transmitter, was in use in public address systems and from the beginning in all the important radio broadcasting stations.

A Momentous First

In 1922 Western Electric stepped up commercial production of microphones, vacuum tubes, public address system units, and various types of radio apparatus. The infant radio broadcasting industry developed a lusty voice. The American public was rapidly being captivated by the new entertainment art.

Craft now decided to step in front of the field by producing a talking motion picture. The group under Maxfield, using the new condenser microphone and improved vacuum-tube amplifying devices, had developed electrical recording by the wax-disc method to a greatly advanced stage.

Accordingly, Craft produced the first electrically recorded talking picture, which employed the new method developed by his engineers. It was exhibited in October, 1922, at Woolsey Hall of Yale University in New Haven.

This picture itself was accompanied by a transcribed lecture which explained the audion. The recorded voice of the speaker came from the screen with so natural a quality that the assembled students and scientists suspected a hoax. All were amazed when the recorded speaker, a Western Electric engineer, appeared upon the stage while his recorded voice came from the screen.

Improvements in Techniques

The New Haven success inspired Craft to produce "Hawthorne," a picture with sound on disc portraying Western Electric's rôle as the manufacturing unit of the Bell System. This, the first industrial sound picture, was shown at the Hotel Astor at a dinner given by Western's President, Charles G. DuBois, to 250 Bell System officials on February 13, 1924. The apparatus had been notably improved since the New Haven demonstration and now included an automatic synchronizing system in place of the manual method used at New Haven. Synchronization of the phonograph with the motion picture was not new, but the problem of designing a synchronous drive free enough from speed variations to be used with the high-quality electric records was a tough one. It was overcome by the groups under H. M. Stoller, H. Pfannenstiehl, and Maxfield.

A dominant factor in the solution of the drive problem was the mechanical filter developed by H. C. Harrison. He developed the high-quality disc reproducer, and also the "rubber-line recorder" which became the standard for high-quality disc recording. These devices represented an entirely new method for handling mechanical problems by the analogous electrical transmission techniques. The Harrison contributions to the development of talking pictures were outstanding.

The Orthophonic Phonograph

MEANWHILE, another portion of Maxfield's group determined better methods of controlling acoustics during sound pick-up by practical applications of methods learned from the use of the Western Electric public address system and from analysis of studio design and sound pick-up at the A. T. & T. radio station, WEAF.

Thus, early in 1924 Western Electric had a phonograph and recordings, in the laboratory stage, which reproduced speech, song, and instrumental music with fidelity and hitherto-unexampled tonal beauty. Many who heard it, including Thomas A. Edison, left the demonstrations with praise which ran to superlatives.

That same year the new method of electrical recording and reproduction was demonstrated to both the Columbia and Victor phonograph companies. After Columbia and Victor had experimented with the new method for several months, the so-called orthophonic phonograph came into being; it included an ingenious six-foot folded logarithmic horn within a phonograph cabinet. Both Columbia and Victor were licensed by Western early in 1925 to use the new method.

Recording Sound on Film

DURING the developments leading up to the orthophonic phonograph, other Western engineers steadily advanced the art of recording sound on film.

Donald MacKenzie's studies of photographic emulsions and the treatment of film had commenced in 1922.

In 1923, equipment was devised for synchronizing the film recorder and motion picture camera by means of an electrically operated gearing.

In that year Wente and MacKenzie made broader studies of emulsions, the problem of printing positives from negatives, amplifiers, the characteristics of light-sensitive devices, acoustics of recording studios, and microphone placement for sound pick-up.

In May 1923, Maxfield's group was making synchronized talking pictures with local talent speaking, singing, and playing musical instruments. In October 1923, a synchronized picture and sound-on-film recording was made and exhibited to members of the laboratory. In November 1923, a one-act

"Cutting a disc" in 1926. The apparatus at the left is engraving sound vibrations on a wax disc, duplicates from which will be played in synchronism with a film

sketch was similarly photographed and recorded.

By March 1924, MacKenzie concluded that better results would be obtained in recording sound on film by using a positive emulsion instead of the high-speed negative emulsion employed up to that time. The motion picture industry was then using a relatively coarse-grained negative emulsion of great light sensitivity and consequently of great speed.

The development of Wente's light valve, with its ability to modulate a light of relatively high intensity, enabled use of a much finer grained emulsion and lower speed, thus obtaining a sound record of improved quality and frequency range with much less background noise. The recording on positive emulsion was later to become standard practice in the motion picture industry.

It will be seen that co-incident with mastery of the art of sound on disc, Western Electric's engineers had also by early 1924 solved the basic problems of recording sound on film. The quality of the sound reproduction obtainable from the two methods was about the same. But the disc method was an improvement of an old commercial art and had the immense advantage that the processes for preparing, handling, and duplicating the discs were well known; while for processing sound-film, an entirely new technique had to be introduced into the film plants, involving changes in the method of developing and printing the pictures themselves.

This situation, coupled with a prospective dual commercial outlet for musical recordings from motion picture productions, predetermined the use of disc recording in the introduction of sound pictures.

A few of E. B. Craft's advisers urged immediate commercialization of the Western Electric sound picture system in 1924. He declined, preferring to await more rigid tests of the equipment in actual or simulated commercial operating conditions. He well knew the difficulties which had been encountered in previous attempts to introduce talking pictures.

Noteworthy attempts to produce commercially acceptable sound motion pictures had already been made by these individuals and organizations:

By synchronism of phonograph and projector

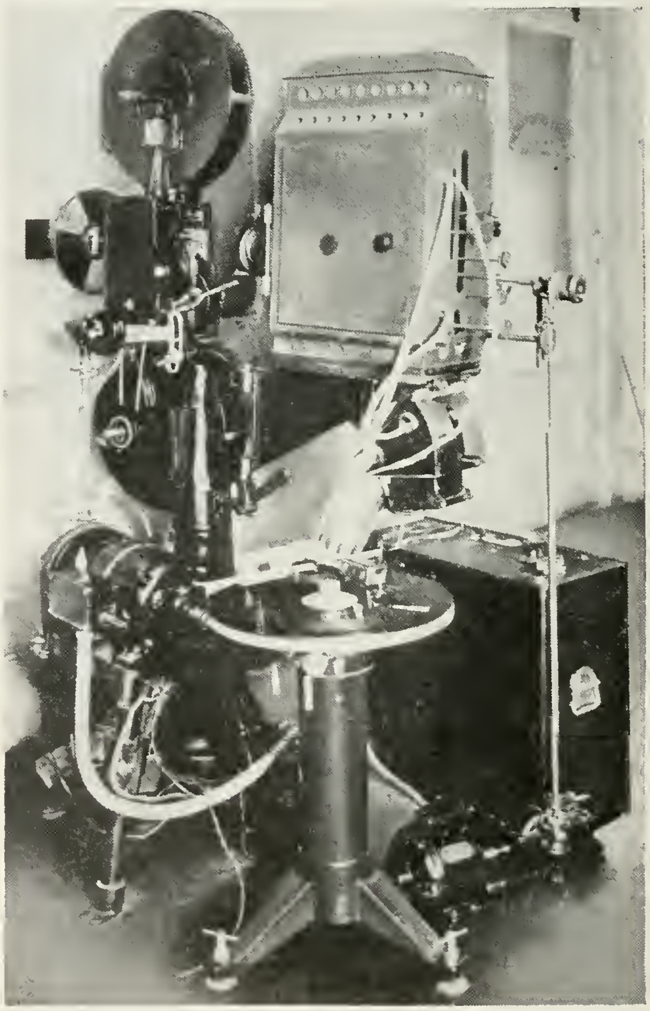
Thomas A. Edison..... U.S.A. and Europe
Pathé Frères......... France and U.S.A.
R. and E. Singing Picture Company. U.S.A.
(J. B. Russell Muselaphone System)
Webb Talking Pictures.......... U.S.A.
(J. B. Russell Muselaphone System)
Cartella Talking Picture Machine Company .... Italy and U.S.A.
(Western Electric receivers and transmitters)
C. H. Verity Talking Moving Picture System .... U.S.A.
(Veritiphone)
Leon Gaumont .... France
Orlando E. Kellum .... U.S.A.

By sound on film

Eugene Lauste... France, England, U.S.A.
Tri-Ergon Corporations
Europe and U.S.A.
Lee deForest....... U.S.A. and Germany

During this testing period, Craft decided to produce a series of musical shorts with professional talent. An exciting period followed. Individuals with motion picture backgrounds, inventors, actors, musicians, promoters, and many others found their way to 463 West Street. Those who reached Craft or his assistants volunteered a thousand varieties of advice and service. Some were admitted to demonstrations. A few made helpful suggestions.

Craft told all who sought to commercialize the apparatus or to effect a Hollywood tie-up that Western Electric would consider any reasonable proposal. He promised to try to protect the interests of any who aided Western Electric in commercializing the apparatus. But to all he declared the Company desired to make the



"The Works." Said a Western Electric announcement of the time, "This projection machine gives a motion picture audience both visual and audible entertainment . . . Absolute synchronism of film with reproduced sound having a naturalness never before attained . . ."

apparatus available to the entire motion picture industry. He therefore favored a responsible intermediate agency capable of performing that function.

Authentic representations were made as to the superiority of Western's new sound picture technique, and offers for its commercialization were vigorously solicited. But by the end of 1924 practically every major producer in Hollywood had rejected Western Electric's sound picture system.

Obstacles to Commercial Use

THE WESTERN ELECTRIC engineers were not discouraged by Hollywood's indifference. Behind it lay valid reasoning.

The motion picture producers had large inventories of silent films, which had cost millions to produce. They had great numbers of actors and actresses under long term contracts, most of whom knew no dramatic technique except that of pantomime. The industry was universally equipped with stages and studios suited only to the silent film technique.

Moreover, world-wide foreign markets had been established for silent films. To serve these markets, it was merely necessary to translate the words printed upon the film from English to any language desired. Finding stars and supporting casts who spoke the various languages of the world, or finding ways to give the illusion of their speaking them, appeared to be an insuperable task.

The art of the silent film had attained superb quality and the public was satisfied. Why then, producers asked, should Hollywood scrap the bulk of its assets, undertake staggering conversion costs, and force upon the public a new and doubtful experimental art?

Nor were the exhibitors equipped for sound. Many, it was argued, would not be able to meet the cost of sound picture equipment.

These rebuffs had no effect upon the zeal of Craft and his associates, and they continuing to carry on their work after the Western Electric Engineering Department was incorporated as Bell Telephone Laboratories at the end of 1924.

AN ALTOGETHER fortuitous visit of a Western Electric field engineer to the Laboratories at 463 West Street determined the immediate future of sound pictures.

One day early in 1925 Nathan Levinson, Western's radio specialist from the Pacific district, arrived at the Laboratories to familiarize himself with the newest developments in radio and public address equipment. Levinson had aided Samuel L. Warner in the purchase and installation work of radio station KFWB, established by Warner Brothers a short time before at Los Angeles. He had worked in close relationship with Sam Warner, and their collaboration had led to a warm friendship.

During his visit to West Street, Levinson attended a sound picture demonstration provided by Maxfield, and saw one of the musical shorts Craft had produced in 1924.

The film began with a pianist entering a studio. Levinson heard the natural sounds of his steps; he heard clicks as he unbuttoned his gloves, the realistic sound when he tossed aside cane, hat, and coat. Then the performer sat down and commenced to play. The music of the piano flowed from the screen with startling reality.

Levinson was an astute engineer who knew sound. What he now saw and heard was to him genuinely thrilling. His face shone with admiration when the lights were turned on, and he pronounced it wonderful. Before he left the studio, his active brain was formulating a plan to bring Sam Warner to West Street.

A few weeks later Levinson visited Sam Warner in Hollywood.

He told Warner he thought the Western Electric Company had the complete solution to the sound motion picture. He declared that the synchronization and quality of the demonstration he had witnessed were so striking that he was confident that an organization with the facilities and technique of Warner Brothers, working with Bell Telephone Laboratories' engineers, could produce such colorful productions as *"Rose Marie,"* the record-breaking musical comedy hit then on the New York stage. The great musicals of Broadway, world-famous orchestras, grand opera, and kindred entertainment luxuries of metropolitan centers could be taken to Main Street and the rest of the world by means of sound pictures.

Sam Warner assured Levinson he would accompany him to a demonstration on his next visit to New York.

"The Greatest Thing in the World"—Sam Warner

WESTERN ELECTRIC had by this time invested heavily and over many years in sound picture development. It was felt that decisive steps should now be taken to make the system available to the motion picture industry. Walter J. Rich of New York was a highly recommended applicant who proposed organization of an intermediate corporation to commercialize sound pictures. On May 27, 1925, Western concluded a limited contractual agreement with Rich for that purpose.

Levinson arrived at West Street with Sam Warner early in June. The best description of Sam Warner's reaction to the demonstration is to be found in the telegram he sent to his brother Harry after he had returned to Hollywood without telling any of his brothers what he had seen and heard. That telegram read:

GO TO THE WESTERN ELECTRIC COMPANY AND SEE WHAT I CONSIDER THE GREATEST THING IN THE WORLD.

Harry went. His report of the visit was a telegram to his brother Sam. It read:

I THINK YOU ARE RIGHT.

On June 25, 1925, Walter J. Rich and the Warner brothers made an agreement under which Rich assigned to Warner Brothers a half interest in his contract with Western, Warner Brothers agreeing to furnish the motion picture studio, associated equipment, and necessary personnel for an experimental program.

FOLLOWING this contract, Western's equipment was installed in Warner Brothers' Vitagraph studio in Brooklyn. In the experimental period, which lasted several months, the Bell System engineers worked in close collaboration with staff men of Warner Brothers. When all parties to the experimental arrangement were convinced that results justified commercial effort, Rich and the Warner brothers organized the Vitaphone Corporation. On April 20, 1926, a license agreement between Western and Vitaphone was concluded. The Vitaphone Corporation was authorized to sub-license the various producers in the motion picture industry.

Warner Brothers thereupon staked their all upon the Western Electric sound system. The Manhattan Opera House was leased for the scoring of Don Juan and the making of various specialties for the premiere.

The premiere of Don Juan was widely heralded. Warner Brothers' New York theatre had been selected for the great first night of sound. Western Electric engineers and helpers worked for weeks installing the necessary equipment.

Meanwhile, Wente and A. L. Thuras, who had been working on a new type of loud-speaker, were able to complete its development in time for the Don Juan premiere. The new speaker had a practically uniform response from two octaves below middle C of the piano to about one-half octave above the highest note. It was from 50 to 100 times as efficient as the loud-speakers previously available. This contribution by Bell System engineers, one of whom had worked almost 12 years on the basic elements comprising sound pictures, helped insure the success of that great first night whose anniversary is now being observed: that first night whose history has been recounted here.

Climax and Beginning

DON JUAN was the climax of the Bell System's part in the *development* of sound motion pictures; but it was only the beginning of the art and the industry which have grown from it and in which Bell Laboratories and Western Electric have continued to play an important part.

Much has happened since: the op-

Western Electric equipment was installed in the old Manhattan Opera House to record the sound for the Vitaphone premiere—notably the scoring of Don Juan. This photograph shows a lull between "takes" of an operatic "short" in which Anna Case sang and the Cansinos danced

On Broadway in 1926

position to sound films by both producers and exhibitors, which in 1928 suddenly reversed itself and became a tremendous demand for equipment; the increasing adoption of the sound-on-film method of reproduction, which is practically universal today; the modification of arrangements with Warner Brothers and Vitaphone, and the establishment of Western's subsidiary, Electrical Research Products Incorporated, in 1926 to handle the Company's activities in the sound picture field; ERPI's withdrawal from the theater equipment field in 1937 when it licensed other manufacturers; and the further change when in 1941 it became a division of Western Electric; the growth to more than 16,000 sound-equipped theaters in this country today and to nearly three times as many in the rest of the world at last count.

Those and many other facts are matters of recorded history; but the history of the last 20 years is beyond the scope of this narrative.

WHAT is set down here is but a salute to the pioneers of the industry: to the scientists and engineers of Western Electric and later of Bell Laboratories, whose recognition and development of certain telephone by-products gave the world one of its most popular forms of entertainment; and to the Warner brothers—Sam, Harry, Albert, Jack—and their associates, who had the vision and the courage to become the first producers of commercially acceptable sound motion pictures. Together they shared a rich experience.

Multi-channel Radio Teletypewriter Circuits Developed by The Bell System and the Signal Corps Were the Backbone of Army Communications with Theaters Overseas

Command Circuits

Eldon Nichols

In the Pentagon Building a Signal Corps technician stands before a steel table. In his hand is a paper tape on which is printed an official radiogram. Beneath the printed letters there are small holes to actuate a machine which is blind but has sensitive fingers of steel. The technician inserts one end of the tape in a slot, and it rapidly disappears. At the same moment a similar tape, bearing the identical printed message, emerges from another slot at Frankfurt, Germany. This is only one of six messages speeding on their way to Frankfurt, and six others are arriving simultaneously in Washington from there. In all, 720 words are crossing the Atlantic every minute between these two points, over one radio circuit.

From nearby tables, messages are making similar flights to London, Paris, Algiers, and Asmara; and from those points some of them take off again for Tehran, Moscow, New Delhi, and Chungking. Other messages take wire lines to San Francisco and then jump directly to Hawaii, Manila, or Tokyo.

Obviously, there is more to this than meets the eye. The little machine that snatches paper tape from the hand of the operator is merely a gateway leading into a complex array of telegraph, telephone, and radio devices collectively known as a multichannel radio teletype system. This system did not exist before the War. It was born in December, 1941, and grew to maturity within a few short months. Before its first birthday it had become the backbone of the vast network of overseas radio circuits of the Army Communications System.

Over this system flashed the words which General Eisenhower impatiently awaited—the words which released the flood of American might that ultimately washed over the Westwall and into Berlin. And over this system General MacArthur received the green light for the fulfillment of his two great ambitions—his return to Manila and his entry into Tokyo as Supreme Commander.

The main radio transmitting station in Algiers. Directional antennas beamed toward it were ready for the invasion of North Africa

Radio's Advantages

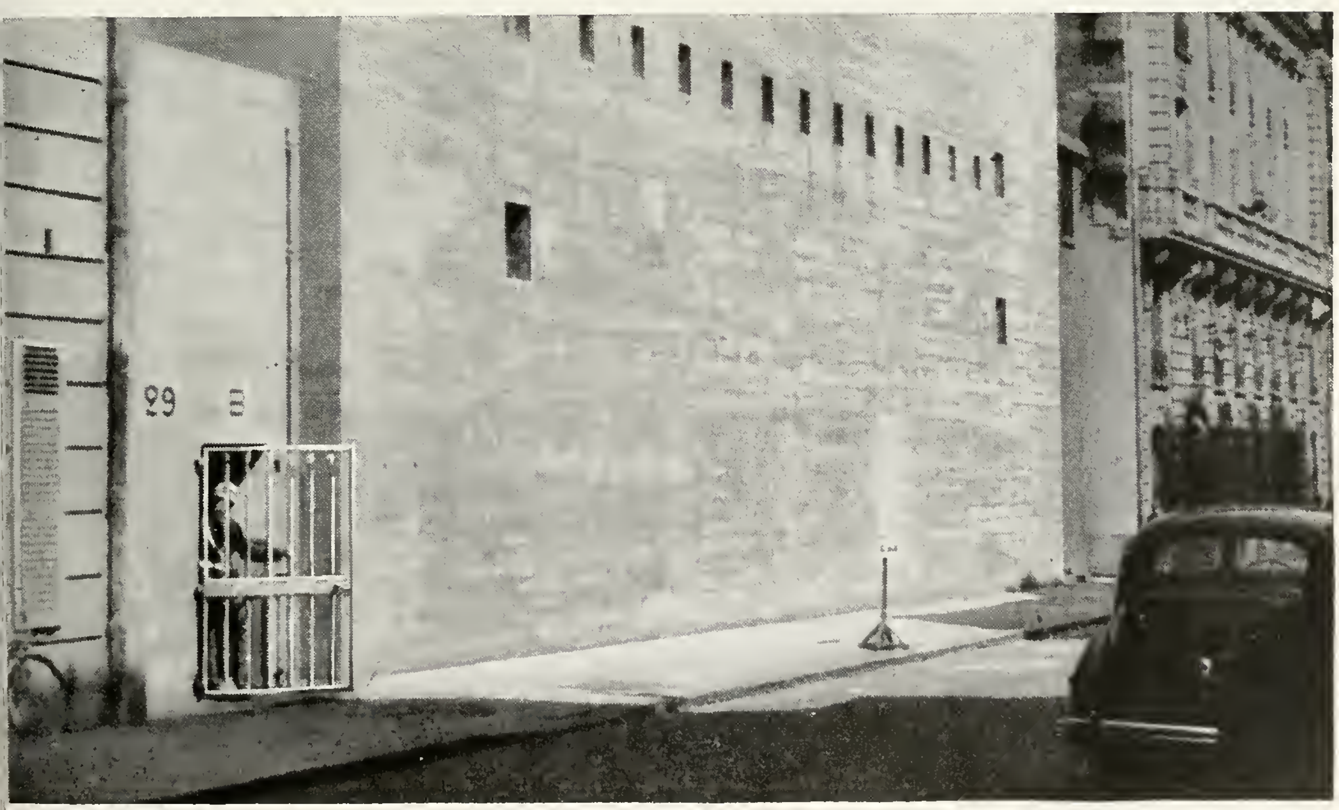
SUCH MESSAGES as these, of course, formed but a small part of the almost incredible total of fifty million words a day carried by the great Army network. There were requisitions for urgently needed supplies, manifests detailing the cargoes of ships, reports of military operations, news items from home for the Stars and Stripes and the Pacifican, and all too often there were long casualty lists. All of these messages were essential to the successful conduct of the War—and it is inconceivable that they could have been handled without radio teletype.

Radio was chosen as the principal medium for overseas war communications because of its mobility. Submarine cables normally carry the bulk of the telegraph traffic over a number of important routes, such as between the United States and England. In wartime, however, cables are at a disadvantage except when they connect allied nations in areas where the enemy is not in a position to interrupt them. The invader can seldom count on them as a means of communication with his bases in the rear because his stepping-stones are often places of little peacetime importance which are not reached by cables. And if there happens to be a cable terminal in the invader's path, it is usually destroyed before he reaches it. It takes much time and skill to lay a new cable or to repair an old one, and in waters within the range of enemy aircraft or submarines such work is likely to be both costly and uncomfortable.

FOR THESE REASONS, radio was the more practical medium in most situations confronting our forces in World War II. But radio has its shortcomings too, and some of these had to be surmounted before it could take the leading role.

Before the War, radio messages

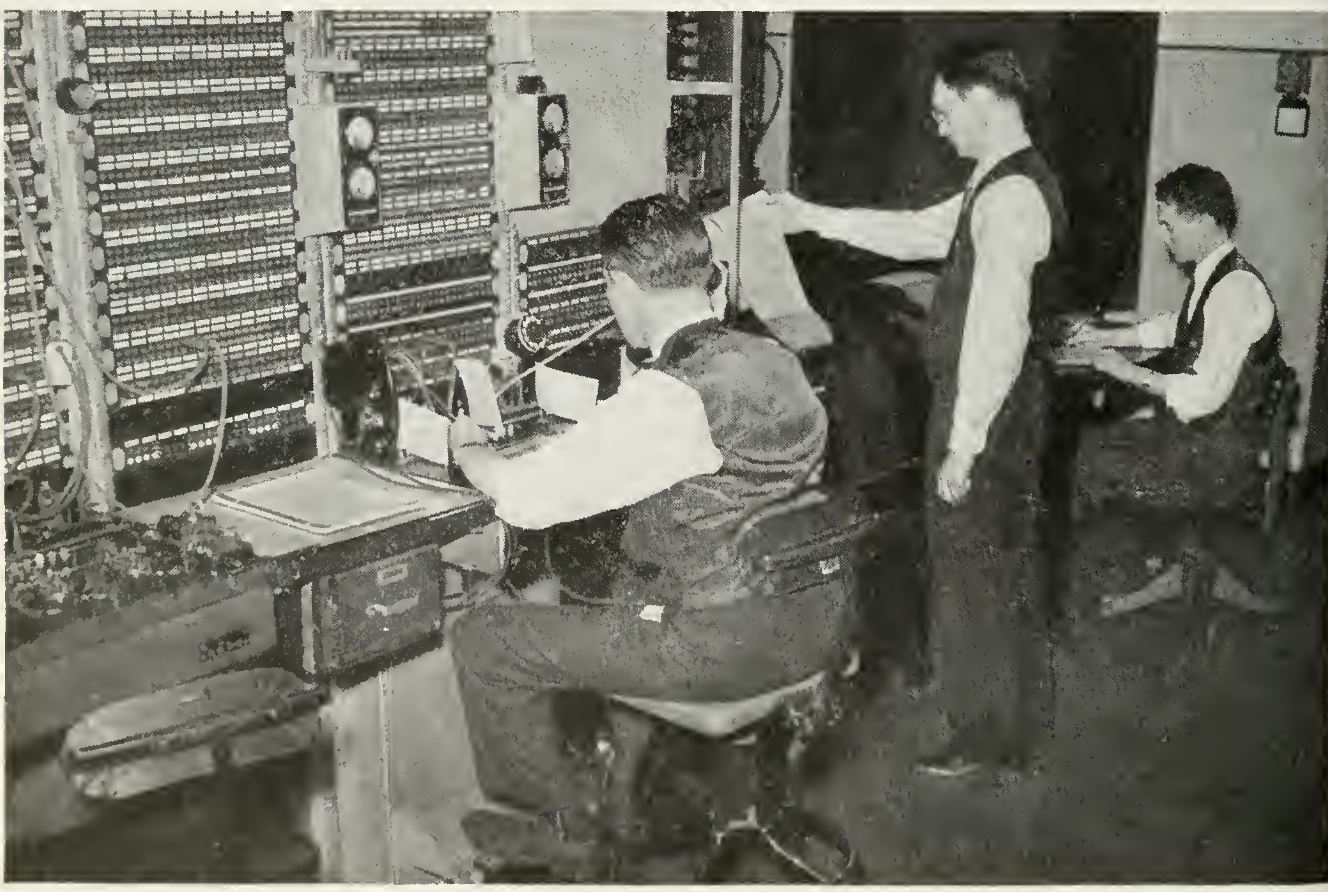
In London: Entrance to the Allies' radio control center, set up under ground because of the blitz



In Paris: The Germans had thoughtfully bomb-proofed this building before it was taken over as Allied communications center were usually sent in the dots and dashes of the International Morse code, either with telegraph keys and head receivers or with tape transmitters and recorders. By the latter method, very high speeds can be attained under ideal radio conditions, but often the speed is severely limited by weak reception, static, or fading, and generally ranges between 20 and 200 words per minute. For the higher speeds, several highly skilled operators are required, and the training of such an operator usually takes from six months to two years.

Naturally, the obvious benefits to be gained by using printing telegraph devices, such as the teletypewriter, on radio circuits had interested several organizations before the War, and considerable work had been done in this direction. This work had been moderately successful, and regular operation had been established over a few of the more favorable radio paths. However, the fading and static gremlins had prevented the extensive use of "printers" in radio.

DURING the Battle of Britain, the British Government became fearful that the Germans might interrupt several of the cables between the United States and England. This would throw the entire load on the existing radio circuits, most of which were subject to interruption in the winter months by electromagnetic storms. The American Telephone and Telegraph Company and the British General Post Office jointly operated a long-wave radio telephone circuit between New York and London. This circuit is usually at its best when short



The Army's multi-channel service gets close attention at the Long Lines Department's telegraph testboard in Washington waves are at their worst. The British Post Office therefore proposed a plan for establishing several emergency telegraph channels on this radio circuit. Tests were made; and though the channels were far from perfect they were well worth while as an emergency measure, so the plan was adopted, and arrangements were made to use it if necessary. Although this need never arose, an idea had been born, and speculation began in the Long Lines Department as to other possible applications of this technique.

Trials Prove Successful

SUDDENLY this interesting train of thought was turned in a new direction by the bombing of Pearl Harbor, and our immediate entry into the War. The Army would surely need overseas communications beyond all precedent. Overseas telephone service with enemy-held countries had been suspended, leaving high-grade radio facilities and expert technicians available for other purposes. How could these assets be employed to meet the Army's need?

In a small conference at Long Lines headquarters in New York, an executive asked: "Do you think we could operate a voice-frequency carrier telegraph system on a short-wave radio circuit, just as we did in the British long-wave emergency plan?"

The first responses to this question were discouraging. It was pointed out that short-wave signals often vary or fade a thousand-fold in strength at intervals of only a second or so. Long waves are not afflicted by this malady, yet the results of the long-wave tests had been only fair. But someone said, "Well, it wouldn't do any harm to make some tests, would it?" So it was decided to try, before giving up, and within a few days experimental work on the multi-channel radio teletype system began.

A Long Lines overseas radio transmitter on the Atlantic coast. Employment of the Bell System's experienced civilians at such posts released Army technicians for duty elsewhere

Although far from satisfactory, the initial tests showed great promise, and stimulated further efforts. More men were assigned to the project, and the Bell Telephone Laboratories and the Department of Operation and Engineering were invited to participate—which they most wholeheartedly did. Ideas for improvement sprang from all sides. Within a short time an experimental system between New York and San Francisco was working so well that the power of the radio transmitter in California could be reduced to only 25 watts—barely enough to light a small lamp—and still good teletype copy would be received in New York!

It was noteworthy that this radically new and phenomenally successful system was created almost entirely of standard units of Bell System equipment, thoroughly tried and tested by long experience and available on short notice. First, there was the single-sideband radio transmitter and receiver, used for more than a decade in overseas telephone service. Then there was the voice-frequency carrier equipment which had long been used in Morse and teletype service. And, of course, there were the familiar teletype machines, used throughout the nation for TWX and private line service.

To these basic ingredients, a few simple but highly important additions had been made. The result was a novel communications system which overcame to an almost unbelievable extent the effects of fading, static, and interference.

Demonstrating the System

WITHIN a few weeks the development work had reached the stage where success seemed certain, and Brigadier General Frank E. Stoner, Chief of the Army Communications Service (later a Major General and Assistant Chief Signal Officer), was invited to inspect the experimental system. His reaction was not only favorable but enthusiastic, and he requested that a plan for the use of the system in the Army be submitted for consideration.

This plan, which was promptly furnished, proposed that the Long Lines Department provide the radio and carrier facilities in the United States,

Overseas radio receiving equipment in California. Long Lines provided the radio stations and the channels to the Signal Centers in Washington and San Francisco, while the Army enjoyed full operational control of the movement of its traffic together with wire line telegraph channels between the Long Lines radio stations and the Army Signal Centers in Washington and San Francisco, and that the Signal Corps purchase corresponding equipment from Western Electric for installation at Army headquarters overseas. Thus, the Army would have full operational control over the movement of traffic, sending and receiving all messages with its own personnel in the War Department; yet it would be relieved of the necessity of building radio stations in the United States, and expert civilians would take the place of Army radio technicians, releasing them for duty elsewhere.

It was further proposed that service be established at a very early date between Washington and European Theater headquarters in England by obtaining the coöperation of the British General Post Office in London. This organization, which had initiated the long-wave emergency plan, was known to have the major items of equipment required, as well as excellent engineering talent.

These proposals were placed before Major General Dawson Olmstead, then Chief Signal Officer, and were quickly accepted. Engineers, installers, and technicians on both sides of the Atlantic rolled up their sleeves, and on the desired date, July 18, 1942, the London system was on the air. Meanwhile, the manufacture of a number of complete terminals, specially arranged in transportable cabinets for installation by Signal Corps men overseas, had been started by Western Electric and was well under way.

Finding Personnel for the Overseas Installations

The difficulty of selecting and training technical personnel for the overseas installations was recognized at the outset. To help solve this problem, the names and last known locations of about 60 Army officers and enlisted men, on military leave of absence from the Bell System, were given to the Army. These men were known to have excellent backgrounds for further training in the technical features of the multi-channel system. The importance the Army attached to the project is attested by the fact that nearly all of these men were promptly released from their current assignments. Even a captain assigned to the Air Forces and wearing pilot's wings was included.

An intensive six-week training course was quickly organized, and officers and enlisted men were hurried to Long Lines headquarters in New York, where a school was opened. First the students were given lectures on the theory of the system, and practical experience with the terminal equipment. Then they were hurried off to Long Lines radio stations at Lawrenceville, Ocean Gate, Netcong, and Manahawkin for further training on radio transmitters and receivers. This school was so successful that it was continued through nearly the entire duration of the War and, in all, 394 men were trained.

These men attracted such favorable attention overseas that a number of them were taken out of the multi-channel teams after their installations were completed, and were

Station W A R, Washington. In this section of the Signal Corps' message center, messages are being punched on tapes for automatic transmission

placed in other important assignments. Initially each team was led by a captain, but all of these team captains and several of their subordinates were later promoted into the field grades, and the ex-pilot became a colonel.

For "Asmara," Read "Algiers" Instead

By rushing the manufacturing work and by diverting equipment originally ordered for other purposes, Western Electric soon completed the first units for installation overseas. Since Long Lines was providing the equipment in the United States, including highly directional antennas beamed accurately toward the corresponding overseas station, close coördination was essential; yet in some cases the need for secrecy was great. In one instance this conflict between coördination and secrecy led to an ingenious hoax.

The Army confided to a few Long Liners that one of the first installations would be in Asmara, East Africa, and requested that antennas aimed at that point be constructed. This was done, but meanwhile another unit had been shipped, to an unknown destination. As time passed, a Long Lines official became concerned lest this second shipment might arrive at its destination and be ready for service before the antennas in the United States were built. Almost daily he called this situation to the attention of a Signal Corps officer in Washington, who always replied: "Don't worry, we'll give you time enough."

On the morning following the announcement to the world of the invasion of North Africa, the officer telephoned the Long Lines man. "We are going to start service soon with a new point," he said. "You can use the antennas you have already built. Look at the globe near your desk and I think you can guess the name of the place."

Examination of the globe showed

another point, almost exactly "on the beam" between Washington and Asmara. That point was Algiers. The secret had been kept—yet the antennas were ready.

Soon Long Lines technicians were waiting anxiously, hoping that the men and equipment had arrived safely, and wondering when Algiers would be on the air. They did not wait long. A voice said: "This is Freedom testing," and presently messages direct from Eisenhower's new headquarters were pouring into the great Signal Center in the Pentagon, which is aptly named Radio Station WAR.

Asmara, however, had not been named for deception alone. A system to that point was established soon afterward. Direct radio transmission between Washington and points as far east as Tehran and New Delhi is only feasible during a very short period in each day. Asmara served as an important relay station, insuring rapid and reliable communication with the Persian Gulf Command and the China-Burma-India Theater.

Other installations followed rapidly. When it was decided that the major effort of the Allied Forces would be directed across the Channel instead of in southern Europe, a team and equipment already in the Mediterranean were quickly shipped out through Gibraltar and up to England to augment the facilities planned for France. A system was established between London and Algiers, creat-

Here Signal Corps personnel are attending the automatic transmitting (foreground) and receiving machines

"Sigcircus": A complete communications unit, equipped as a mobile station to keep pace with Headquarters as it moved forward

ing a triangle whose apexes were Washington, London, and Algiers, and providing an alternative route between any two of these points. A second system, with Signal Corps equipment in England, was set up between Washington and London, and before D-Day a capacity of more than a million words a day was available over direct channels between these two great capitals.

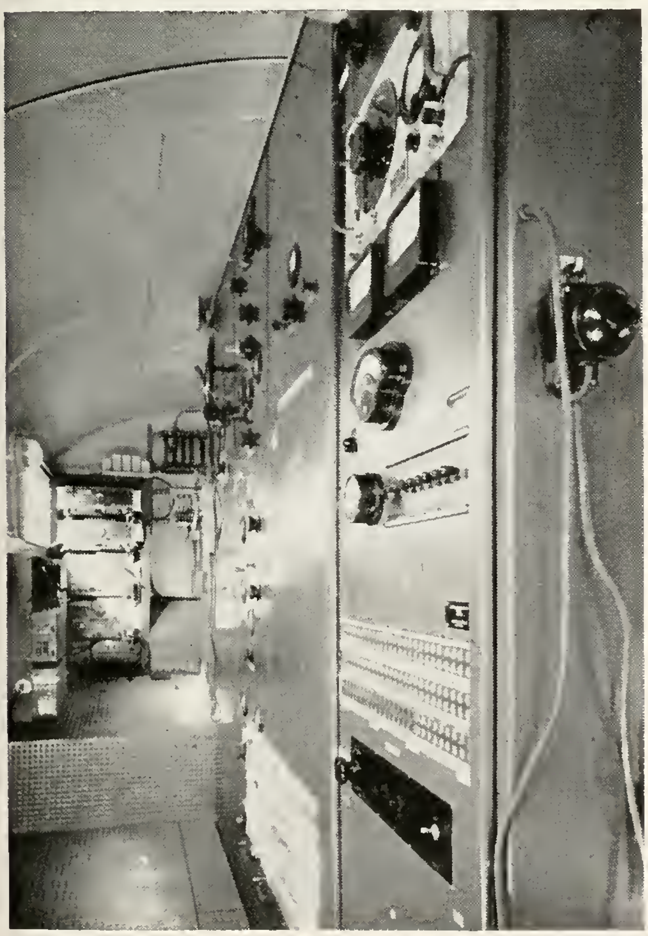
The Mobile "Sigcircus"

Well in advance of D-Day, three complete units were made ready for use on the European continent. One of these was to be held in reserve as protection against possible combat losses. The others would permit "leap-frogging." One of them would be installed at main headquarters. Then, as soon as a forward echelon had been established, the second unit would be installed there. When main headquarters moved up to the forward echelon location, the unit left in the rear would be dismantled and made ready to "leap-frog" forward to a new location. To facilitate these moves, one of the equipments was installed, near Paris, in a complete mobile station mounted in 18 trucks and trailers, ready to move forward into Germany. In accordance with the Signal Corps practice of using the prefix "SIG" on certain kinds of equipment, this caravan was dubbed "Sigcircus."

Plans for the future employment of the multi-channel units were made and revised continually to meet changes in the strategic situation. With the "drying up" of North Africa and the establishment of a firm foothold in France, the London-Algiers system was no longer needed. But the War in the Pacific was advancing at a faster pace, and more facilities were needed there. So the Algiers terminal was shipped back to Western Electric, reconditioned, reshipped, and finally was installed in Manila.

This was by no means the only installation of multi-channel equipment in the Pacific. The first system had been placed in operation in Brisbane, Australia, in March 1943, and remained in service there until the summer of 1945, when it was dismantled and "leap-frogged" northward to meet a need for service much farther forward—in Tokyo.

Three terminals were installed in Hawaii in bomb-proof tunnels built shortly after the Pearl Harbor disaster. Two of these worked with San Francisco, the third with Guam. In addition to the usual Army traffic, some channels of these systems were extended to Navy headquarters, one



Interior of one of the trailers shown in the preceding picture

was used for air traffic control, and others made it possible for the Joint Chiefs of Staff to maintain almost instantaneous contact with the Twentieth Air Force units whose swarms of B-29s reduced Japanese industry to ashes. "Bombs away" signals from B-29s over Japan were picked up at Guam and flashed on to Washington so quickly that it is likely that the news reached the Pentagon before the first bomb struck the target.

"Sigcircus" Afloat

THE ROUGH TERRAIN and transportation difficulties experienced early in the New Guinea campaign pointed to the need for more mobile equipment. But mobile installations like the "Sigcircus" caravan used in Europe would have been useless in lands where roads were mountainous or nonexistent. So the Signal Corps went to sea. A complete "Seaborne Communications Center" was built in two large barges, one containing the radio transmitter and the other the receiver and terminal equipment. These barges, together with two others housing less complex equipment for shorter circuits, and a mother ship with quarters for technical and operating personnel, were first moored in Humboldt Bay, near Hollandia, New Guinea.

Here again the leap-frogging technique was used. The barges were planned to arrive at a new headquarters as soon as possible, to furnish communications until land-based stations could be built. Then the barges were released and towed forward. In this manner the Signal Corps "navy" moved on from Hollandia to Manila, and then to Tokyo—the last

"Sigcircus" afloat: the Signal Corps' complete "Seaborne Communications Center" used in the Pacific. Right: Teletypewriter equipment installed in one of the barges

of the series of islands that once had seemed endless.

New Developments

INVENTIVE MINDS found the multichannel system to be an excellent springboard for new ideas. "Top secret" or even "restricted" radiograms must be encrypted to conceal their contents from enemy eyes. Initially this was a tedious job which took much time and labor. Ways were found to do this work automatically and instantaneously, and with the requisite security.

Another development was a teletypewriter conference service to meet the occasional need for instantaneous "back-and-forth" communication, in which questions and answers could be exchanged rapidly. For this purpose, special teletypewriters in private rooms were connected to an overseas channel, and staff officers at each terminal exchanged questions, answers, and information. Over a direct connection of this kind between a crude shelter in New Guinea and a luxurious room during the Roosevelt-Churchill conference in Quebec, General MacArthur set the date for the invasion of the Philippines.

It was also found possible to transmit telephotographs over the system without interrupting or interfering with teletype traffic, and many of the best Signal Corps news photographs reached the American press in this way, only a few hours after the click of the camera.

Extensions of the System

A Signal Corps officer felt that it should be possible to build a jeep-like radio teletype system which would use some of the principles of the multi-channel system to provide a single channel for use on secondary routes. The Department of Operation and Engineering and the Bell Laboratories studied this problem and submitted plans and designed a system. Then, in June 1943, the first single-channel system was rushed into service between Miami, Florida, and Boriquen Field, Puerto Rico.

So successful was this system that several hundred of them were manufactured and installed at top speed. War Department circuits to oversea commands such as those in Panama, Trinidad, Brazil, and Central Africa were quickly converted to teletype operation. So were the circuits between the several Theater Headquarters and their subordinate bases. Extensions from Asmara to New Delhi and thence to Brisbane and Manila completed the girdling of the globe.

Since all messages were received in the form of a printed and perforated tape, it was a simple matter to relay a message on to another distant point, over either a wire or radio teletype circuit, without retyping. Thus a multitude of wire and radio circuits throughout the world were integrated into a single efficient communications system: the Army Command and Administrative Network. A request for a critically needed airplane part could be typed at an airfield in China, relayed at New Delhi, Asmara, and Washington, and received at Wright Field, Ohio, all within a matter of minutes.

At each of the now famous "Big Three" conferences, radio teletype service with Washington and the rest of the world was available within a few steps of the conference room. Even in such far-off places as Cairo and Tehran, President Roosevelt, General Marshall, and others of the American delegation were in close touch with Washington and with our commanders in the theaters of war. Every day they received voluminous reports of the current military situation on all fronts.

Radio teletype needed no salesman. Whenever a communications officer saw it in action, he instantly saw other applications for it within his own field. The initial single-channel circuit between Miami and Puerto Rico soon became a link in an independent worldwide network operated by the Army Airways Communications System for the control of planes flying the air transport routes. Air Forces used radio teletype for the coördination of long-range bombing missions from widely separated bases. A channel between Washington and Moscow gave these nerve centers dependable communication for both diplomatic and military traffic. And still demands for additional circuits arose daily.

An Important Contribution to the War Effort

Only the collapse of Japan brought this expansion to an end. Then reconversion began. Multi-channel equipment no longer needed overseas was installed in the Army stations at

Contrasts: The City Hall in Manila (left). After heavy shelling during the recapture of the city, it became the American Headquarters and message center. The building fronting on the palace moat in Tokyo (below) is now the Headquarters and message center of the Supreme Commander for the Allied Powers

Washington and San Francisco to operate with occupation forces and permanent bases. The Long Lines facilities were released, and were quickly returned to their post-war task of furnishing overseas telephone service. They were to be kept busy for many months to come, carrying calls between thousands of lonely servicemen overseas and their folks at home.*

* See "Three-Minute Furloughs," MAGAZINE, Spring 1946.

In a presidential citation which accompanied the award of the Medal for Merit to President Walter S. Gifford of A. T. & T., radio teletype was given a prominent place as one of the Bell System's most important contributions to the war effort. Its development had enabled the Signal Corps, during the most difficult period in its history, to live up to two important slogans: "Get the Message Through," and "Security, Accuracy, and Speed."

THE SCIENTISTS at the Bell Telephone Laboratories . . . were handed the job of focussing radio *micro-waves* into a narrow beam to transmit the impulses of sight and sound from one place to another. These micro-waves, you see, have a habit of shooting off in all directions, going on and on out beyond the horizon into the wild blue yonder. The problem was to herd them together so that, literally, they would "stay on the beam" over the distance that separates the relay stations. That was no small task when you realize that beams sharper than a searchlight are needed.

But—the problem *was* solved. Bell Laboratories scientists designed a metal *lens* which can focus these micro-waves much as a magnifying glass collects the sun's rays to burn a hole in a piece of paper. With this new lens, the micro-waves can be focussed into the sharpest beam of its kind ever produced, so that radio photos, radio broadcasts, and television may be transmitted more clearly, and with freedom from static and other interferences.

Bell Laboratories' scientists and their associates explore every scientific field which offers hope of bettering communications. That's one big reason why your telephone service has continued to improve throughout the years. And why it will be even better as time goes on.

From an announcement on the "Telephone Hour" radio program

The Special Knowledge, Skills, and Form of Organization Of the Bell System's Research Unit Contributed in Many Ways to the Prosecution of the War

Bell Laboratories' Rôle in Victory

Part II

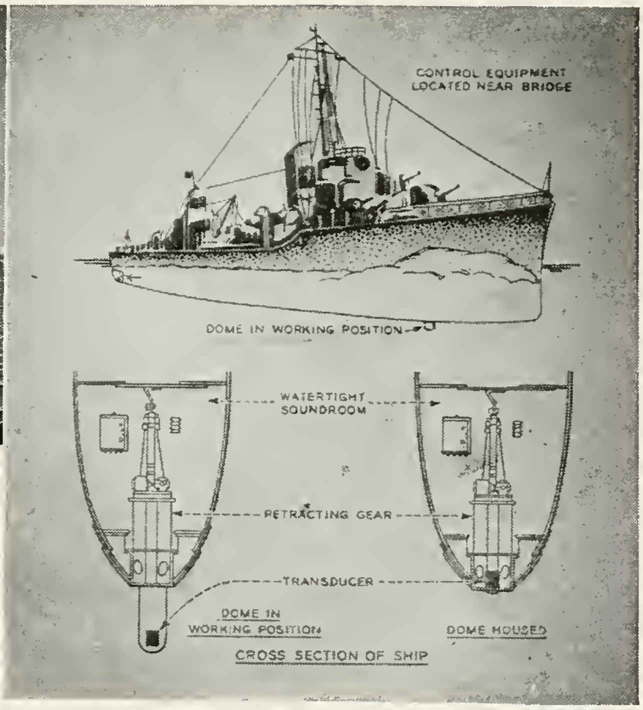
Editors' note: Several of the Laboratories' major contributions to the Allied Nations' victory over the Axis powers were described under the above title in the preceding (Spring) issue of this MAGAZINE. The following paragraphs, compiled after a survey of all the Laboratories' many and varied war-time projects, summarize as much of the rest of the story as may be told within the limits of military security.

DURING WORLD WAR I, a group of Bell Telephone Laboratories men had been active in studies of underwater sound; and when the clouds of World War II gathered, their successors began to think along the same lines. When the Laboratories entered the SONAR program, the greatest need was for precise methods of measuring underwater sound, a field in which little quantitative work had been done. Yet this was an important aspect, for precise measurement is a fundamental factor in good development and design of any equipment. With their broad experience in the measurement of ordinary sound in the development of telephony, Laboratories engineers undertook investigations which laid the groundwork for the standardization and improvement of sonar techniques.

In 1941 and 1942 they established the first lake calibration stations, one in New Jersey and the other in Florida. These were later taken over by the National Defense Research Committee as the national standardizing laboratories for underwater sound.

Sonar locates hostile submarines by projecting a beam of vibrations through the water and observing the

Above: the "Elcovee," a floating laboratory used in the development of sonar

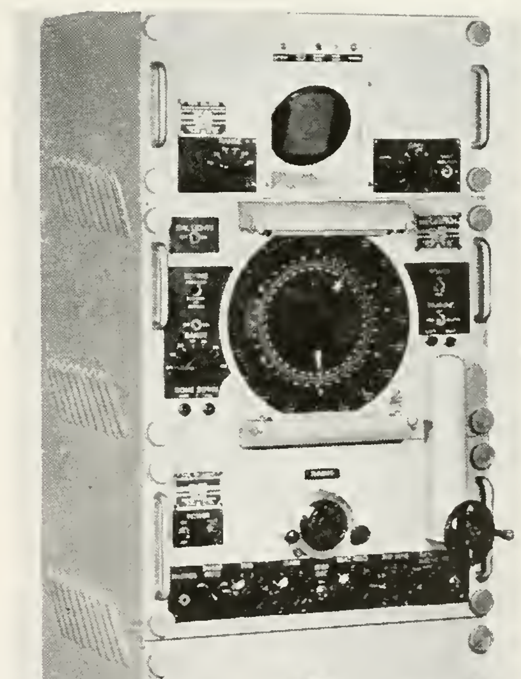


Right: How the sonar "antenna" is lowered and retracted

time and direction of the echo. The principle is the same as that of radar but the vibrations are of water molecules, and the frequencies are measured in tens of thousands instead of millions. Most difficult part of the job was to devise a transducer, a device to convert electrical vibrations to mechanical and vice versa. The Laboratories developed a synthetic piezoelectric crystal for this, and with Western Electric worked out a procedure to make it in very large quantities.

Another contribution was a dome to be attached to the ship's hull to house the transducer. Its streamlining and other features minimized noise pick-up—a very important factor. About three-score different transducers were designed for special uses.

Equally important was the Laboratories' contribution in the form of good design of the sonar circuits, which generated the high frequencies, broke them up into pulses, timed the returning pulses and directed them



Sonar equipment developed for installation aboard ship

The relay computer used by the Army to perform complicated mathematical computations. Note the "problem" tapes on the rack at the right

into the indicating circuits. Sonars of Laboratories' design were installed on every type of naval ship.

The thoroughness and versatility of the Laboratories' sonar development work were demonstrated when, midway through the war, its scientists were called upon to change completely the emphasis of their investigations. During the first part of the war, the problem had been one entirely of using sonar to combat German U-boats. With the winning of the Battle of the Atlantic, the emphasis changed to the Pacific theater, where Allied submarines were in the position that German underseas craft had occupied in the Atlantic; that is, using sonar on submarines to attack merchantmen and warships.

CIRCUITS have always been one of the Laboratories' special interests. Some years before the war, a scientist and an engineer teamed up to develop a circuit that would do sums in arithmetic. Starting with a problem typed on a keyboard, the relays would click for a few seconds and out would come the answer, neatly typewritten.

During the war, a need arose for hundreds of computations of the path taken by an anti-aircraft shell, in order to check the performance of the electrical gun director. A computer made up of relays and teletypewriters was developed, and one was built for the Army and one for the Navy. These computers employ a punched tape to direct the apparatus, tape on which the problem is recorded, and other tapes carrying such tables as sines and logarithms. The machine will run for hours unattended. If it spots an obvious mistake which makes a problem insoluble, it will make a note and pass on to the next problem.

The flight instructor can create conditions within the trainer which simulate those found aloft

A PROBLEM of another kind is posed by an airplane in flight. Given a sudden updraft, the pilot will "nose down" to maintain altitude; the plane will pick up speed, and so on. Many of these variables are indicated on instruments, and the skilled "instruments" flyer can hold an even course by their aid. To teach the art, a number of "trainers" had been built which were "mock-ups" of an airplane, with linkages—mostly mechanical—between the instructor, the instruments, and the control.

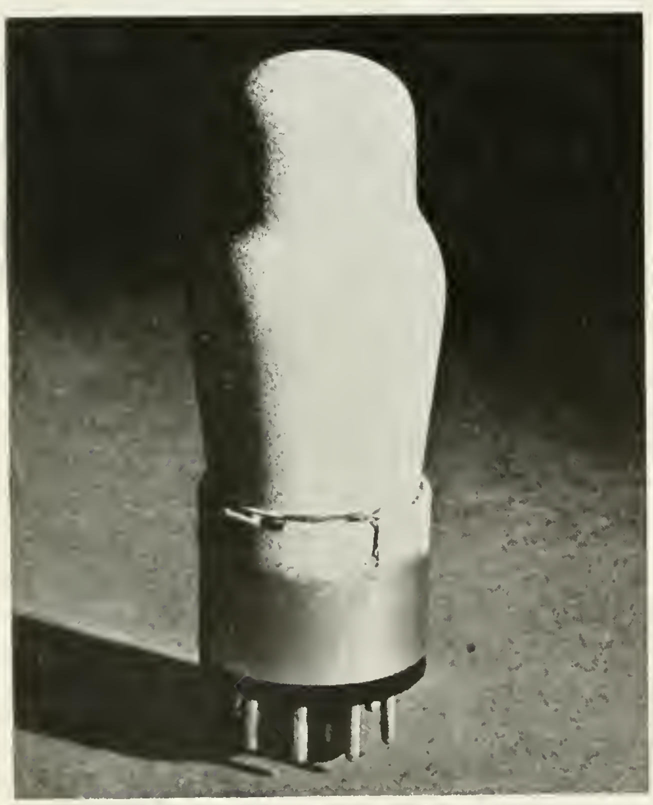
With the desire to set up a working replica of a medium bomber which would provide training for a flight crew of five, the Navy asked the Laboratories to develop an all-electrical trainer. Preliminary work for the circuit engineers involved a study of aerodynamics, and the working out of equations which would connect throttle opening, propeller pitch, elevator setting, and plane load with rate of climb—to name only one set of relations. When installed in a stationary mock-up of the airplane interior, complete with noise and vi-

Telephone relays, vacuum tubes, and switches (below) interconnect the controls and instruments of the flight trainer. Right: Pilot and co-pilot, at the controls of the Navy trainer, can encounter all the problems—and most of the sensations—met in actual flight

bration, the effect was so realistic that more than one experienced flyer left the ship in a sweat after the instructor had given him a real workout.

As MIGHT be expected, the Laboratories' long experience with vacuum tubes was of great value to the war effort. Out of all the electronic development which was going on, one small but dramatic incident emerges. A group of repeater stations had been captured in Germany, intact except for the tubes. Signal Corps men, ransacking employees' lockers, had found one tube which fitted the sockets. In a few days that tube was in the Laboratories; in three days more, eight replicas had been built and were on their way to the front for service tests.

Western Electric did not wait for results to filter back, however; they turned out a thousand tubes in three weeks. Confidence in the Laboratories was well rewarded; the design was right, and the tubes restored service on an important European cable route.



This replica of a German vacuum tube was produced in the Laboratories in three days

ONE OF the Laboratories' earliest concerns was to eke out the supply of scarce materials by providing substitutes. One acute shortage was in tin; the metallurgists reduced the tin content in solder and developed new procedures to make good joints with this tricky alloy. Rubber was replaced by synthetics, of which the rubber chemists had wide knowledge. The zinc die casting of the combined telephone set was replaced by a plastic molding, again based on accumulated knowledge. Mica had been selected for capacitors on the basis of its appearance; feeling that much good mica was being rejected, physicists worked out electrical tests which proved so much mica usable that the shortage was alleviated.

EARLY in the war, when coastal cities were seriously concerned about air raids, the Laboratories was asked to develop a powerful warning siren. The one it produced had an engine-driven blower, a rotor or "chopper" driven by a second engine, and a sextuple horn to deliver the interrupted puff to the air. One was installed on the highest building in Radio City, New York, and several more in other cities.

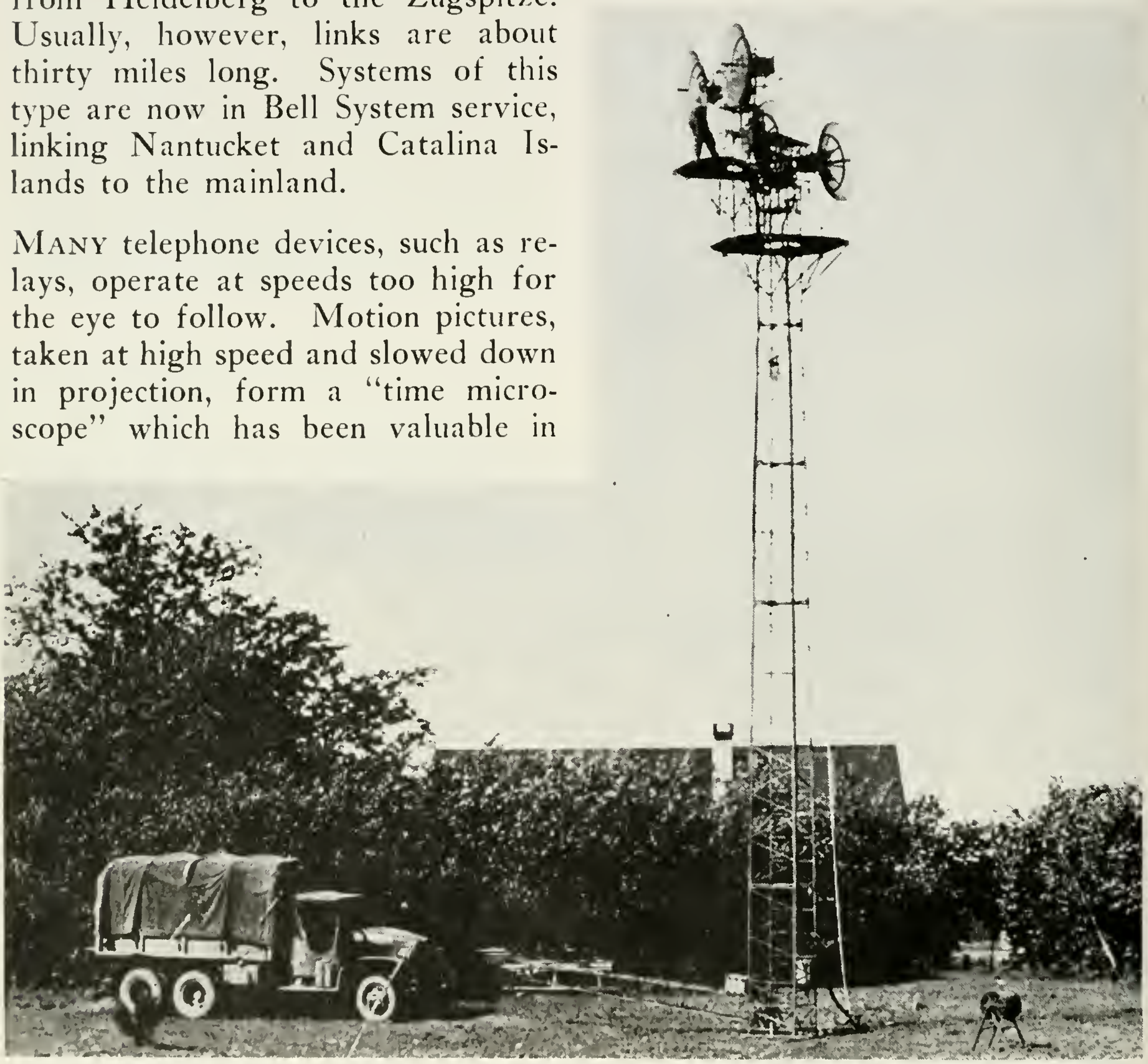
AS A SUPPLEMENT to wire circuits in the communications zone, the Laboratories developed a micro-wave radio system operating at about 5,000

When mica was selected on the basis of electrical tests (above), rather than of appearance, much more was found to be usable.

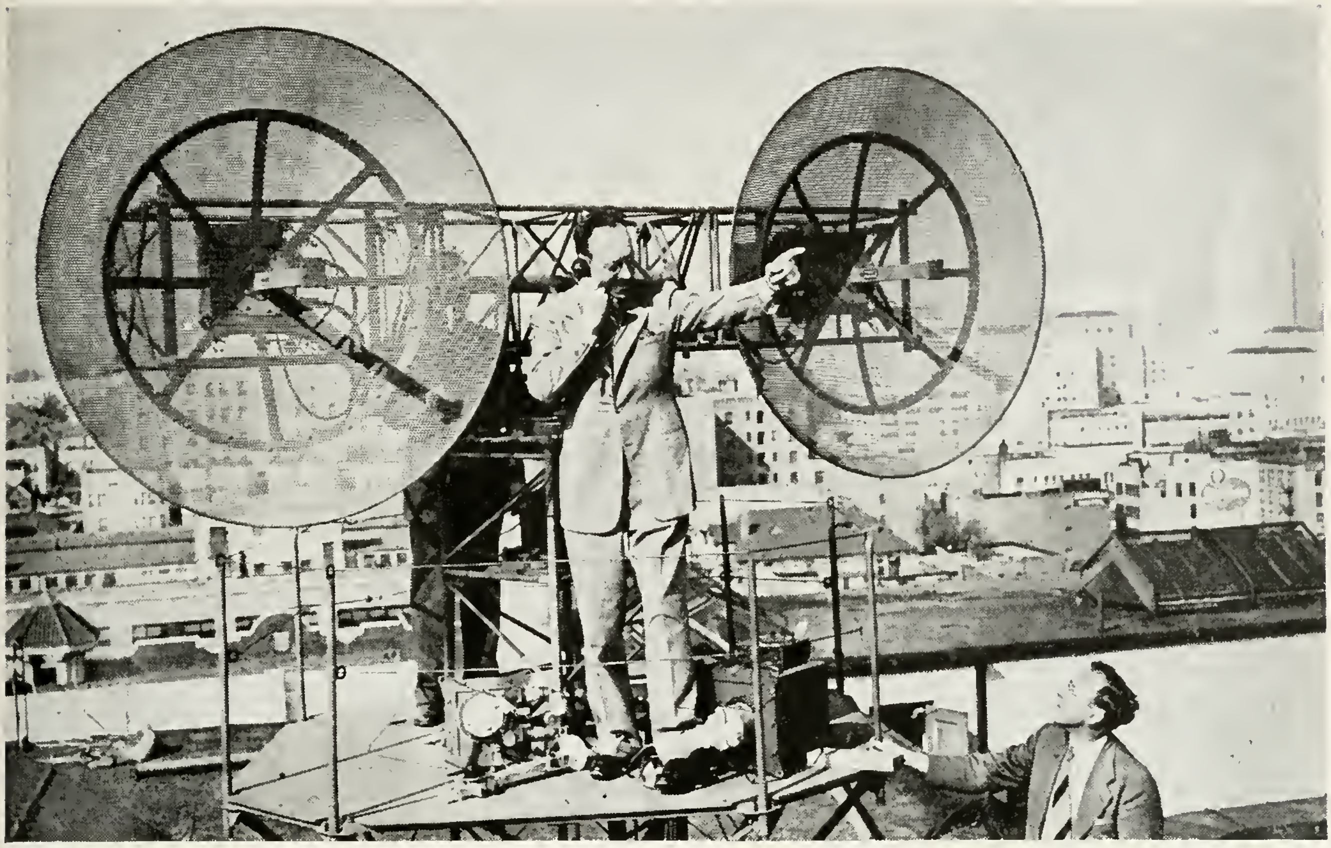
Right: A Western Electric worker adjusts silvered mica capacitors

It produces the loudest man-made sustained noise: the Laboratories' air-raid warning siren, shown here on its way to a roof-top installation megacycles. At that frequency, the waves behave like those of light, and a clear straight-line path is required. Waves are directed into a concentrated beam by a parabolic reflector and concentrated into the receiving system by a similar reflector. At both ends the reflectors are raised on light portable towers which are preferably mounted on hilltops. A number of these systems were built by the Western Electric Company, and were installed near the end of the war in South Germany and functioned well; one link was over 100 miles long, from Heidelberg to the Zugspitze. Usually, however, links are about thirty miles long. Systems of this type are now in Bell System service, linking Nantucket and Catalina Islands to the mainland.

Many telephone devices, such as relays, operate at speeds too high for the eye to follow. Motion pictures, taken at high speed and slowed down in projection, form a "time microscope" which has been valuable in studies of relays, ringers, handset breakage and the like. So useful proved a high-speed camera developed in the Laboratories that Western Electric marketed it under the name of "Fastax." In one form it uses 16 mm. film and operates as fast as 4,000 pictures a second; in another form it uses 35 mm. film for a wider picture. This camera has had wide application to war work. So well did "Fastax" perform on atomic bomb researches that about 60 cameras recorded the test at Bikini this summer,



In Germany: a relay point on a micro-wave radio system. Several of these systems were used by American forces, and proved very satisfactory



On the Pacific coast: Mainland antennas of the new peacetime radio telephone installation to Catalina Island

with an engineer from the Laboratories on hand to service them.

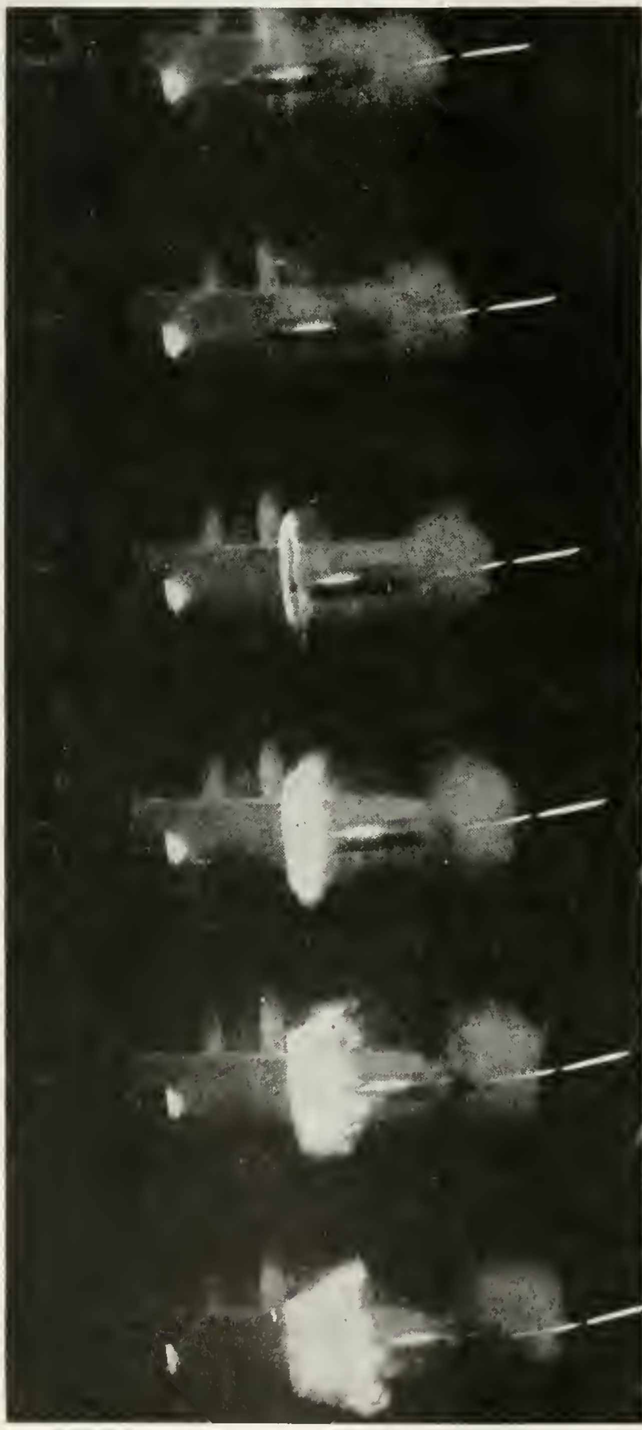
For some years the Laboratories has been interested in the thermistor, a device whose resistance changes rapidly with change in temperature. Since resistance can be measured with great accuracy, the thermistor could be the heart of an instrument to measure extremely small changes in temperature. Devices were worked out which could be used to detect ships, vehicles, and even men at a few hundred feet by the difference in temperature between them and their environment.

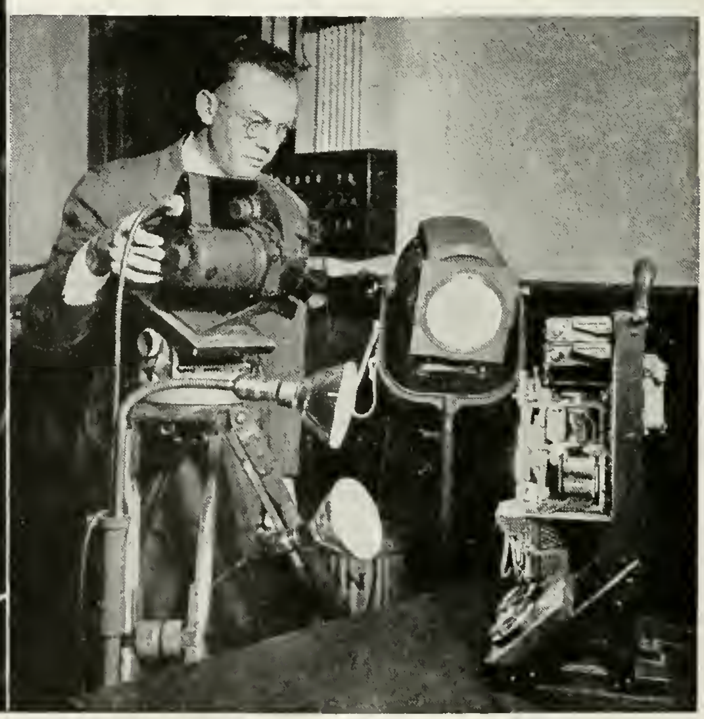
One of the pre-war problems in micro-waves had been to detect extremely minute amounts of such energy. The vacuum tube was unsuitable because its own noise level was too high. Recalling the crystal detector of the early days of radio, the engineers studied and developed it into a thoroughly reliable device. They learned how to make the crystalline silicon, and even what impurities were important. When radar came along, the crystal detector was ready.

The "aerial doodle-bug" for finding and tracking submerged enemy submarines was developed by the Laboratories in conjunction with the Naval Ordnance Laboratory and is expected to find important peacetime application in aerial prospecting for oil and mineral deposits. This airborne magneto-meter has been credited with being an important weapon in the crucial struggle against enemy submarines, because it could detect the great masses of iron in submarines when they were submerged too deeply for ordinary aerial observation.

In its peacetime application it provides the means for a quick large-scale survey of geological structure of the earth's surface, and thereby may provide clues for the discovery of new oil and mineral deposits. For this sort of work it has been combined with SHORAN, a radar mapping device, and special mapping cameras.

A MAGNETIC FUZE for mines was another development of the Laboratories, and about 12,000 mines equipped with it were dropped by airplane in shallow water in Japanese shipping lanes. The magnetic fuze was based on the Laboratories' earlier invention of permalloy, an alloy which is remarkably sensitive to magnetism. As a mine lay on the bottom, the permalloy in the fuze responded to the change in magnetism when a ship passed within lethal range. The fuze was so designed that it could count off and pass the first ship or several ships in a convoy and blow up the next one to pass. Mines equipped with this fuze destroyed about 300,000 tons of shipping, and many more tons were neutralized by fear of the mines.



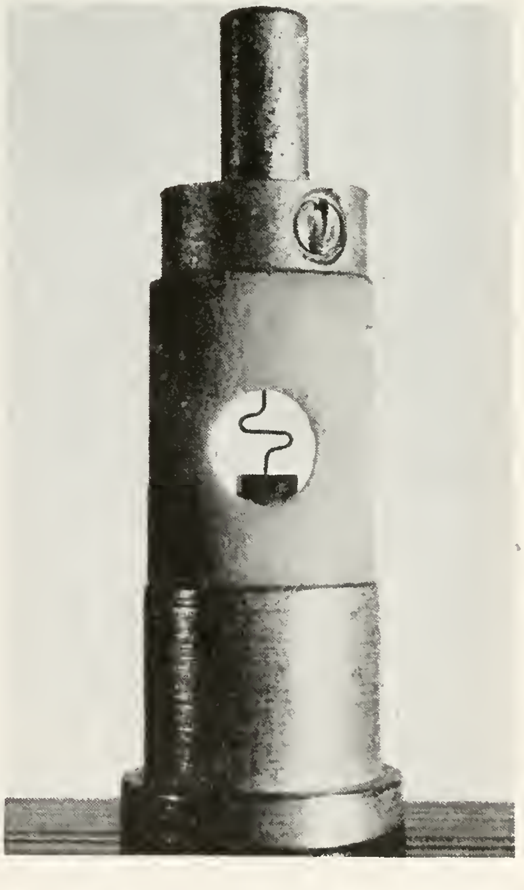


How a rocket flies (left): pictures taken at the rate of 4,000 per second. Right: A Fastax camera in the laboratory, about to photograph dial telephone switching equipment which moves faster than the human eye can see

To use highly technical developments effectively in combat required that they be handled and serviced by skilled men. Shortly after Pearl Harbor, the Services directed the Laboratories to set up a school for war training in which key men would be prepared to train others in military schools. A few maintenance men were also to be trained, to care for the first equipments until the military schools' trainees were available. The first class started in April 1942, and from then until the end of the war a stream of trainees went through the school. They ranged from radio repairmen fresh from their work benches to graduate engineering officers who had had months of training at Massachusetts Institute of Technology. There was a steady procession of apparatus, too. Nearly every radar developed by the Laboratories appeared in the School—frequently Serial No. 1, just off the production line. For each equipment there was a special textbook, often written by the school's faculty. In all, some 125 courses were given to a total of 4,400 students.

A thermistor bolometer, useful in measuring minute changes in temperature

The Laboratories was often drawn upon for technical or administrative skill to serve the Forces as civilians. Numerous committees had Laboratories men as members or chairmen; several men had long leaves of absence. About eighty men went overseas, some of them on lengthy assignments to act as technical advisers; others on shorter investigations.



A silicon crystal in its holder (greatly enlarged). It was important in radar

Gather together a group of experienced people of outstanding qual-

An airborne magneto-meter, otherwise known as an aerial doodlebug. Suspended below a plane, it hunted out submarines beneath the surface

ity and specialized skills and of naturally coöperative instincts, infuse them with the spirit that disregards working hours, and there follows an output of new technical tools of war far beyond what anyone could have predicted. As their friends and associates return from fighting fronts, the men and women who staffed the Laboratories are proud to hear of the performance of the tools they contributed to Democracy's arsenal.

At the Laboratories' school for war training, some 125 courses were given to a total of 4,400 men

"Now We Are All Happy . . ."

In the Magazine for Winter 1944–45, "More and Better Telephone Service for Farmers" outlined the Bell System's program for rural expansion—which has been making great strides ahead since the advent of peace. The following letter, written to a rural development representative in Georgia, expresses what the extension of service means to one family to which the telephone has but recently reached out:

"I have always loved telephones and have dreamed since childhood of having one in our home. . . . When I first went away to school, I wished we had a telephone. Then when I started working away from home I began to realize how very much telephone service was needed. But it was on my return from overseas service in World War II as a Wac that I felt this need the most.

"The minute I landed in the United States I wanted so much to call my family, to hear my mother's and daddy's voices. I felt sad when other Wacs and soldiers were lining up to call home. I could only send a telegram, which could not be answered for security reasons. I definitely decided I would have a telephone installed in our home at the first opportunity.

"On April 30, 1946, my dreams came true, and our telephone was installed in spite of the fact that mother and daddy could not agree with me that we needed one. They said they had gotten along without one for 75 years and asked, 'Why get one now?' Their ages alone present one reason for the need.

"The first night after our service was connected, I placed chairs for mother and daddy at the telephone and my sister and I stood while we called every member of our big family: a brother and family in Birmingham, Ala., a brother and family in Washington, D. C., a sister and family in Atlanta, Ga., and a brother and family in Decatur, Ga.

"It was quite a thrill to see mother's and daddy's faces brighten up as they heard each voice. It was a picture I shall never forget.

"After the calls were completed, I asked mother and daddy how they felt about having a telephone now. They answered smilingly. 'It seems as though we have seen each one of our children.'

"That sold them, and now we are all happy we have telephone service."

On the Matter of Reports

To do our work, we all have to read a mass of papers. Nearly all of them are far too long. This wastes time, while energy has to be spent in looking for the essential points. I ask my colleagues and their staffs to see to it that their reports are shorter.

(i) The aim should be reports which set out the main points in a series of short, crisp paragraphs.

(ii) If a report relies on detailed analysis of some complicated factors, or on statistics, these should be set out in an appendix.

(iii) Often the occasion is best met by submitting not a full dress report, but an aide-memoire consisting of headings only, which can be expanded orally if needed.

(iv) Let us have an end of such phrases as these: "It is also of importance to bear in mind the following considerations," or "Consideration should be given to the possibility of carrying into effect." Most of these woolly phrases are mere padding, which can be left out altogether, or replaced by a single word. Let us not shrink from using the short expressive phrase, even if it is conversational.

Reports drawn up on the lines I propose may at first seem rough as compared with the flat surface of officialese jargon. But the saving of time will be great, while the discipline of setting out the real points concisely will prove an aid to clear thinking.

WINSTON CHURCHILL

IT TAKES time and money and the patient effort of supervisors to inform employees of the reasons behind routines and about the fundamental policies of the company, and about anything else which they are likely to be asked by the public. Yet without adequate knowledge to answer, they cannot make the company appear reasonable and it is more difficult for them to be polite and helpful. To have such knowledge spread down through the ranks of an organization means that from the foreman up to the top management, all supervisors must look upon the process as one vital to the success of the business. Being reasonable and polite to the public must be done by the company as a whole. It is not a gesture—it is a way of life.

From "The Bell Telephone System," by Arthur W. Page, Vice President, A. T. & T. Co. Harper & Brothers, publishers, 1941.

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Bell Telephone MAGAZINE

erican Telephone & Telegraph Company • New York

Bell Telephone *Magazine*

Autumn 1946

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *Pres.;* Carroll O. Bickelhaupt, *Sec.;* Donald R. Belcher, *Treas.*

Who's Who & What's What

in This Issue

Stupendous undertakings seem to be the order of the Bell System's post-war day, and among them is the important one which Raymond A. Steelman describes in this issue's first article: employing an unprecedented 250,000 women in a single year. On November 20 Mr. Steelman observed the thirtieth anniversary of his employment by the Bell Telephone Company of Pennsylvania, at Philadelphia. There and thereabouts he had charge of operating the company's cafeterias until he transferred to the A. T. and T. Company in 1923. Since then, in the traffic division of the Department of Operation and Engineering, his interests have grown from dining service and kindred matters to include the recruiting and selection of traffic employees, safety and health activities, and the personnel aspects of the development of women supervisory employees. His most recent contribution to this Magazine was "Recreation Facilities for Bell System Women," in the issue for Summer 1944.

Another huge project became bigger still when it was announced last October that the Bell System's nation-wide coaxial cable program would be nearly doubled in extent and halved in time schedule. At that time three men familiar with the various elements of the job described to the members of the Television Broadcasters' Association the implications for that industry—Laurance G. Woodford, General Manager of the Long Lines Department of A. T. & T.; Keith S. McHugh, Vice President in charge of Public Relations of A. T. & T.; and Oliver E. Buckley, President of the Bell Telephone Laboratories.

Mr. Woodford's 35-year career with the Bell System began with the Iowa Telephone Company, and continued with the Northwestern Bell Telephone Company until 1923, when he joined the A. T. and T. Company. In the O. & E. Department he progressed through the plant division until in 1941 he was appointed chief engi-

Raymond A. Steelman

Laurance G. Woodford

Keith S. McHugh

Oliver E. Buckley

William H. Harrison

Leon W. Germain

neer—the post he held until he moved on to his present Long Lines responsibility in 1943.

It was as a clerk that Mr. McHugh joined the A. T. & T. Company in 1919, but within a few months he became an engineer in the O. & E. Department. From 1921 to 1925 he was General Commercial Engineer of the Chesapeake and Potomac Telephone Company in Washington, D. C., and for the next four years he was with the New York Telephone Company as general commercial manager and as vice president. In 1929 he returned to A. T. & T. as commercial engineer, and was appointed an assistant vice president in 1934. Two years later he was elected a vice president. His appointment to the public relations position, succeeding Arthur W. Page, took place last June. Mr. McHugh contributed "War Activities of the Bell Telephone System" to this MAGAZINE for November 1942, and was one of the authors of "The Bell System's Interest in Program Television" in the issue for Spring 1944. His graceful adieu to radio broadcasting station WEAF appears on page 162 of this issue.

Dr. Buckley entered the Bell System as a research physicist in 1914. He became Bell Telephone Laboratories' assistant director of research in 1927 and director in 1933, was made executive vice president in 1936, and was elected President of the Laboratories in 1940. His "Bell Laboratories in the War," in these pages for Winter 1944–45, although written under the wraps of war-time security regulations, gives some notion of his and that organization's part in victory over the Axis powers. Dr. Buckley is a fellow of several scientific and engineering societies, and is a member of the National Academy of Sciences, the American Philosophical Society, and the National Inventors' Council.

A READING OF WILLIAM H. HARRISON'S brief talk to the Pioneers in Cleveland last October will reveal both the authority and the sympathy with which he discusses service under conditions of peace and of war. He understands both. Since he began in the telephone business as a repairman in 1909, he has worked in the New York Telephone Company, the Western Electric Company, the Bell Telephone Company of Pennsylvania and the Diamond State Telephone Company, and the American Telephone and Telegraph Company—always with increasing responsibility. From the last-named he took leave of absence in 1940 to accept heavy administrative burdens for the nation, first in civilian capacities and then as military officer; he resigned from

(Continued on page 187)

Crossing Ol' Man River: an armored section of coaxial telephone cable being laid on the river bottom near Vicksburg, Miss., as the southern transcontinental coaxial cable project pushes westward toward the Pacific coast. *See page 147*

More Than a Million People Will Have Been Interviewed During 1946 to Obtain the New Employees Needed in the Bell System's Greatest Employment Year

Hiring a Quarter of a Million Women

Raymond A. Steelman

A QUARTER OF A MILLION well qualified women to be hired in 1946: that was the requirement put up to the Bell System men and women who work in the recruiting and employment field.

The request was the largest they had ever received. To many of them the figure at first seemed fantastic. Back in 1938, before World War II began, and things were, let us say "normal," the System's needs were met by bringing in only 18,000 women. Yet the answer to the request was a quick "All right; it will be tough, but let's get going *and count on us to deliver.*" And they are doing so.

For the recruiters, the figure is even larger. For it is necessary to recruit more applicants than the number of employees required, so that proper selections can be made; and, as is to be expected, some do not accept the position offered to them. Thus it is likely that when the books for 1946 are closed, it will be found that more than a million women will have passed through the Bell System's employment offices and other points of hiring.

New people are required for many different kinds of jobs. Telephone operators comprise, of course, the largest single group of women employees: a force, with their supervisors, of nearly 250,000. And besides these, there is need for clerks who prepare and issue the bills to customers; other clerks who prepare the pay checks; typists, stenographers, and comptometer operators; and representatives who handle business office contracts with the public.

But why are so many new people still needed? The answer is enlight-

Telephone Operator

These illustrations are from a booklet entitled "An Invitation from the Telephone Company" which is distributed widely among prospective applicants

Service Representative

ening. When Japan surrendered, the Bell System was holding hundreds of thousands of orders for telephones, which, because of war shortages, it had been unable to fill. Soon after V-J Day, new telephones were being installed in an orderly rush. But the end of the war didn't bring a slackening of demands. Rather, the orders began to come in faster than ever, and the calling rate went up. So did the usage of long distance. So more employees—many more—were required to handle an unprecedented growth which the Bell System was experiencing.

That wasn't all. Because of the war, many of the employees of the telephone companies, along with those in other industries, were working overtime. The problem here was to get back to a five-day week, and that too required many additional employees.

Finally, force losses had to be reckoned with. With so many thousands of employees, substantial numbers of resignations are inevitable. They are, of course, running at a higher rate in the hectic postwar world than in normal times.

Need for Recruiting

There was a time when more than enough well qualified girls applied voluntarily. Waiting lists were maintained and no form of recruiting was required.

Those days are gone. Now, in order to obtain the large numbers of new people who are constantly needed to keep the System ticking, they have to be recruited, and getting them is not an easy task. This can be understood when it is kept in mind that the telephone companies have to obtain their quarter of a million new employees for 1946 from the same local supply from which the needs of all other employers are filled: industries geared to produce the peacetime needs of an equipment starved nation, stores with sales volumes hitting one new peak on top of another, banks, insurance companies, transportation companies, and other employers of women.

Take a look at any want-ad page in the newspaper and see how many employers are appealing for employees. On a recent Sunday, the columns of a large metropolitan daily contained over 1900 classified ads for women, exclusive of domestic help and employment agencies. Many of these were for large numbers of employees.

To be able to obtain so many new employees, and to hold them after they are hired, requires that basic conditions be right: pay, hours, working conditions, and relationships with individual employees. Many betterments have been made, and ways to improve the attractiveness of the job are constantly under review.

Team-work Needed

Team-work is also needed. While the recruiting and employment of the System's women employees is largely a responsibility of the Traffic Departments, because it is in these departments that the large majority of the women are located, others participate actively in the work—notably the Information Departments. Throughout, the approach is that this is a Company-wide problem: one to be met by wholehearted coöperation. It is largely because of this that such excellent results have been achieved.

In a large number of communities all over the country it has been a responsibility of the chief operators and comparable supervisory employees in other departments to recruit and employ, and they have done an outstanding job. In many big cities, however, because of unusually heavy volumes, special recruiting organizations have been established. The number of new people needed and the tightness of employment conditions are two of the factors that control the exact set-up. In a typical area where 5500 additions are required this year, the recruiting organization consists of fifteen people—two men and thirteen women. This full-time recruiting organization is augmented by others who work part time on recruiting as the needs arise.

An important person is the one who heads up the recruiting program. The basic work he does and the extent to which he is able to motivate and inspire others are fundamental requirements of success. Initiative, imagination, creative ability, a background of selling experience, familiarity with departmental functioning and needs, and the ability to plan and execute an intricate program, are among the qualifications for the individual who is given this key role in the recruiting scene.

An initial step is to estimate how many people are expected to be required for each of the starting positions, for each week and month. While difficulties are experienced in making precise forecasts, it is surprising how closely experienced people can predict the needs.

Recruiting Through the Schools

It is through the high schools that the largest numbers of people become available as employees each year. These girls make fine employees—they learn quickly and are likely to remain in the locality.

The Bell System long ago pioneered in this form of recruiting. But when employment needs began to accelerate so rapidly, the need was crystal clear for strengthening contacts with the schools.

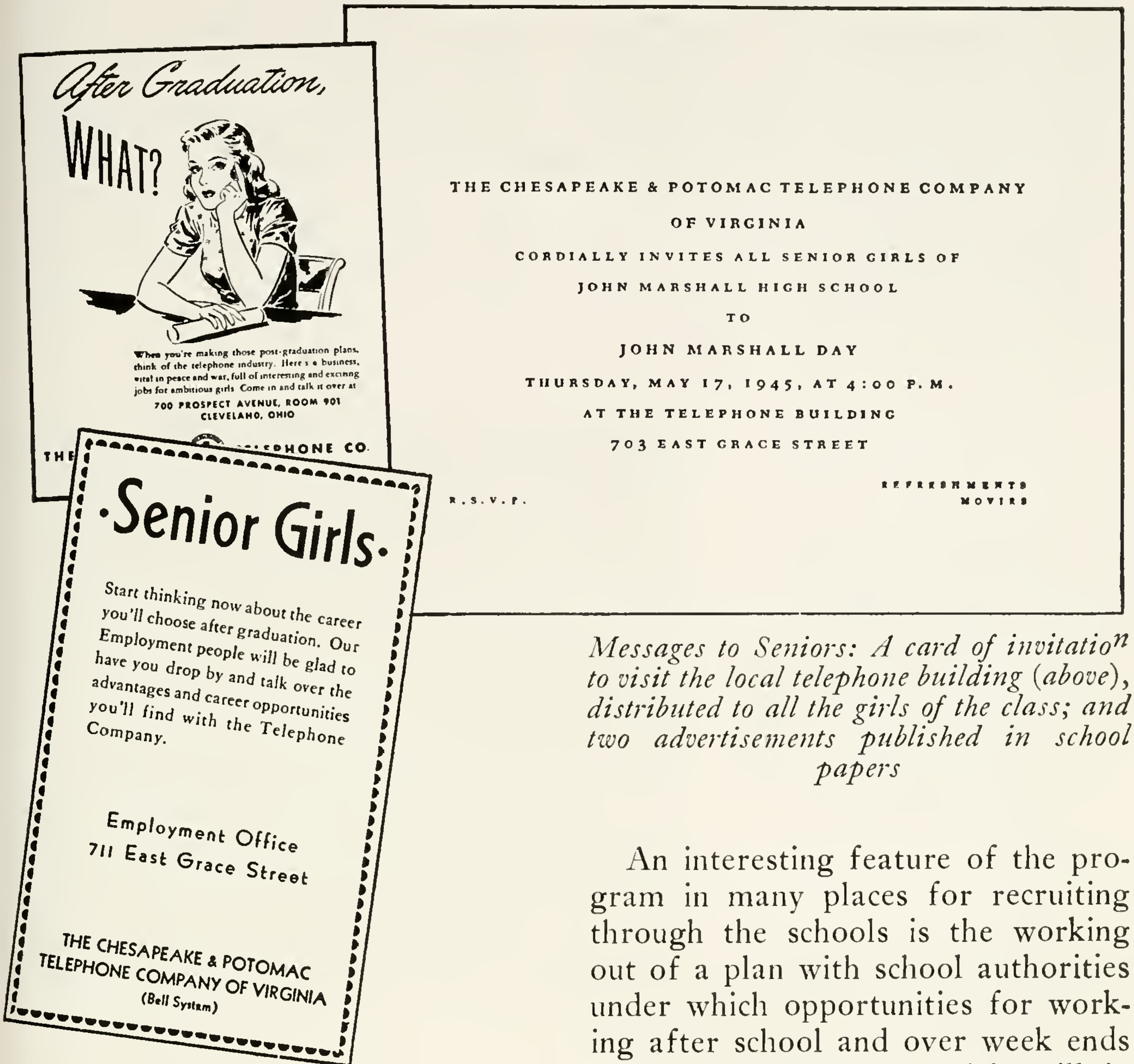
The objective now is to obtain just as many new employees as possible from this important source. Visits are first made to school officials. They naturally want their students to obtain good positions, and it is here that the excellent reputation of the telephone company as an employer is a factor of importance.

Initial contacts are followed by others with principals and counselors in the individual schools. So that principals, teachers, and counselors may have a first-hand picture of what the business has to offer, they are invited to visit the telephone building, usually in groups. Here they see the various kinds of work young women perform, and observe the working environment, the kind of supervision provided, the type of girls their students will have as associates, and the lounges, cafeterias, and other facilities provided for employees to use while not at work. Often they are guests at a dinner which is followed by short addresses and a discussion period.

So that the counselors may be able to discuss telephone company employment in specific terms with students, comprehensive reference material is provided in the form of a Counselor's Handbook, entitled *Careers in the Telephone Business.* Counselors were consulted in its preparation, and pictures are included to show the girls when jobs are discussed.

Various methods are used in attracting the students themselves. Among them are short talks in the schools by pleasant young women who are employees of the telephone company, in connection with which recruiting literature is distributed; recruiting movies, and group visits of students to telephone buildings. Many employment advertisements appear in student publications.

The movie *Step High,* a Hollywood production, was shown early this year, first to school counselors and then, with their approval, to thousands of students in schools all over the country. This picture, in a light vein, was extremely popular among young people, and was directly responsible for motivating many of the System's present employees to apply. While the operator's job is featured, all of the other beginning positions are covered, with on-the-spot scenes showing the work



Messages to Seniors: A card of invitation to visit the local telephone building (above), distributed to all the girls of the class; and two advertisements published in school papers

employees actually perform. Another picture to be used for recruiting purposes has just been released.

A still different activity, in which the local telephone company is simply one participant, is a school-planned college and career night, in which each college and industry represented is provided an opportunity to point out the advantages it offers, whether as a place to continue one's education or to work. At the company's booth, each visitor is given a copy of the company's recruiting booklet, an invitation to visit the employment office, and a card of introduction.

An interesting feature of the program in many places for recruiting through the schools is the working out of a plan with school authorities under which opportunities for working after school and over week ends are made available to girls still in school. Such employment, obviously, is not permitted to interfere in the least with their progress at school. Many of these girls who are seniors become full-time employees at the close of school. Others work for the telephone company during the summer, return to school in the fall, and are ready for full-time employment when they graduate.

No attempt is made to induce girls to discontinue school. The emphasis is in the other direction. In a recent radio employment program the announcer said, among other things, "That summer job may look awfully good to you now, but chances are better than even that with a diploma tucked under your arm, you will have much better opportunities for gainful employment. If it is within the realm of the possible, I urge you to return to school."

Recruiting Through Employees

WHILE MANY girls apply for work of their own accord simply because they have friends who are employees, substantially larger numbers can be attracted when voluntary recruiting efforts are carried on among the employees on a planned basis. This method of recruiting rates high not only as to numbers but also as to quality: a company employee naturally "knows what it takes." Such

High school seniors sign the guest book as they enter the central office building for a recruiting party. Below: The mirror reports that the operator's new light-weight headset, being adjusted by a hostess, looks good on the girl who is considering what telephone operating offers as a career

activities are participated in by all departments, although some may need few or no employees at the time. With a total of over 485,000 employees in System companies, the potentialities are great.

Bell System employees like their work—they are proud of their company and what it stands for. The "Spirit of Service," traditional among telephone operators of the past as well as of the present, is catching, and it doesn't take long as a rule for one of the operators, a "First Lady of Communications," to "sell" the idea of working for "her" company to others. Often these newcomers land at a switchboard, sometimes at another kind of work. Similarly, a prospect sent in by a Commercial Department employee may be assigned to that department, or she may take her place at a switchboard or at a desk in the Accounting Department. The employment offices try to place each employee in the kind of job she is best suited for, and the kind she would like to get.

Two methods of recruitment are used. The first is a recruiting campaign—a concentrated drive of short duration. This method is used principally when substantial numbers are required quickly. In one large city where employment conditions were very difficult a few months back, 50 "recruiters" worked full time among the employees for a four weeks' stretch. Thousands of prospects were obtained, and the names of others are still coming in.

Under the other plan, recruiting is continuous, and in the aggregate it produces the best results. It takes advantage of the fact that the employees make many new friends from time to time, and extends the recruiting plan to the new employees who are continuously entering the ranks.

Launching interdepartmental recruiting from the top, and the assumption of responsibility by all management levels, are prerequisites to its vitality and continuance. Coördination is done by interdepartmental recruiting committees, at different levels and in different localities. Among the functions of these committees are setting objectives, formulating the mechanics of the undertaking, sponsoring it in the various departments, publicity, and informing those concerned of the results achieved. Finally, the committee, on the basis of comparative performance, strengthens any weak spots that may appear in the program.

The crux of this form of recruiting is the personal contact between a recruiter and each employee on the force, to the end that prospects for employment will be referred by employees to the employment office and their names given to the recruiter for purposes of follow-up. New employees, naturally, are seen soon after they start. Last June and July, in the Traffic Departments alone, nearly 40,000 young women were added to the payroll. Most of them were right out of school. By seeing these new people promptly, recruiters obtained the names of many of their friends, as yet unemployed, and large numbers of additional employees were thus acquired.

The recruiter may be an employee who works regularly on this assignment, one who has been detached from other work temporarily to recruit, or an employee who carries on recruiting in connection with other duties. They are all carefully selected. Important qualifications are enthusiasm, ability to talk well, persistence, and enough experience to be able to answer or obtain the answers to questions that arise. Above all, they are people who feel strongly from their own experiences that their company is a fine place to work. Needless to say, recruiters are trained in recruiting methods before they see employees on this important assignment.

In contacts which the recruiter has with the employees, she furnishes material to stimulate and guide them, as well as material for the employees to give prospects—such as recruiting folders and booklets, earnings cards, and cards of introduction to the employment office. Popular for this use are book matches, lipstick tissue books, and address-telephone number books—all containing employment messages.

A typical booklet used to inform employees opens with a letter signed by the president of the company, and covers such important questions as *What Is the Employment Situation?*, *Why Do We Need So Many More People?*, *What Is Being Done to Get Them?*, *What Jobs Are To Be Filled?*, *What Are the Requirements?*, *What Are the Advantages for New Employees?*, *Where Do I Find People?*, *What Do I Do if I Have an Employment Prospect?* and *Where Are the Company's Employment Centers?* The book is illustrated in a light vein and much color is used.

To re-enforce the efforts of the recruiters, general publicity is given to this form of recruitment by such means as illustrated stories in company magazines, posters, lobby displays, cards for cafeteria tables, and pay-check enclosures.

Family Nights, while not distinctly recruiting activities, have aided substantially. In these affairs, popular among the employees, members of their families and others are invited to the telephone building to meet those in charge and the other employees, and to see the building, the job, and the facilities. At an employment table, suitably designated, a recruiter is present to tell the story of Bell employment, furnish printed matter, and answer questions. A common plan is for the employees to use this opportunity to give their friends who are prospective employees a close view of what the company has to offer.

INCENTIVES maintain enthusiasm. While the employees are thanked generously for their aid by people in the organization who are close to them, other methods are also used. These include a recruiting news sheet —*Recruit-her*—for example, which publicizes the results by groups and gives the names of participating employees, and an honor roll posted in the office. A novel idea is the chain poster, which features the photograph and name of the employee who recommended the new employee, followed by the photographs and names of all other new employees added to the force as a result of hiring the original girl.

Other activities are informal luncheons at which participating employees are entertained, and the recruiting dance—for which employees qualify through participation in the recruit-

High school students, visiting a telephone building, take part in the company's "Teen and Twenty Time" radio program, one of its many recruiting activities. Right: A "still" from the Bell System's Hollywood movie "Step High"

ing plan. At one such dance, which was preceded by a well planned campaign involving bulletin board posters, booster handouts, and easel displays, the ballroom of a large hotel was engaged. In attendance were 640 employees and their guests. Many additional employees were acquired as a result of the campaign, while stimulation was given to the entire program of recruiting through the employees.

Making Our Needs Known

THE PLACE to which most people go when they are seeking employment is the want-ad section of the newspaper. Here the approach is direct—the kinds of positions open are stated, and the advantages are described completely and attractively. Striking captions are used and in many cases pay is highlighted. While telephone company pay is good, many do not know it. Putting money in the ads has been responsible not only for attracting applicants—it's what they want to know—but it has a public relations value as well.

Display advertisements are also used. While direct appeals in such advertisements are not ordinarily as immediately productive as in classified ads, display advertisements permit stating the company's needs for people more completely and dramatically than space on the want-ad page permits, and to a large audience.

One of the principal uses of display advertisements in newspapers and also in magazines is in connection with long range programs aimed at establishing in the minds of the public, and of young women in particular, the attractiveness of the telephone business as a place of employment.

Featured in all types of recruiting publicity are those things which young women want in a job which the telephone company has to offer. Included, in addition to good pay, are convenient places of employment, interesting work, competent and friendly supervision, congenial associates, pleasant surroundings, opportunities to get ahead, and job stability. Many excellent ideas have been obtained from the employees themselves. In a contest, *What Would You Tell Mary?*, Mary being a girl who soon may be considering taking a job, 900 entries were received from the employees of all departments of one company. The contest was announced in the company magazine, entry blanks were included, and substantial prizes were awarded the winners.

Radio is used in two principal ways. Where other methods do not produce enough applicants to permit filling the need, it is used in the same way as the classified ad—to attract applicants at the time. Its other use is to assist in establishing in the public mind, over a period of time, the fact that the telephone company is a good place to work.

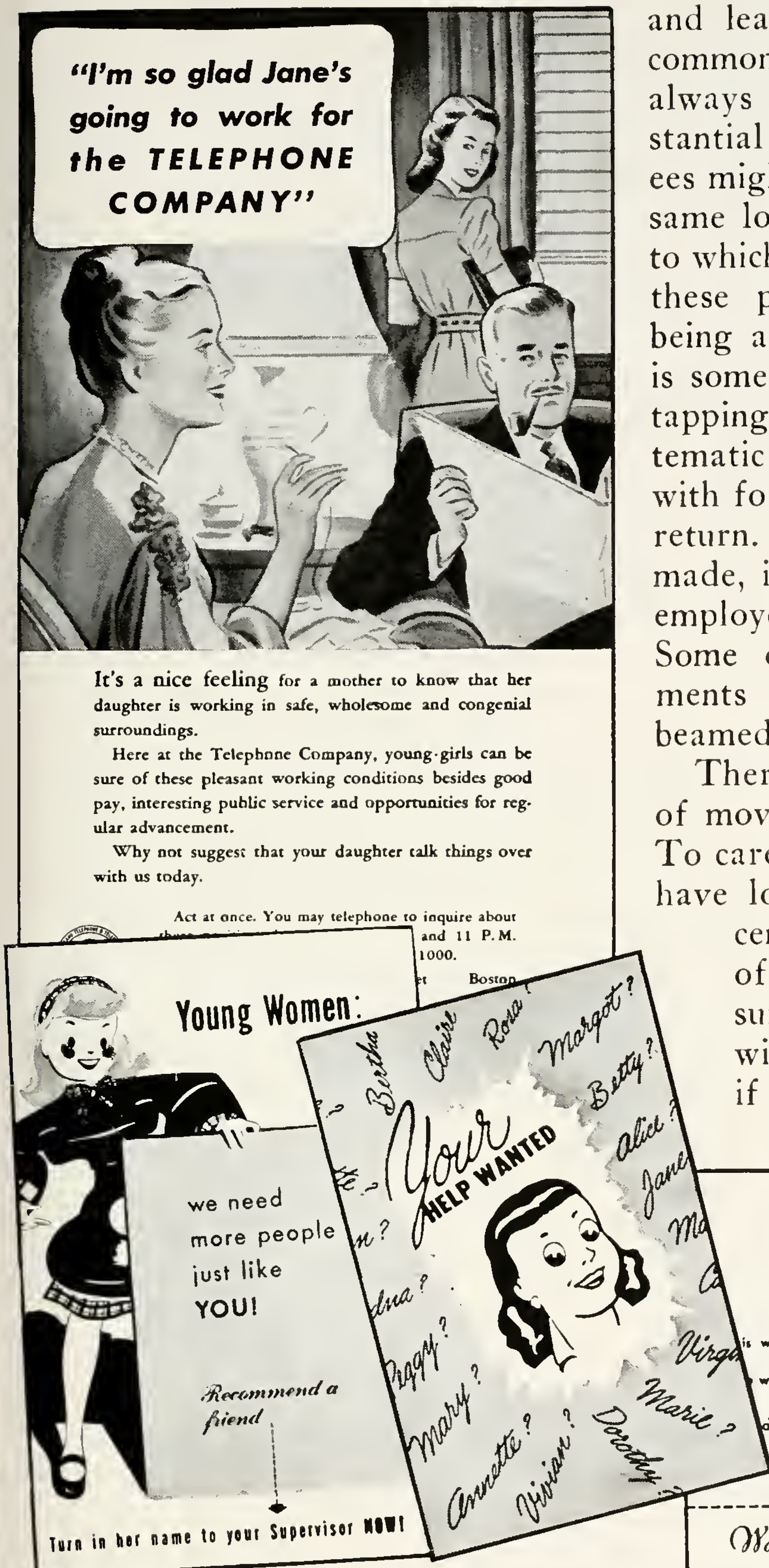
Among the well established telephone employment programs which have a big following among young people locally are *Teen and Twenty Time*, *Serenade for Smoothies*, and *The High School Hour*. A feature of one of the regular programs, broadcast on Saturday nights, is a salute to the high school whose team was the winner in a local football game of importance that day. Another features fan mail from girls' clubs, along with a weekly studio party, in which nationally known guest stars, popular among young people, appear in person. Another dramatizes incidents in the lives of telephone operators, parts being taken by high school students whose names are announced.

Additional forms of radio employment advertising include interviews with employees and spot announcements, while recruiting messages are often included in programs that contain diversified commercials. Specific wage information is given in many of the announcements.

A recruiting campaign, to be fully effective, must be comprehensive in scope. Thus, while relying heavily on recruiting through the schools and present employees, together with the use of the newspapers and the radio, the total picture, where recruiting is difficult, includes supplementary media such as window displays, displays and posters in lobbies of telephone buildings used by the public, street car and bus cards, cards on company vehicles, contacts with the public in business offices by specially selected and trained recruiters, and in extreme cases door-to-door canvassing.

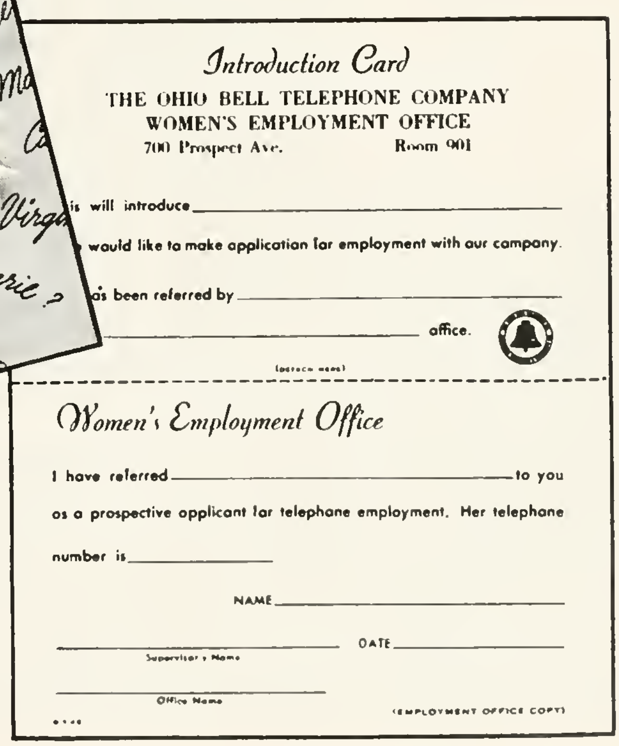
Bringing Back Former Employees

Many employees who resign from the telephone company do so not because of any dissatisfaction with the job; marriage, home conditions,



and leaving town are some of the common causes. There is thus the always present possibility that substantial numbers of former employees might like to return, either in the same location or in a different place to which they have moved. Many of these people are experienced, and being able to utilize that experience is something worth striving for. In tapping this supply, there is a systematic program for keeping in touch with former employees, and many do return. When basic changes are made, in wages for example, former employees are promptly informed. Some of the newspaper advertisements and radio commercials are beamed solely at them.

There is always a certain amount of moving around from city to city. To care for this, transfer procedures have long been established. In recent years there has been more of this than normally, and to insure that experienced employees will be "saved" for the System, if possible, information is sent


Introduction Card

THE OHIO BELL TELEPHONE COMPANY
WOMEN'S EMPLOYMENT OFFICE
700 Prospect Ave. Room 901

is will introduce ____________________

would like to make application for employment with our company.

as been referred by ____________________

____________________ office.

Women's Employment Office

I have referred ____________________ to you as a prospective applicant for telephone employment. Her telephone number is ____________

NAME ____________________

____________________ DATE ____________
Supervisor's Name

____
Office Name

(EMPLOYMENT OFFICE COPY)

A newspaper display advertisement (top). A poster, a booklet, and a referral card, all designed to enlist the help of present employees in interesting their friends in telephone work to the proper supervisory people in the new location, giving the details regarding employees who move, whether within the same company or to the territory of another company. This permits reaching them directly if they do not apply for work.

Employment Offices

For years the System companies have had employment offices for women in all cities where the size warrants them. All applicants go to these centers, regardless of the kind of position desired. Large volume hiring has necessitated the opening of many additional offices and the expansion of others. Paralleling the expansion of these facilities has been the addition of many new interviewers and other employment office personnel. These carefully selected women are prepared for their work on the basis of a recently developed training course, geared to meet the needs of present-day employment conditions. Where there are no employment offices as such, designated supervisory employees have the employment responsibility.

Induction and Training

After employment come induction and training. Induction procedures are aimed at establishing and main-

Booklets which emphasize the advantages, financial and environmental, of telephone employment taining pleasant contacts between supervision and the new employee from the very start, and giving information promptly to her about the many things she wants to know and those with which the company, as her employer, wants her to be familiar. Movies are used as one of the ways in which interesting stories are told. Titles of two such pictures recently completed are *The Big Day* and *Meet Your Company*.

Another activity is popularly referred to as *The ABC's of Our Business*. In this, new employees—and older ones too—in group meetings are given information about fundamental principles applying to the successful running of any business, and the telephone business in particular. Sound-slide films are used, trained leaders conduct discussion periods, and booklets are distributed as take-home pieces.

In preparing the new employees to perform their work, and keeping pace with the current heavy intake, training forces have been substantially augmented, new training facilities provided, and improved training methods introduced. A recently released movie, *Emily Talks Training*, illustrates vividly for instructors the principles of carrying on training discussions with operators.

Recruiting activities:—Left, a "recruiter" discussing with an employee the possibility that some of her friends might be interested in telephone work. In circle, a switchboard scene from the new Bell System film "Emily Talks Training." Below, the men who guide a recruiting program—a general staff interdepartmental recruiting committee

Part of a telephone company employment office in a big city

Looking Ahead

By now the System's employment program for 1946 is well along towards completion. In retrospect, the hiring, training, and assimilating of a quarter of a million women in but one year represents, in the minds of many, one of the greatest recent accomplishments of the Bell System.

But employment people must always be looking ahead, and in the foreseeable future large scale activities will surely continue. The size of the force will have to be increased still further, force losses are continuing at a substantial rate, and the employment situation is tightening in many places. And so, in getting ready for 1947, three regional conferences on recruiting and employment, in which every Bell Company was represented, were recently held in Washington, Chicago, and San Francisco. The discussions were thorough-going, and growing out of these meetings is the confidence that no matter what the future needs may prove to be, nor how difficult the obtaining of employees may become, the men and women who carry the responsibility will find ways to insure that the problem will be solved.

About 2,700 Route Miles of Coaxial Cable Are Now in Place, and the Installation Schedule Has Been Speeded Up to a Rate of 3,000 Miles Next Year

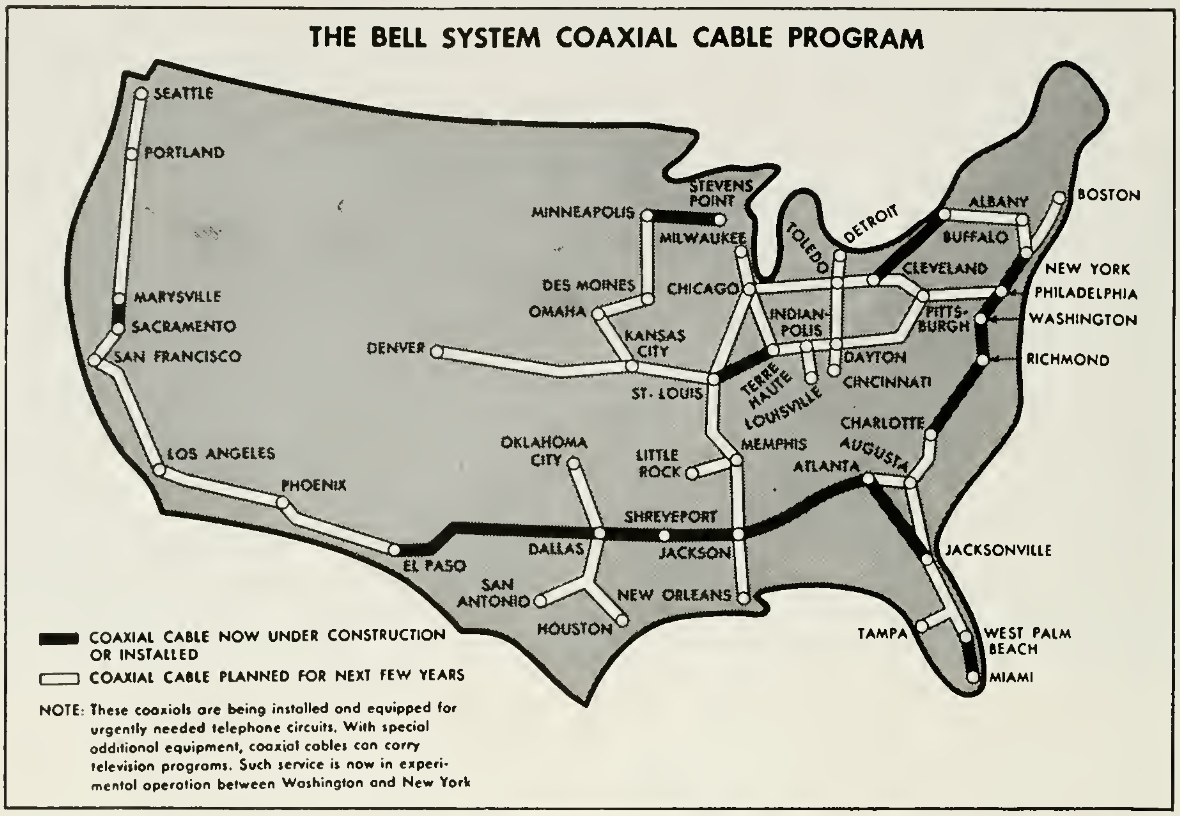
The Bell System's Progress in Television Networks

Editors' note: Important announcements concerning the Bell System's transmission facilities for the television industry were made at the second Television Conference of the Television Broadcasters' Association, held in New York on October 10 and 11, by Laurance G. Woodford, General Manager of the Long Lines Department, Keith S. McHugh, Vice President of the American Telephone and Telegraph Company, and Oliver E. Buckley, President of Bell Telephone Laboratories. Mr. McHugh and Mr. Buckley spoke in connection with their acceptance, on behalf of their colleagues, of gold medals presented by the Association; and Mr. Woodford's was the principal address of the second day's session. The substance of their remarks follows:

I. *Laurance G. Woodford*

Early in 1944, the American Telephone and Telegraph Company announced a five- to six-year construction program involving 7,000 route miles of coaxial cable. That program is now being compressed into about three years, and additional routes have been added to the enlarged program, so that by about 1950 we expect to have some 12,000 route miles of this broad band cable in service.

As of October 1, about 2,700 miles of coaxial cable were in the ground, and construction is moving forward rapidly at a rate which will approach 3,000 miles next year. Right now, cable plow trains on the southern transcontinental route are laying cable between Jackson, Miss., and Shreveport, Louisiana, and are operating as



The 12,000 route miles—installed, under construction, or planned—comprising the Bell System's nation-wide coaxial cable program which is scheduled for completion by about 1950

far west as El Paso. Other trains are placing cable between Buffalo and Cleveland.

Coaxial cable is tailor-made to fit the requirements of each type of terrain. Through cities it is placed in conduit; through areas subject to frequent electrical storms, it is enclosed in a special copper jacketing; through particularly rugged sections where rocks and boulders are encountered, and in crossing streams, a protective armor covering is used.

The coaxial "tubes" first used in 1936 were about a quarter of an inch in diameter. Because of the wider frequency bands now contemplated, the diameter of the tubes now being put into the cables has been increased to three-eighths of an inch. These larger tubes permit us to station the auxiliary repeaters eight miles apart, instead of five and a half miles, and to put the main repeater stations as much as 150 miles apart, as compared to 90 miles in the case of the earlier cables. The repeaters, as you know, make up for the weakening of the signal in passing over the cable. Toward the end of an eight-mile section, the strength of the signal may be only a hundred-thousandth as great as it was at the beginning of the section. Most of the auxiliary repeaters are in small unattended buildings which are visited only in case of trouble and for periodic routine tests.

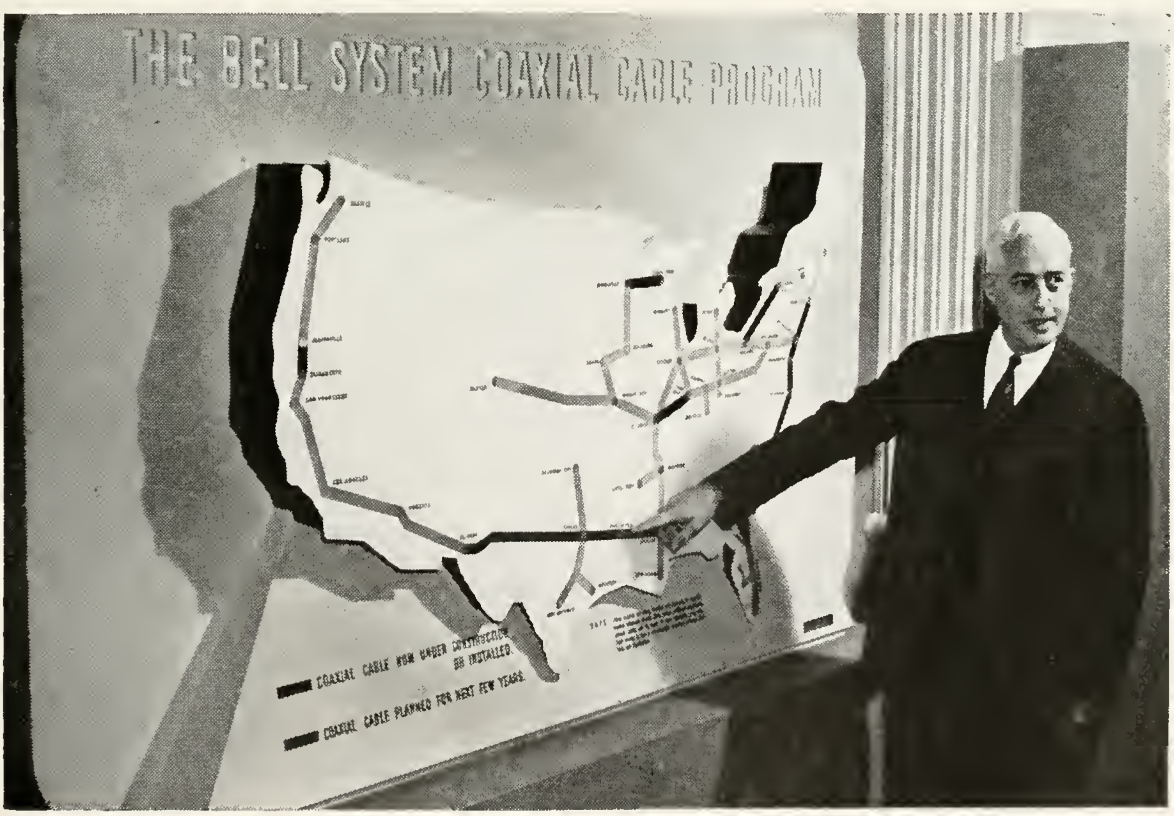
Safeguarding Operation

Steps which have been taken to insure continuous and satisfactory operation are particularly interesting. You know perhaps that coaxial cables contain special pairs of wires, in addition to the actual coaxial tubes, which help us to do the maintenance job. Continuous information as to the operation of the equipment in the auxiliary repeater stations is sent automatically over these wires to the main repeater stations. A change in the signal strength at any repeater may indicate a weakening of that link in the chain. Such an occurrence is immediately made known to attendants, even though they may be miles away. This permits potentially weak apparatus to be replaced before a failure can occur.

As a further precaution to insure continuous service, each repeater has a double set of vacuum tubes, so that failure of a single vacuum tube will not cause an interruption.

Power for operating the repeaters is supplied from commercial sources through connections at the main repeater stations. Here again careful precautions are taken to prevent interruption of service. Large storage batteries and engine-driven generators are provided for emergency use. Power for the auxiliary repeaters is transmitted from the main stations over the central conductors of the coaxial tubes themselves.

In television transmission, each frequency component in the broad band required must travel over the circuit at the exact speed of every other frequency in the band. We know that if some frequencies arrive at a distant point a millionth of a second later than the other frequencies, the picture will appear quite fuzzy. Our precision job in this respect has been to develop apparatus which makes extremely accurate adjustments in the time of travel as between frequencies. The frequencies on the outer edge of the band have a tendency to move just a little more slowly than those nearer the center.



Mr. Woodford points out the southern transcontinental route

This means that certain frequencies must be *slowed up* to permit other frequencies to *catch up.* For the sake of comparison, just imagine two trains in a coast-to-coast race reaching the finish line less than a train-length apart.

Coaxial Cables and Micro-wave Radio Relay Systems

It has been our view that coaxial cables are fairly certain to play a prominent role in network television transmission. Their reliability, the fact that the Bell System is constructing a network of coaxial cables for telephone usage between the principal cities of the nation, and the expectation that further developments will make it possible to provide both telephone and television channels over the same coaxial conductors, all make the coaxial seem an attractive type of facility for television network use.

We are not placing our reliance solely on coaxial cable, however. The Bell Telephone Laboratories are also conducting extensive development work on radio relay systems. One such system is now being installed between New York and Boston and is expected to be available for experimental use next spring. Should radio relay systems prove advantageous for use either alone or in conjunction with coaxial cables, they will, of course, be utilized where indicated.

Thus far we have been speaking only of facilities for inter-city network transmission. These would appear to be of first importance because of the economics of network broadcasting and because of the urge there will be to bring events of national interest to all important centers of population. But local facilities also are a necessity to the broadcaster, and the Bell Laboratories have made progress in developing arrangements for this purpose as well.

For studio-transmitter links—where a permanent, reliable, high-grade facility is required—coaxial cable already has been provided in a number of cases and we are now experimenting with a type of specially shielded balanced cable pair which we believe will be even better suited to this purpose in many situations.

For carrying programs from remote pick-up points to the broadcasters' control rooms, we have developed both radio and wire methods; in fact, facilities of both types are in use for bringing programs to this conference.

It has been found that ordinary telephone wires can be used for this purpose when special amplifying and equalizing equipment is provided and the wires are cleared of all branching connections. This method has the great advantage that the wires already exist to most all points of interest.

Micro-wave radio links may be better adapted for local pick-up facilities where "line-of-sight" locations can be found for the transmitter and the receiver. In short, it appears to us that both wire and radio facilities will have fields of use for local pick-ups.

Our plans for future construction are based primarily on our need for coaxial facilities for telephone service. Since these facilities will be provided to take care of growth over a reasonable period of years, we expect to have spare coaxials on almost all of these routes, which can be used for television transmission until more facilities become available. Such use for television, however, requires special terminal and line equipment and other arrangements over and above those required for telephone service.

We expect the embryonic network which now connects this city and Washington with two-way television facilities to be extended to Boston next year, using radio relay. We expect also to make available two additional one-way television circuits between New York and Washington next year. In 1947 we will push westward towards Pittsburgh, and hope to be able to connect such cities as Cleveland, Buffalo, Detroit, Chicago, and St. Louis by the end of 1948 or shortly thereafter. Other cities in this general area probably can be connected not much later than this.

In addition, we expect the southern transcontinental route through Washington, Atlanta, Dallas, El Paso and on to Los Angeles to be completed by the end of 1947, as well as an extension along the Atlantic seaboard to Miami. This does not mean that a coast-to-coast television circuit will be available by that time, although the basic coaxial facilities will be installed and operating for telephone service.

Anticipating Television's Expansion

One aspect of the situation which we expect will be present for the next couple of years is that the number of television network facilities we can make available between these major cities generally will be limited to one in each direction. This means that the several broadcasters may have to share in the use of these networks.

As soon as we can catch up with the demand for telephone circuits or the development of new equipment can be completed—for example, a new type of repeater which will permit us to transmit telephone and television simultaneously on the same coaxial conductors—this sharing can be eliminated. We will endeavor to provide for your individual service needs as rapidly as possible.

Local television facilities for use in picking up programs, as some of you know, have been provided by the Bell companies to supply most of the service requests which have arisen to date. Since the war we have furnished more than twenty such facilities to various broadcasting stations. Both radio and wire arrangements have been used successfully. The development and manufacture of the necessary equipment is being pushed, and next year we expect to be in a position to provide over one hundred of these pick-up facilities.

We have already indicated, to some of you at least, that television network rates necessarily will be considerably higher than those for sound broadcast network service. This is mainly due to the fact that the transmitting facility required is one which otherwise could be used to provide a great many telephone circuits—a fact which is readily apparent when one considers the relative widths of the frequency bands required for television and telephone circuits. Nevertheless, we believe we can make rates for network service low enough to be attractive to the television industry, and hence look forward to a rapid expansion of the industry in which we will be participants.

II. *Keith S. McHugh*

As long ago as April 7, 1927, President Hoover and Mr. Gifford, the president of our company, were the principals in a demonstration of television over a special wire circuit from Washington to New York. On the same day, a television program was sent by radio from Whippany, New Jersey, to a station here in New York. The first public demonstration of color television was given on June 27, 1929, here in New York. And in April, 1930, two-way television was demonstrated publicly between our building at 195 Broadway and the Bell Telephone Laboratories at 463 West Street. This pioneer work helped make possible the developments of today.

Two-way television service is being given between New York and Washington without charge to the industry during an experimental period, and two additional one-way circuits will be available over this route next year.

Next year we also expect to complete for trial the New York-Boston radio relay link which will tie into the coaxial cable system at New York. We expect this relay link to afford comparisons with the coaxial cable of great value as to relative quality of transmission, flexibility, reliability, and costs.

We have also been doing much in the way of experimenting with short links for local pick-up purposes and for short legs off the main networks, using both radio and wire facilities. These show promise equal to that of the longer main networks.

I cannot refrain tonight from comparing this occasion with the early days of broadcasting. I had the good fortune personally to be rather closely associated with those days, as I was the general manager of one of the two Bell System broadcasting stations —Station WCAP at Washington. I participated in the early trials and tribulations of studio design and program techniques, sold one of the earliest commercial contracts to a sponsor, had the usual difficulties with performers both amateurs and professionals, and worked closely with the first general network transmissions, which at the start included all of two stations. Those few years had many headaches, but were of wonderful interest. I have never lost this interest in the industry, even though the Bell System companies shortly disposed of the stations and confined themselves to the business of transmission of programs. Today we are furnishing 135,000 miles of program channels.

Many of you will remember those days when we used cat-whisker receiving sets costing a few dollars, and when almost anyone—if he scurried around diligently—could build a five-watt broadcasting station for a few thousand dollars. Perhaps the dollar risks were not very great; but it was from those modest beginnings that a great industry has grown—an industry which gives employment to thousands of men and women and which brings education, information, and entertainment to millions of American homes.

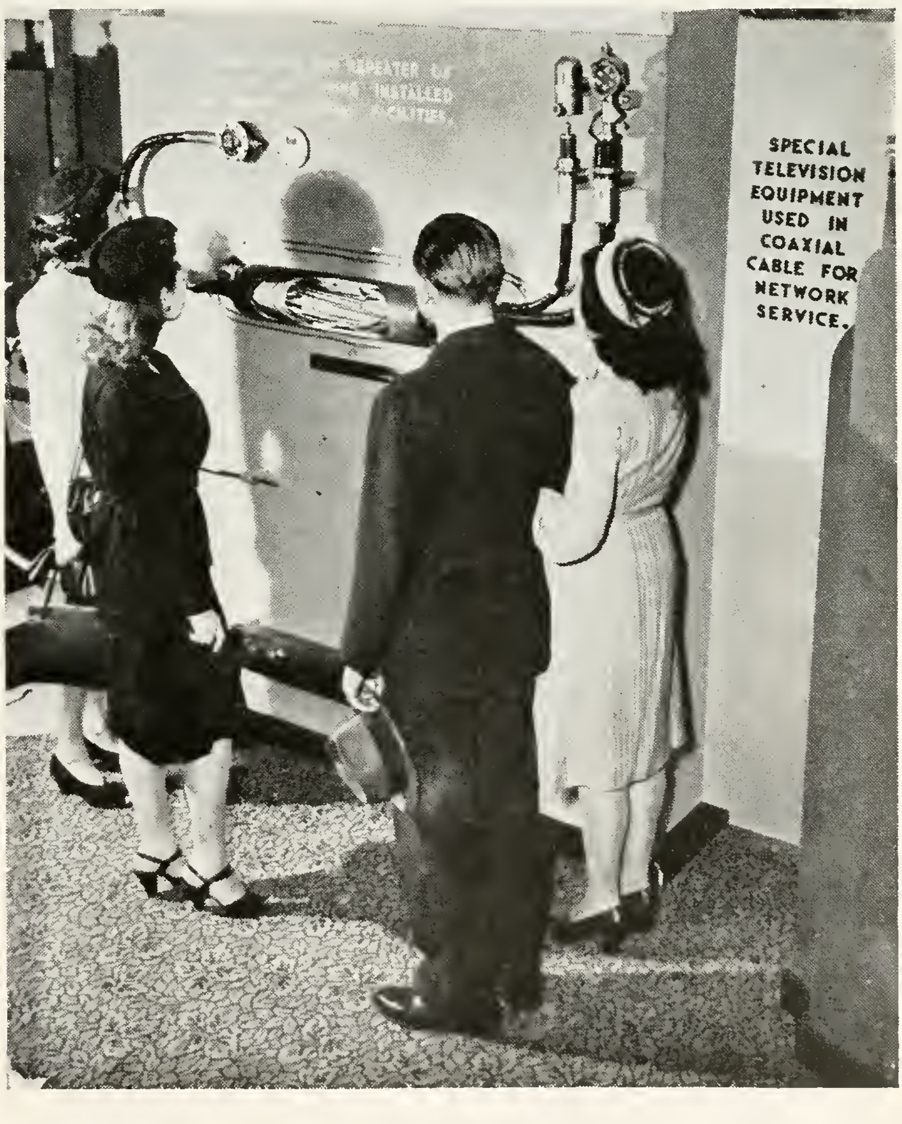
Today, while our techniques and our knowledge are enormously advanced over those days, the risks to the entrepreneurs are very great. I do not know what a modern television station and studio will cost, but it will be many-fold that of the investment in the first broadcasting stations. I do not know what the set manufacturer must risk in our highly competitive and fast-changing markets, but it must be very large compared with that of the set manufacturer in 1922. The networks and the motion picture people must necessarily be contemplating extensive outlays in experimenting with programs, films, and the equipment and techniques necessary to make this infant industry grow to lusty manhood.

Our own risks in the comprehensive program to obtain split-second projection of television signals from one part of the country to another are not inconsequential. There are hazards of technical quality; there are hazards of production; hazards concerning frequency assignments; there are the usual hazards of intense competition in a new art which may be changed suddenly and violently over night by some unexpected invention or development; and, of course, there are the hazards of the loss of large sums of money.

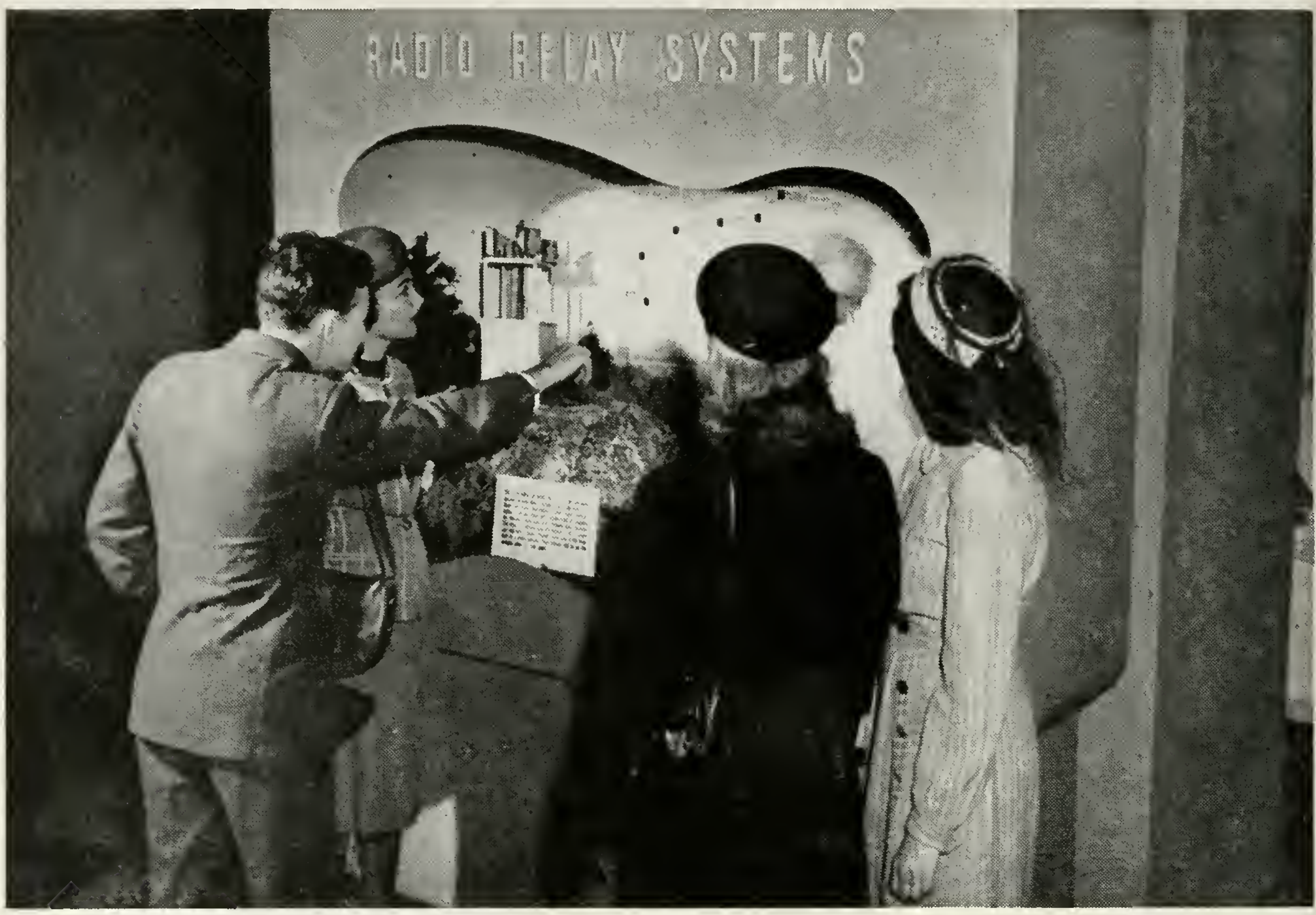
Fruit of Free Men's Dreams

AND WHAT FAITH prompts the challenging and the risking of these hazards? That faith is simple. Its roots are deep in the belief that the American people will be as eager to have education, information, and entertainment brought to their homes to see as they were keen to hear; that in this modern day of instant communication, the extension of the ability to see distant places and people will add as much as or more than the extension of the ability to hear.

Nowhere but in America could a



A cutaway section of a coaxial cable splice, and a repeater and a gas pressure gauge, were included in the Bell System's exhibit of television equipment



This diorama of the Bell System's experimental radio relay system now being installed between New York and Boston was displayed at the television conference

project of this magnitude be undertaken with the zest and zeal and push essential to its early and successful completion. Just as our form of government has permitted free men to span this continent by rail and by air, to perfect a communications system which permits connection with the wide world, so too America encourages free men to risk their capital and their reputations in projecting sight to distant places. A great building, a bridge, a tremendous dam are magnificant works; but they are built best and lift the spirit highest when they represent the fruit of free men's dreams and of their vision and courage in making these dreams come true. We are proud and grateful that we have this heritage, and that our countrymen have the good sense to fight to preserve this right of free men to take a chance.

III. *Oliver E. Buckley*

It is natural that the Bell System should have an interest in television for, like telephony, it is a system of transmitting intelligence electrically. The fundamental problems of transmission for telephony and television are the same, and the same medium of transmission which works for one will work for the other. In each case, one converts intelligence into variations of strength of an electric current, transmits those variations over an electric circuit, and then reconverts them.

But there is a significant difference in television and telephone signals, in that the rate of variation differs widely in the two cases: for telephony, thousands of variations per second; and for television, millions. This is basically the result of the fact that we can absorb intelligence with our eyes much more rapidly than with our ears. In a given length of time, we can learn far more from looking at a picture with our eyes than we can get through our ears from hearing a description of it. Indeed, the signals of television must vary roughly a thousand times as fast as those of telephony; or, to put it another way, television takes a frequency band a thousand times as wide as that required for telephony.

Except for this, the problems of transmitting telephony and television are nearly enough the same so that the facilities for transmitting telephone conversations can be adapted to transmitting television.

Three Transmission Paths

THE THREE WAYS in which we transmit telephony, and how they are applied to television, are: first, by wire; second, by pipes or tubes; and, third, through open space by radio.

Any pair of wires which carries a telephone conversation can carry television, but because of the high frequencies involved it won't carry so far before the signals fade out to such a low level that it is necessary to boost them by an amplifier, or in telephone parlance a repeater. So we can use for television the very wires which are buried under city streets for telephone service, if we just apply to them enough amplifiers along the television route. It takes actually about one amplifier every mile. This method works well in practice but has a limitation in that we can use for television only a few of the hundreds of pairs of wires in a particular cable. If we try to use more, we get crosstalk between the different wires in the same cable. However, there are a lot of cables, and many television programs can be thus accommodated in existing cables.

A slight modification of the ordinary telephone cable, by including in it wires spaced a bit farther apart and shielded by a wrapping of metal foil, will let us transmit any desired number of television channels in telephone cables, and in this case the amplifiers may be placed farther apart. We are going ahead with the development of cables thus adapted for television, and they promise to play an important part in local television distribution of the future.

THOSE same methods of transmission of television over wires could be developed for long distance transmission as well as for local, but we have found it more economical in long distance telephone transmission to send the signals through a pipe or tube with a wire down the middle. Such a tube is called a coaxial conductor, and a cable embodying such tubes is called a coaxial cable. Over a coaxial cable, we send hundreds of telephone conversations at once. Alternatively, we can transmit television. But because of the high frequencies involved in television, one television program demands the facilities which would accommodate hundreds of telephone channels.

As presently equipped for telephony, the coaxial cable handles television quite successfully and with little loss of detail. We recognize, however, that it does not go high enough in frequency at present to give the detail that will be demanded for television of the future. To meet that situation, we are hard at work pushing up the limit of frequency of the coaxial system.

Now a nice thing about the coaxial cable is that you don't have to change the cable to raise the limit of frequency, but only to replace the amplifiers by new ones more closely spaced and capable of working at higher frequency. We now transmit up to about 3 megacycles and expect with new amplifiers to advance that limit to 7 megacycles or more. But there is no basic reason for stopping there if ultimate demands go higher.

At present, we are not planning to send more than one program through a single coaxial tube. Hence the number of programs we can transmit over a given route will depend on the availability of tubes in coaxial cables. The most we now have in any cable is eight, and some of these must be held for telephony. But if we are willing to look far into the future, there is no reason for assuming such a limit. Methods will eventually be developed for hollow pipe or wave guide transmission which can handle groups of television programs as we now handle groups of telephone channels. There is no technical limit to what may be done with conducting structures. It is only a matter of economics and the demand for service.

THE THIRD MEANS of transmitting television is through open space by radio. Again, the means which we are developing for telephony will meet the needs of television. Here, as with the coaxial cable, it is economical to carry in one bundle large groups of telephone conversations. Alternatively, or additionally, we can carry television. A system for doing this is already in operation over the 20-mile span between our laboratories at 463 West Street, New York, and Murray Hill, N. J. The equipment in this installation has been engineered with the objective of ultimately meeting the severe reliability requirements of telephony, and it is a pattern for the equipment soon to be installed on the repeatered radio route from New York to Boston. This system may be looked on as an alternative to coaxial cable.

Now, it is a good question to ask what sets the limit to accomplishment in this problem of transmitting television signals. There are many factors which I will not go into, but one which is outstanding. As you all know, the arts of television and long distance telephony have developed around electronic tubes, and their advance has been coupled with the advance of electronics. As means have been devised to make vacuum tubes operate at higher and higher frequencies, the way has opened for broadband telephone transmission and for the transmission of television. One limit after another has been overcome.

I can illustrate by the transmitting tube presently in use in the West Street-Murray Hill beam radio circuit. It is one of the Klystron type which was designed by Dr. Samuel of Bell Telephone Laboratories just prior to the war, and made use of principles discovered by the Varian brothers of Stanford University. The Klystron provided a way to overcome the limit set by the time it takes electrons to travel the small distances between the electrodes in the amplifying tube. It does this by making use of variation of velocity of electrons. This is sometimes referred to as bunching, for the distribution of electrons is varied along the electron stream in contrast to the older method of varying the number of electrons which could pass a grid.

The availability of this type of tube has let us go to 6,000 megacycles or more, which means waves less than 5 cm in length. These short waves can be focused into sharp beams, and this permits using low power to transmit from one station to the next. But this tube, too, has its limits. One cannot amplify very much with a single tube of this type. Also, the band width, and so the amount of intelligence or detail of picture, is limited, especially when you come to long distance transmission with many repeater points.

Dr. John Pierce with the traveling-wave tube he developed at Bell Laboratories

Recently this limit has again been broken, with a new tube working on quite new principles which I want to tell you about. It is a tube which was developed by Dr. John Pierce of Bell Telephone Laboratories and is called a traveling-wave tube. It works by having a stream of electrons operate on an electric wave much as wind operates on the surface of a pond to build up waves on water. Here in a bulb at one end of it is an electron gun which shoots a beam of electrons down a tube which is like a gun-barrel, to a target at the other end. Inside the gun-barrel is a wire wound in the form of a helix or spiral and running the length of the gun-barrel, but not connected to the gun or the target. This spiral wire carries the electric wave to be amplified, the wave being fed in at the end close to the gun and out at the end close to the target.

In traveling the length of the spiral, the wave follows the turns of the spiral wire so it takes about 13 times as long to go the length of the gun-barrel as it would to go the same distance in a straight line. Thus the wave is slowed up enough so that the beam of electrons going down the middle can be driven faster than the wave. This is the condition for the electron to push the wave or feed energy into it. Thus an electron wind blows the wave up and it comes out at one end much stronger than when it went in at the other.

With a tube of this sort, we can amplify much more. The limit on band width is greatly extended. We can now think of transmitting numbers of television programs and bundles of telephone conversations at once through the same system and over any distance that we can span by an array of line-of-sight radio repeaters. The same principles in tube design can also be applied with advantage to coaxial and wave guide systems.

It should be pointed out that this tube has not been perfected. It is, on the contrary, an early development model, and has yet far to go before it becomes the practical and reliable instrumentality which can form a part of a commercial transmission system. But it does serve to illustrate my point, which is that there is no limit to what can be done in the electrical transmission of intelligence. The only limit is in the intelligence to be transmitted.

Being somewhat familiar with the Bell System's relations with the public, we can only say that we know of no other private (or public) organization more determinedly solicitous of its clients' welfare, except for a touch of paternal sternness about talking too long during wars and an unrelenting impression of conducting its whole vast, complex operation solely for you. Subjected to its bright, old world charm long enough, any susceptible person could begin to get the idea that when he picks up the receiver, a hush comes over the Bell domain, thousands of technicians spring to their posts, trumpets blow somewhere in the distance, massive gears begin to grind, and a million ergs of electrical energy are spent just so you can say —"Hello, dear. Will you bring a loaf of bread on the way home?"

From an editorial in the *Main Line Times,* Ardmore, Pa.

The Bell System's War Record and Its Accomplishments of the Past Twelve Months Inspire Confident Expectation of the Rapid Restoration of Service Standards

"Service to the Nation in Peace and War"

William H. Harrison

Editors' note: The following paragraphs give the substance of Vice President Harrison's address to the 21st General Assembly of the Telephone Pioneers of America in Cleveland on September 18.

THINGS HAPPEN so fast and change so rapidly, it is hard to realize we are starting our second post-war year, and before touching on current matters I want to make brief reference to the Bell System at war.

There stands in the lobby of the A. T. & T. headquarters building in New York an impressive and beautiful memorial dedicated to SERVICE TO THE NATION IN PEACE AND WAR. The Operating Companies, A. T. & T., the Western Electric Company, the Bell Telephone Laboratories, individually and collectively gave substance and life to that dedication during the trying four war years.

The pattern of war devotion of the Bell System was the pattern of our nation as a whole. I had the good fortune to observe a fair cross-section of activities on the home front here, in Canada and in England, and on the combat fronts; and while in no way detracting from the valor and sacrifice of those doing combat duty —for their contribution to the cause of victory outdistanced all others—it is a privilege to pay tribute to the men and women in every walk of life and at every cross-roads of America who gave so much to make victory possible. Never before in the history of our nation or any other nation have a people so successfully and so unselfishly devoted themselves to the cause of war. I saw unbelievable and indescribable sights: fine examples of energy, devotion, enthusiasm, ingenuity, in factories and shipyards and communication and transportation work, in the Red Cross, the U.S.O., the Selective Service Boards. In common parlance, the butcher, the baker, the candlestick maker gave long hours—late and all-through-the-night hours—many with anguished hearts for their loved ones in exposed areas.

Out of it all, never shall I cease to marvel at the spirit of America, and the spirit of our Allies of the British Empire and Soviet States of Russia—for I saw something of what the peoples of those countries gave to the cause of their victory and our victory.

Hand in hand with this pride in what our country did is pride in what you of the Bell System did. I wish time permitted telling of some of the spectacular accomplishments of the Operating Companies, and more particularly of the products of that great development-engineering-manufacturing team, Western Electric and the Bell Laboratories. On ship, in the air, on the ground in tanks and combat vehicles, behind the lines and in the forefront of the attack, their detection radar, gun firing radar, radio, wire communication, navigation aids, ammunition devices—all formed the backbone of the Army and Navy electronics equipment. Simply by way of illustration:—over half the radar used was the product of this great Bell System team.

High-lighting the job, at battle stations on every combat front, 68,000 Bell System men and women in the uniform of their country gave striking testimony that Bell employees know and accept the responsibility of citizenship. I saw them in far-off lands under strange and trying conditions, and I know of the character they made for themselves and for the Bell organization. In strange lands, comradeship of locality exerts a strong bond: Texans find comfort in other Texans, Californians or Brooklynites in fellow Californians and Brooklynites; but the bond of Bell comradeship is far more binding.

There is great satisfaction that V–J Day found us ending a determined and glorious period of service. Truly the war years were the System's finest, unequalled for sheer brilliance of performance and devotion to service.

As we swung into the road of service to the nation in peace, we were faced with all the pent-up problems of the war years.

Some 2,130,000 applicants were waiting for service. Our force was 60,000 hands short. Our plant was overloaded in a measure beyond the engineers' reckoning. Our manufacturer scarcely had ceased full time war production.

There was apparent reason to count on a pause in telephone demand. Instead, new applications mounted to heights beyond any previous experience, beyond predictions—almost, it might be said, beyond comprehension.

For the 12 months to date, there has been a net new demand for 3,400,000 main telephones—more than three times the highest pre-war year. Along with this, calling rates increased; material shortages became acute; the supply situation became worse, then better and now worse; war and wartime devotion and tolerances faded.

Burdened with what seemed an impossible task, 12 months of peace-time operations have produced achievement beyond expectation: the rapid reconversion of Western Electric, a truly remarkable job; building up of the System forces by some 160,000 people; renewed determination on the part of the men and women to serve.

To illustrate better the magnitude of recruiting and training: 12 months ago the operating forces totaled 350,000. During this period 315,000 people have been added—a tremendous and expertly handled job.

For the 12 months, total station gain has been 2,900,000 stations. Some 80 percent of the applications held a year ago are now cared for. There has been a 20 percent increase in volume of calls—with little additional plant but with greater stability of service and with no loss of public good will and confidence. These, I submit, are achievements of distinction—worthy of most cherished Bell System tradition.

You know far better than I that the going has not been easy—nor is it likely to be easy for some time to come. As fast as the older held applications have been cleared, they have been replaced by new ones in even greater number. And physical relief—although Western production and shipments already are well above the best pre-war levels and will be coming through in increasing volume in the months ahead—up to now has not been enough to make any considerable dent in existing shortages. In spots, facilities are not equal to the present volume of calls; and in these spots service labors and for want of facilities will continue to labor, and we will be unable for months to come to give the public the kind of service we know they should be receiving.

Yet in considered perspective, more people are getting more service, lower cost service, and better service than ever before. And from here on in, with but a reasonable break from outside suppliers and influences, and recognition by regulatory bodies of increasing costs and need for large sums of new money for expansion, measurable progress will continue.

Though there are hazards ahead, confidence born of proven competence runs through the entire fabric of the Bell System organization. It is this proven competence which soon will again adequately serve the nation in peace.

Pioneers can take satisfaction and modest pride in the knowledge their experience, their ideals, their deeds give force to this expression of confidence. And I want to close on the note of pride I know each of us has in being part of the Bell System—that great institution dedicated to the Service of the Nation.

Farewell to WEAF

Keith S. McHugh

When the call letters of radio station WEAF were changed to WNBC, on November 2, Mr. McHugh, who is A. T. & T. Vice President in charge of Public Relations, was invited to take part in the program of observance. His remarks follow:

I SUPPOSE that relatively few of our listeners are aware that the American Telephone and Telegraph Company founded radio station WEAF in 1922 and managed it for the first four years of its existence. This was a pioneering venture in at least two important respects.

First, we were deeply interested in exploring every development that would make for better communication service, and WEAF was an extremely valuable proving ground, so to speak, for our study of radio techniques.

Second, and even more important, this station, in the days of telephone company management, pioneered the American method of supporting the expense of broadcasting service by selling time on the air to advertisers.

Although it is now 20 years since our company brought its own experiments in broadcasting to an end, our service *to* broadcasting has steadily grown and will, I expect, continue to do so. Every day, as Ben Grauer here speaks to WEAF listeners, he is actually talking over a telephone line. Your voice, Mr. Grauer, goes over the line from the studio to the radio transmitter and then is broadcast to all of your listeners. And not only do our telephone lines connect studios and transmitters—135,000 miles of them also link stations with other stations to make radio networks possible.

Thus it is that radio listeners in New York or San Diego can enjoy a football game in Chicago, just as if it were being played in their own neighborhood. And for the future, we are now building new types of facilities which will make it possible to send television programs over nationwide networks.

All of this is a far cry from the rather humble beginnings of WEAF in 1922. In August of that year we gave our first evening program, in an improvised studio in the long distance telephone building at 24 Walker Street, New York. The program included vocal and instrumental solos by amateur musicians among our local telephone people. There was also a baseball talk by Frank Graham, a recitation of a poem by James Whitcomb Riley, and music from records and a player piano.

Naturally, we of A. T. & T. can't help feeling a bit proud that *our* station has played such a significant part in broadcasting history and achievement. Tonight we join in saying "hail and farewell"—farewell to call letters which we instituted and which have been so long familiar to radio listeners—and a friendly hail to WNBC and to the new opportunities for radio broadcasting in the years ahead.

Nitrogen Gas Introduced under Pressure Protects Service Both by Transmitting Signals When a Leak Occurs and by Excluding Moisture until Repairs Can Be Made

Damaged Telephone Cables Send Their Own Alarms

Leon W. Germain

SPRING FLOODS had disrupted service on two aerial long distance telephone cables crossing Pennsylvania by way of Shippensburg and Bedford. The two remaining cables, routed through Altoona and Lewistown, were taking a severe beating from the water and were already showing signs of trouble. It was not long after the first two cables had failed that alarm signals at Lewistown and Altoona indicated damage to one of the two remaining cables, and early the next morning another signal in the Altoona testroom heralded further trouble.

Promptly after the first alarm, repair men were dispatched from both Lewistown and Altoona; but with the roads flooded, both crews were soon stopped. It looked like the final stage of a complete service interruption on one of the most important Long Lines toll routes.

Shortly after the second alarm came in, the Altoona testroom received a telephone call from a farmer near the scene of the trouble. He reported that the pole line near his farm had washed out, dropping the cables into the water. In fact, he had been out in a boat (most providentially available) and noticed bubbles coming up from one of the cables. He went on to say that he had often watched the section man putting gas into the cables, and as there were valves above water on each cable, he would be glad to attempt the job of gassing them if gas could be made available to him.

(The farmer alluded to the standard practice of keeping long distance telephone cables filled with nitrogen

Testing the gas pressure in a reel of cable before it is loaded onto a cable-laying train to be plowed into the ground. Low pressure would indicate a leak in the cable sheath

gas under pressure, so that if the cable sheath is punctured, the gas pressure prevents the entrance of moisture.)

This obliging and enterprising individual went on to say that there was a dry meadow on his farm where a small airplane might land with the necessary equipment.

Just about that time, two pairs in one of the cables failed—due, obviously, to moisture. It was plain that, with the loss of gas pressure, it would not be long before the cables were waterlogged.

Flying weather was not good, but the Altoona airport was dry, and a pilot offered to try to reach the farm in a small cabin plane. He figured he could carry one man and a cylinder of gas, or two cylinders of gas. After considerable discussion, it was decided that the second cylinder was more important, and from what the farmer had said, it would not be too much. So the chief testboard man wrote out some instructions which he gave to the pilot, with a prayer that he and the farmer could work it out between them. Then he went back to the testroom, to be met with the news that two more pairs had failed.

In the meantime, the farmer had marked off a landing strip. He signalled the pilot and the latter tried for a landing. On the second attempt he made it, and he and the farmer hauled the gas cylinders over to the cables and connected them to the valves.

Altogether, only eight pairs failed out of about 600 in those two cables. When the water receded a few days later, the sheaths of both cables were found to be punctured in several places.

THE IDEA of keeping nitrogen gas under pressure in toll cables as a means of constant protection against moisture developed about 20 years ago out of the use of vapors of vari-

"Flash testing." The sleeve covering the splice in this buried cable is being painted with soapsuds, which will bubble if gas can escape through leaks in the solder

ous kinds to test the tightness of cable sheaths. The results were so gratifying that all toll cables maintained by Long Lines are now kept permanently under gas pressure. Associated Companies have likewise adopted this protective device, and the greater part of their toll cables are kept filled with gas.

Gas has done a remarkable job in reducing cable failures and maintaining the continuity of toll service. This was particularly important during the War, when every available facility was urgently required for the war effort. It is no less important now, when all toll facilities are so loaded that if serious troubles or failures should occur on any of the toll cables, there are almost no spare facilities available over which the services may be re-routed.

It is significant that in 1929, when the program for gassing cables was getting under way, there were 247 pair troubles a month per 1000 sheath miles of ungassed underground cable; while in 1945, with all underground cables under permanent gas pressure, this figure had dropped to 12 pair troubles a month per 1000 sheath miles. Similar figures for aerial cables show 91 pair troubles a month per 1000 sheath miles in 1929 against 29 in 1945.

It will be noted, in the figures given above, that the use of gas had a greater effect in improving the performance of underground cables than was the case with aerial cables. One reason for this is that underground or buried cables frequently lie in moist ground or even under a head of water so that any small crack or hole developing in the sheath may, without the protection of gas pressure, immediately wet the entire cable. Another reason is that underground or buried cable, protected by Mother Earth, is not exposed to certain hazards resulting in damage to wires in aerial cables which gas pressure cannot prevent. Among these are fires near the aerial cable line, and bullets fired by unskilled or careless hunters.

Toll cables are charged with dry nitrogen gas at a pressure of seven pounds per square inch in aerial and ten pounds per square inch in underground and buried cables, figured at a temperature of 60° F. These pressures will, of course, be greater at higher temperatures and less at lower temperatures. The higher pressure used in underground and buried cables is to afford greater protection against moisture when a cable is submerged under water. For every two feet of water over the cable, one pound of pressure will successfully resist the entrance of moisture.

Gas-tight Cable Sections

CABLE under pressure is divided into gas-tight sections 10 miles or more in length. Every two or three miles an alarm "contactor" is installed. A contactor may be compared to a steam gauge, the needle of which will close a contact when the pressure in the cable is reduced to a predetermined value and thereby signal a nearby testroom. At about half-mile intervals along each cable, valves similar to ordinary tire valves are soldered into the cable. These permit the cablemen to determine the pressure at each of these points with considerable accuracy—and, if desired, to add gas at those points.

Let us assume now that a section of aerial cable is filled with gas up to pressure. A rifle bullet intended for a deer drills the cable. It is a soggy Fall day of wind and intermittent rain. If it were not for the gas escaping through the holes made by the bullet, water would soon begin to soak the paper insulation of the 600 wires inside that cable. But the gas pressure keeps the water out.

At the same time, the escaping gas naturally causes pressure in the immediate vicinity of the hole to fall; and when it has dropped three or four pounds at an adjacent contactor, a contact closes. The contactor, through a pair of wires in the cable itself, rings a bell in the testroom 30 miles up the pike. Although some gas has already been lost, it leaks slowly through even a relatively large hole, and the remaining reservoir of gas in the cable will keep out the moisture for a number of hours after a contactor has operated.

Since all of the contactors in a considerable stretch of cable are connected to a single pair of wires, there is no indication as to which particular contactor gave the alarm. However, by the use of a Wheatstone bridge, the man at the testboard can measure the resistance of the circuit completed by the contactor, which will immediately tell him which contactor it is.

Repair men are sent out to the vicinity of the contactor which operated. As these are at two- or three-mile intervals, the men might have quite a time locating a small bullet hole on an aerial cable, especially if it was dark by the time they got there. They have the tire valves, however, to help in the search. They note the pressures at valves on either side of the contactor and find that these pressures drop off and rise again. Obviously the break must be between the two valves with the lowest readings.

This is still not close enough, since the valves are half a mile apart. However, if the searchers plot on cross-section paper the pressures shown by a number of valves on either side of the low-pressure point, and then draw lines through them, thereby establishing the "pressure gradients," they will pin the location of the sheath break down with satisfactory accuracy. This operation is illustrated on page 168.

Sometimes the physical damage suffered by a cable results in "crosses" or "grounds" on some of the wires. In such a case the testroom man can make resistance measurements and locate the break without waiting for the repair gang to determine pressure gradients, for the Wheatstone bridge will put its finger down very close to the actual trouble.

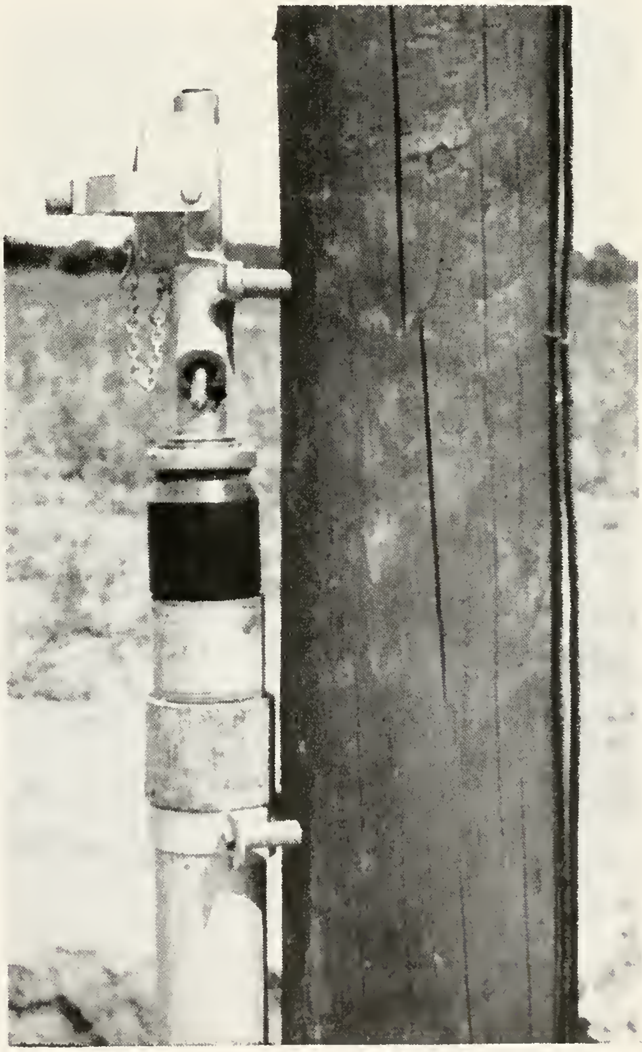
Where Gas Would Have Helped

In the early days, when gas in cables was unheard of, the only prevention against porous solder work and punctured sheath was to make a time-consuming and laborious visual inspection—which might or might not detect a defect. As long as joints were properly sealed and the sheath was unbroken, the cable would give no trouble; but when they were not, there was plenty of work for the outside maintenance and testroom people. Almost any not-so-old-timer could tell stories of drowned cables. For instance—

Some years ago, a group of cable splicers had just finished cutting over open wires into a brand-new toll entrance cable. It was a raw day with high wind, and by late afternoon a blizzard had set in. The men who had been working on the poles were still thawing out frozen fingers when the report came from the testroom that one of the circuits which had been cut over had failed. While they were looking for trouble at the terminals, another circuit went out, and from then on it was a succession of trouble reports.

Measurements located the trouble near a river crossing. There was nothing for the splicers to do but spend most of the night back-tracking on their job, cutting the wires back to the old open-wire line.

The next day they dug down to the cable beside the river crossing.

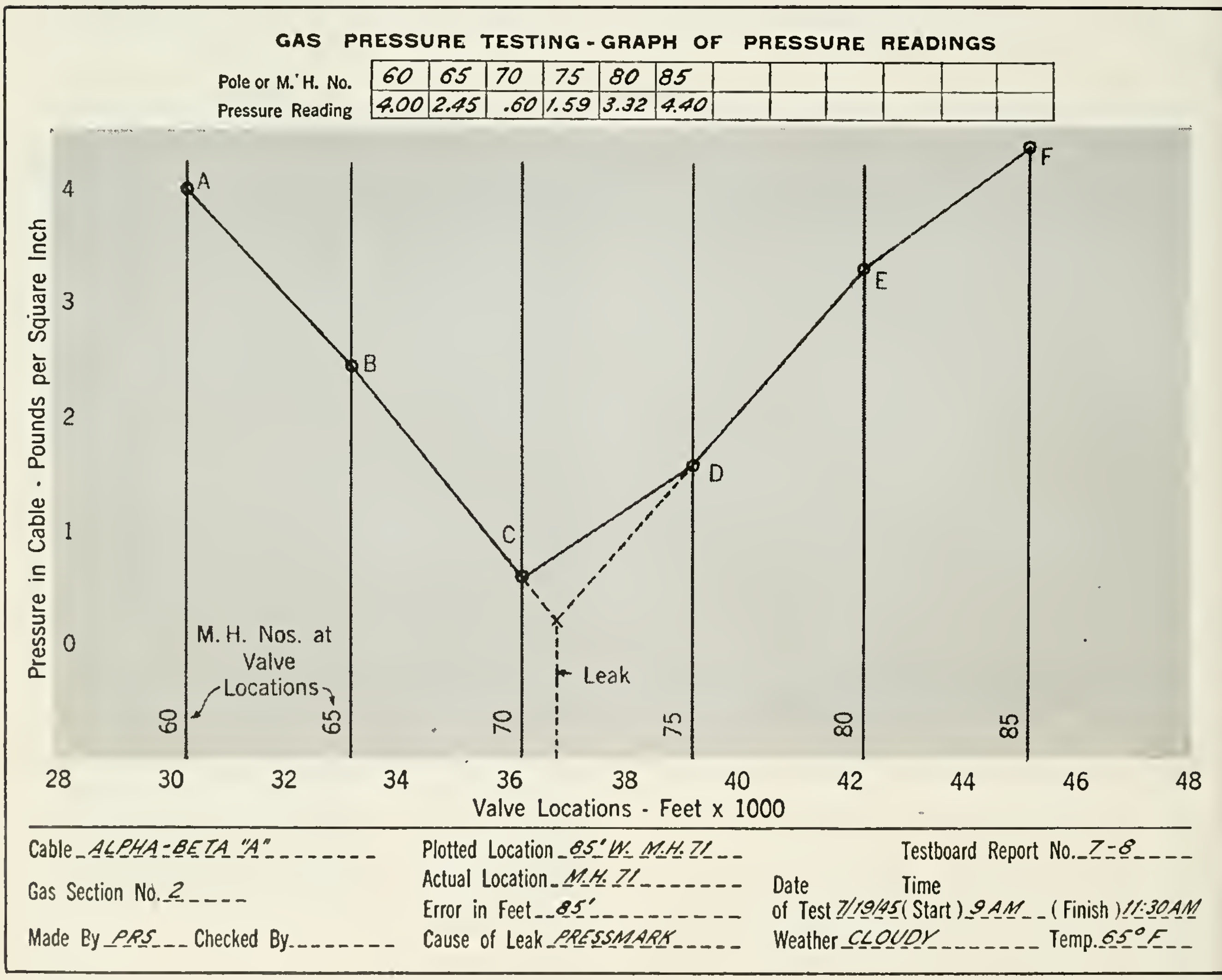


The pipe at the left of the pole, rising from a gas-filled buried cable, permits testing of both the gas pressure and the contactor alarm at this point, and also enables the cableman to talk with the test board

There was a hole in it, covered with a clumsy wooden clamp. Investigation showed that some workman, digging a ditch, had struck the cable with his pick a number of days before, and instead of reporting it, he had covered the hole with the clamp. The storm on the day of the cutover had raised the water level until it reached the cable. Gas pressure would have kept the water out of the cable and given warning of the break, so that it could have been repaired before the cutover was made.

On another occasion a cable in a duct underneath a bridge failed when a flood submerged the duct. When the water receded, a large hole was found in the cable sheath, evidently caused by lightning. As the duct was normally dry, it is not improbable that the cable had lain in this condition for months.

These are typical examples of what used to happen before the days of gas pressure. Holes and cracks would develop in cable sheaths, but in the dry season no one would have warning of them. When the rains descended and the floods came, every testroom in the storm area would be in an uproar. In contrast to this, gas pressure tips off neighboring testrooms soon after a break of any kind



A pressure graph, showing how readings at valves on either side of a low-pressure point may be charted to locate the point of cable sheath damage occurs in a sheath, permitting repairs, before service is affected.

Developing Gas Methods

An early use of gas for the purpose of testing the tightness of solder work in a telephone cable was initiated about 1912 by the Bell Telephone Company of Pennsylvania. In this use, plant forces gave a cable what was called the "flash" test: dry air was forced into a section of the cable and they listened for gas leaks and checked gauge readings at either end of the cable for 10 or 12 hours.

Dry air was also recognized as a means of dessicating a wet cable. When the air was forced through such a cable, it dried the paper insulation—just as one of those hot air devices in a washroom dries the hands.

The great difficulty experienced in the use of air was to free it from moisture. Moreover, the air-conditioning apparatus usually consisted of a compressor and a number of large storage cylinders containing trays of calcium chloride, put there to absorb the moisture. This apparatus was cumbersome, and required care to produce air sufficiently moisture-free.

Soon after World War I, the French introduced the process of testing cables with an absorbent gas, carbon dioxide. This was much more effective and economical than the chemically dried air.

Although the carbon dioxide apparatus was superior to the air-drying equipment, it had numerous disadvantages. Unless the tanks were kept at a reasonably high temperature, carbonic snow formed at the outlet, which did not improve the flow of the gas. Also, water formed in the bottom of the tank, which had to be drained off.

In 1925, the A. T. and T. Company's Department of Development and Research (now incorporated with Bell Telephone Laboratories) issued the results of tests with oil-pumped nitrogen, which indicated that it was superior to either carbon dioxide or dried air. While the supply of this was limited, sufficient quantities became available and it has since been universally used in the Bell System. It has none of the disadvantages noted above for carbon dioxide. It is obtained from the manufacturer in cylinders under a pressure of about 2000 pounds per square inch, and regulators are used to reduce the pressure at the outlet to the desired value.

In July 1925, Long Lines made its first extensive use of nitrogen gas for testing, on the aerial line being built between South Bend and Toledo. While the main thing this test proved was that the soldering job on this cable was 100 percent in the sections tested, it suggested the idea of making similar tests on an underground cable. At that time the "C" cable was being placed between Boston and Providence. The splices on this underground cable were "flash tested" with gas pressure and 38 small leaks were found in the 760 splices tested.

Shortly after this, in the Spring of 1927, gas pressure was introduced into the old Philadelphia-Reading "A" cable for a distance of 30 miles, as a permanent protection from excessive moisture trouble occasioned by ring cuts and cracks in the sheath. It was on this cable that the first gas pressure plugs were introduced.

These plugs, shop manufactured sections of impregnated cable about 10 ft. long, spliced into the main cable, prevented the gas from flowing out of the terminals and into the many branch cables. The first arrangement had valves at intervals of 2½ miles, with the gas under 15 to 20 pounds' pressure.

After the cable was charged, daily pressure gauge readings at the valve points indicated low pressure in two sections, each about three miles long. With the object of locating the cause of leakage in these two sections, a gas flow indicator was developed. This consisted of a U-shaped glass tube filled with oil. Since the gas pressure decreases as the leak is approached, by connecting the indicator between two valves a few feet apart, the column of oil would be depressed on the high-pressure side and rise on the low-pressure side—which would be in the direction toward the leak.

This worked all right for large leaks; but when the location of small leaks was attempted, it was soon realized that the old familiar Charles's Law operated inside telephone cables as well as anywhere else, and consequently gas expands in a section of higher temperature and flows to one where it is lower. This introduced considerable difficulties in the search, since it upset the small differences in pressure on each side of the leak.

One ingenious proposal for the solution of this difficulty was the use of scented gas to locate trouble. Gas scented with peppermint was tried, but it was found that the paper insulation around the wires in the cable absorbed the peppermint flavor, and the escaping gas was odorless. Other odors were equally ineffective, and the problem in this particular case was finally solved by isolating the low sections through the installation of temporary gas plugs. This led to the introduction of permanent gas-tight plugs at 10-mile intervals to reduce the length of the section under test. These plugs were made in the field by cutting away a section of the sheath, covering it with a lead sleeve and filling the sleeve with a hot wax or asphalt compound.

Gas Pressure Is Standardized

During the next few years, interest in the possibilities of gas pressure to reduce cable failures was at a high level in the Long Lines Department. Late in 1927, instructions were issued to the field to pressure-test all cables being installed, in order to locate construction defects. About this time, it was also decided to place all Long Lines underground toll cables under permanent pressure, and in 1929 a similar treatment was decided upon for aerial toll cables. All the experience with methods and materials which had been gained during the trials was then issued in instruction form.

In the Summer of 1931 an exhaustive series of tests was made by the Bell Laboratories on a 25-mile section of underground cable between Morristown and Chester, N. J. As a result of these tests, it was concluded that the pressure in underground cable should be reduced to nine pounds and contactors set to operate at six pounds, and in aerial cable the pressure should be six pounds with contactors set to operate at three pounds. The contactor spacing was set at two miles, the valves (for recharging and pressure testing) were spaced at 3,000-foot intervals, and the length of a gas section was set at 10 miles.

The Morristown tests resulted in numerous other important contributions to gas pressure practices. Engineers developed a formula for charging cables with gas and introduced a new type of gas flow indicator and mercury manometer for locating small leaks.

The gas flow indicator is a hollow glass valve so arranged that when gas in the cable is by-passed through it from valves installed a few feet apart on the cable, the flow of gas will blow ammonia fumes over a small strip of chemically treated paper and cause it to turn pink. The direction of flow is determined by observing at which end of the valve the treated paper changes color.

The manometer consists of a long calibrated glass tube containing a column of mercury similar to that in a thermometer. When the manometer is connected to a valve and the gas pressure in the cable applied, the column rises. This allows a much more accurate reading of pressure than had been possible with the standard pressure gauges, and thus greatly increases the precision of leak location.

A similar test was undertaken a few months later on an aerial cable between New York and Southfields. Among other things, these tests showed that variations in temperature throughout an aerial cable were too small to seriously mislead cablemen in locating a large leak, but did cause difficulty in finding a small one. It was also found that there were certain periods when temperature changes were at a minimum, at which times it was much easier to find a small leak. The best times, the tests indicated, were on a cloudy day or in the interval between dawn and sunrise,—a discovery not hailed with delight by cable maintenance men.

Refining the Process

Some idea of the exhaustive nature of the studies of the subject of vapor phenomena in cables is revealed by a glance at the instructions covering gas pressure work. For example, corrections must be applied for change in altitude of a cable climbing a mountain, as well as for variations in temperature and in the barometer. Allowance must also be made for the different resistances to the flow of gas in cables of various types and make-up. Gas sections longer than the original 10 mile length have been found practicable in the newer cables, and where two cables are on the same route they are connected together at the plugs to form so-called circular gas sections. This latter arrangement is a distinct advantage from a protection standpoint, since it does away with the danger that a leak occurring close to a plug will quickly drain the gas on the plug side and allow water to enter the cable.

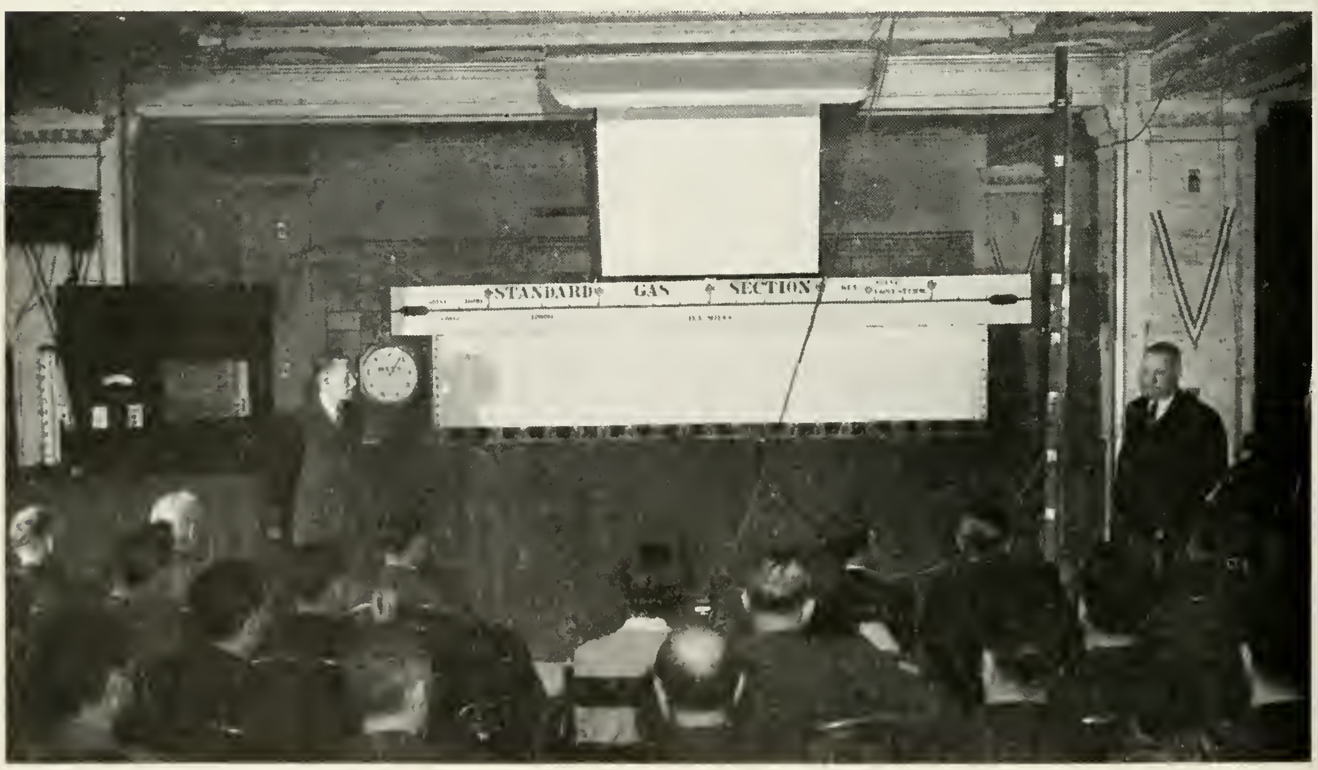
In order to keep the maintenance and supervisory personnel posted and trained in the latest developments and methods, gas pressure training courses have been held throughout the Long Lines Plant Department. A novel feature of these courses is apparatus which visualizes the behavior of the gas pressure in a cable when leaks occur. This consists of about 1000 feet of small-size cable simulating a normal gas pressure section, with 21 manometers connected at 50-foot intervals and mounted side by side. These manometers show the pressure along the cable and permit the men to see at a glance just what happens to the pressure under various conditions.

Long Lines Training Program

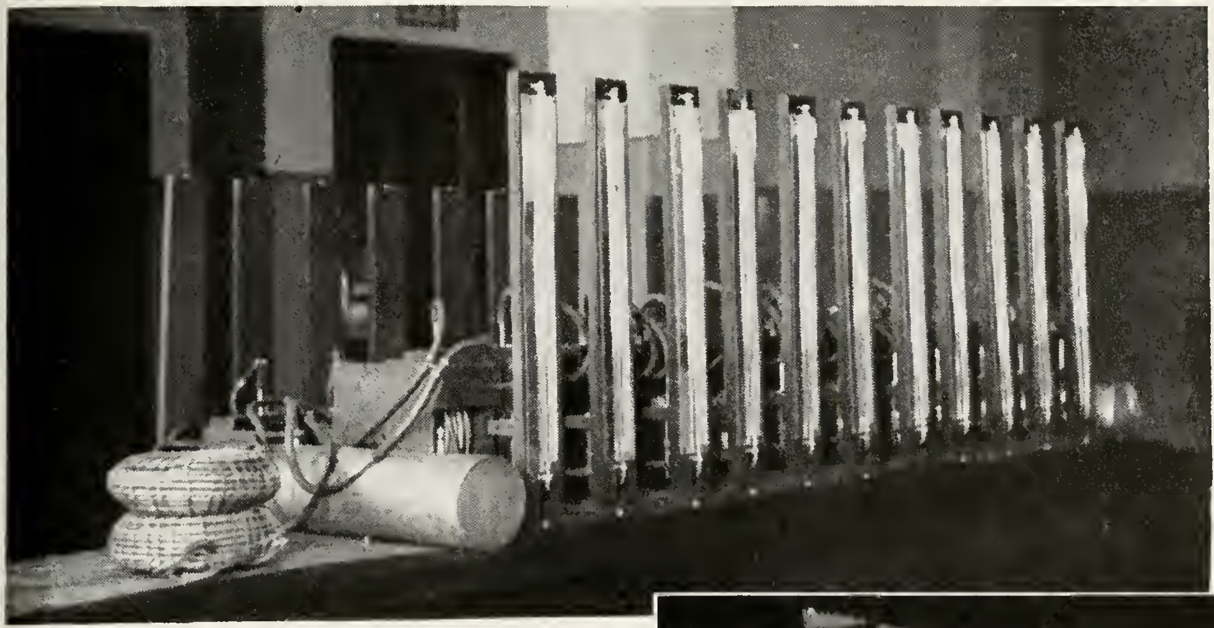
THIS training program has been divided into four different courses. A half-day appreciation course is given to Long Lines and Associated Company supervisory and management people who are broadly interested in the subject. The remaining three courses, each of two weeks' duration, are respectively: for those field people who are actively engaged in placing and maintaining cable under pressure; for those directly concerned with the supervision of gas pressure work; and for those engaged in engineering gas pressure systems.

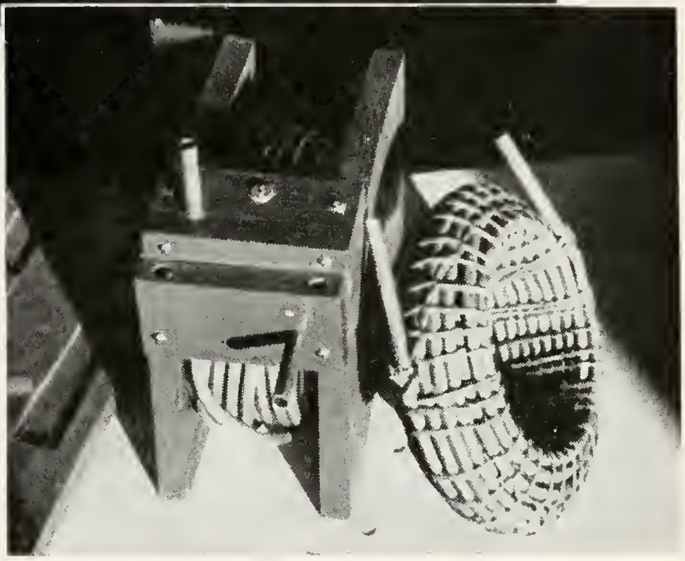
The apparatus illustrating behavior of gas pressure in a cable was made up into several portable exhibits which traveled all over the country. This apparatus and the four training courses have brought the facts about gas pressure to hundreds of Bell System employees—to those in the Long Lines who have had the job of keeping an eye on that Department's 18,000 miles of sheath, and to Associated Company people who are engaged in the installation and maintenance of toll cables.

The protection to service afforded by gas pressure is becoming increasingly important with the introduction, in the last few years, of K-Carrier systems in existing voice frequency cables, whereby twelve telephone circuits are superimposed on one pair of



A lecture-demonstration in the field, part of a training program to keep maintenance and supervisory personnel posted on methods and developments of gas pressure testing





Some of the demonstration apparatus used to show the behavior of gas in cable. Above: 1,000 feet of small cable, connected to manometers at 50-foot intervals, simulate a normal gas pressure section. Right: Such 50-foot sections of cable are interconnected to form the 1,000-foot section used in the demonstration

wires. Such protection is even more important for the Bell System's new coaxial cable network, which is now being installed throughout the country. Without it, the concentration of so many important circuits under one cable sheath would be hazardous.

As IS USUALLY the case in regard to telephone facilities, the most exhaustive sort of test cannot write the last chapter to gas pressure technique. For example, the introduction of a new type of cable—the buried cable—resulted in a need for more accurate leak locations. The various types of sheath protection with which these buried cables are covered may cause gas to flow under the covering for a considerable distance from the actual break in the sheath before it is released. However, refinements in methods and equipment for locating a sheath break have been developed, and specialists in gas pressure feel that whatever problems may be created by new designs of cable, they will be able to solve them.

FOOTNOTES TO AMERICAN HISTORY

Alexander Graham Bell gets a wrong number during one of the early demonstrations of the telephone

Thoroughgoing Preparations Permitted Changing All of a Great City's Telephone Numbers with a Maximum of Public Coöperation and a Minimum of Difficulty

Philadelphia Goes "2-5"

Harold S. LeDuc

FROM THE DAYS of vaudeville—and probably long before that—Philadelphia has been joked about, satirized, and maligned as a city where any change is regarded as painful, any deviation from "things as they have always been" carefully shunned. Philadelphians, the old saying goes, are "taller and fairer than Chinese, but not quite so progressive."

But recently a change was accepted by Philadelphians—with great good nature—that makes these allegations seem an undeserved and libelous label on a great and growing city.

Literally overnight a change took place in Philadelphia which called for the coöperation of all telephone users. It was a change which at first glance might seem trivial—but which actually was far-reaching in both its immediate and its ultimate effects on the city's telephone service.

Since Philadelphians first started using dial telephones, early in the 'twenties, they had been accustomed to dialing the first three letters of the central-office name, then the four digits that make up the telephone number. Last July 5th, they changed this long-established habit with one brave stroke and instead began to use only the first two letters of the central-office name, plus a newly added digit, and then the four digits of the telephone number.

A small change, it might seem—merely the substitution of a figure for a letter.

But dialing is such a familiar, every-day act that with most telephone users it's almost as natural and automatic as breathing. And, paradoxically perhaps, a small change in a deep-set habit is harder to make than a big one.

In any case, the change was made smoothly and painlessly. Philadelphians took it in their stride, and the new way of dialing is fast becoming second nature for them.

The shift from 3–4 to 2–5 dialing


"PREVIEW" ANNOUNCEMENT

to all users of telephones in the City of Philadelphia

Effective July 5th, a figure will be added to the name of each Central Office in Philadelphia . . . ***and the figure is to be used in dialing* IN PLACE OF THE THIRD LETTER OF THE CENTRAL OFFICE NAME.**

There will be no change in any Central Office name . . and no change is involved in the last four figures which you dial to comolete your calls.

Here is an example: PEN nypacker-3725 will become PE nnypacker 5-3725 . . . and you will simply dial PE 5-3725 instead of PEN-3725.

Notice that you will still make only seven turns of the dial, just as you do now . . **THAT THE ONLY CHANGE YOU WILL NEED TO REMEMBER WILL BE TO DIAL CENTRAL OFFICE NAMES WITH TWO LETTERS AND FIGURE . . . INSTEAD OF**

delphians with better, faster, and more flexible telephone service. It is essential to meet the growth requirements of the nation's third largest city and to pave the way for service improvements that will come in the years ahead.

So let's repeat: On Friday, July 6th—the day after Independence Day—you will start dialing ***two letters and a figure,*** and then the four figures of the telephone number, ***instead of three letters*** and then the four figures of the telephone number.

Here's how easy all this will be

A NEW TELEPHONE NUMBER PLATE FOR YOUR TELEPHONE IS ENCLOSED

An Important Message
To Our Philadelphia Customers:

Starting July 5th, a figure will be added to the name of each Philadelphia Central Office and that figure is to be used in dialing in place of the third letter of the Central Office name.

THE 3rd LETTER OF THE CENTRAL OFFICE NAME SHOULD NOT BE DIALED AFTER JULY 4.

For example -- PEnnypacker 3725 becomes

PEnnypacker 5-3725 and to reach it you dial

PE 5-3725 instead of PEN 3725

The only difference is that you dial a "5" instead of an "N".

ON JULY 5TH, PLEASE BE SURE TO:

1. Tear out the temporary card (it has the first 3 letters of the Central Office name in large capitals) on top of the number plate on your telephone. You can lift it out easily with a nail file or fingernail.

2. rid of your 1945 lphia Directory.

was made for a number of sound reasons.

First, it provided for a vast number of new central-office codes. Of course, when three letters are used in a dialing code, they must be the first three letters of the central-office name—and only a limited number of such combinations make good names which are easy to dial correctly and are easily understood when passed over a circuit or left in a message. Under the two-letters-and-a-figure system, Philadelphia can now have not only a "PEnnypacker 5" central-office, but also a "PEnnypacker 6," "7," "8" and so on. And that's important as a city's telephone system grows.

Second, direct dialing of Philadelphia numbers by telephone users in the city's widespread suburbs is just around the corner. As fast as we can get the dial equipment, suburban offices will be converted to dial and direct customer dialing to Philadelphia will begin. In fact, it is already in effect in one suburban office—Whitemarsh.

This, too, will call for a greatly increased range of unduplicated central-office codes. For instance, in Philadelphia we have a Chestnut Hill central office. In the suburbs, there are Cheltenham, Chester Heights, Chester Springs—all beginning, you

Newspaper advertisements, booklets, and letters mailed to subscribers were among the elements of the carefully timed and coördinated educational campaign which kept customers fully informed of the progress of the program and of their part in it notice, with CHE. Under the new system, the code for Chestnut Hill is "CH–7"; other figures will be added to the "CH" of the various suburban offices.

Third, the new dialing system is a necessary step in the extension of intertoll dialing. Here again the problem is to avoid duplication of dialing codes over a very much wider area. The 2–5 system will provide the needed flexibility.

Of course, 2–5 dialing is not a new story. It was introduced in New York back in 1930, and has been in use not only there but in northern New Jersey and other parts of the country. What made it an unusually interesting problem in Philadelphia was the timing.

The change to 2–5 was introduced to Philadelphia at a time when the city's central offices were carrying record-breaking volumes of traffic—often beyond the capacities of the offices—with the result that delays in dial tone had reached serious proportions.

Inevitably, the introduction of new dial codes would carry the danger of an increase in traffic volumes, since customers dialing old codes would have to dial the call again after learning the new code. Should the percentage of wrong codes dialed reach the proportions encountered in other communities in the past, it might seriously affect the service in the heavily loaded offices.

So the problem was simply this: to effect the change with negligible wrong dialing by the telephone-using public, thus reducing to the minimum the added burden of extra calls.

One obvious course to follow would have been to add sufficient switchboard positions, hire enough operators, and intercept all calls dialed incorrectly. Even in normal times this would have been difficult and costly; under present conditions, we simply could not get the equipment and we could not get the operators. Actually, a much better plan was devised, by installing the type of recording equipment used to give weather reports and using that to intercept calls dialed with the old codes.

So the success or failure of the change hinged almost entirely on getting the story over to Philadelphia's telephone-using public in such a way that they would understand the nature of the change and remember it when dialing. And, since this involved a change in ingrained habits, it could be accomplished only by what is known as "saturation" advertising.

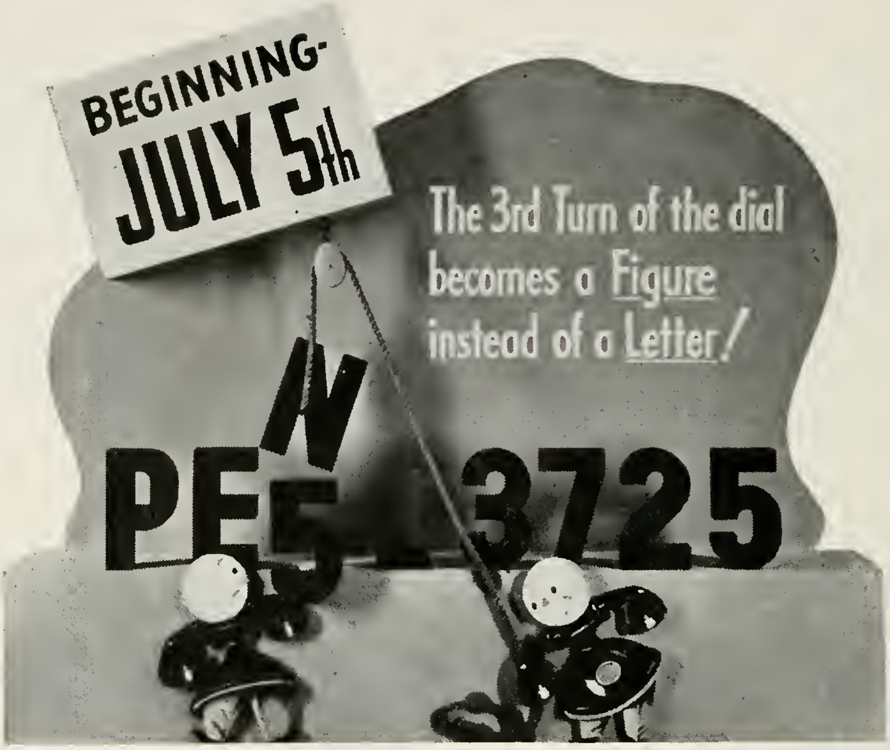
Planning Started Far Ahead

The transition program started a year ahead of the cutover date, and with it started the advertising campaign.

The first step was to change the number plates on all Philadelphia telephones, and this involved explaining what it was all about. Before the change was made, Philadelphians began reading about it in newspaper advertisements, bill inserts, and news releases, and hearing about it on the radio. They were told why we were changing the number plates, and their alarm as to any effect the change might produce in their service was allayed.

The change of nearly half a million number plates—a tremendous job in itself—was done in part by high-school boys employed for the

Window displays announced the news in three dimensions



purpose during the summer of 1945, in part by our regular installation forces, and in part by mail. It is of interest that a telephone check of those mailed—some 70,000 — revealed that customers found very little difficulty putting the plates on their telephones.

Next came the job of completely re-setting the type for the Philadelphia telephone directory and giving proper instructions for its use. This large job was complicated by the fact that with this issue it became necessary to split the Philadelphia book into two volumes—Alphabetical and Classified—because of the tremendous increase in its size resulting from the increase in telephones during the last year.

The big task of delivering more than a million Philadelphia telephone directories began June 3rd of this year and was completed by July 1st. The educational and informative advertising, starting well in advance of the time of directory delivery, explained as its first phase the directory situation. Customers were told to keep their new directory under wraps and to continue to use their old directories until July 5th, then to start using the new book. The directories themselves carried a special imprint with this message.

Then came an intensive advertising campaign of the transition date and what telephone customers should do when that date rolled around. Seven o'clock in the morning, Friday, July 5th, had been selected as the time of cutover in order to take advantage of the long holiday week-end when normal traffic would be low.

"Saturation" Advertising

PHILADELPHIANS began hearing and reading about July 5th as early as February 7, 1946. They heard about it through radio announcements, newspaper advertisements, bill inserts, newspaper stories, car cards, truck posters, and such publicity media.

Publicity in connection with the change has been called "saturation" advertising—and "saturation" advertising it truly was.

One large advertisement per week appeared in Philadelphia's four daily papers from May 13th through June, and one advertisement per day in the morning papers of July 1st, 2nd, 3rd and 4th, and in all dailies for the three days following the cutover. In addition, three small advertisements a day were scattered through the papers the week of July 8th. Philadelphia's 34 "neighborhood" weeklies and 21 German, Italian, Polish, Hungarian, Jewish and Negro papers also carried advertisements.

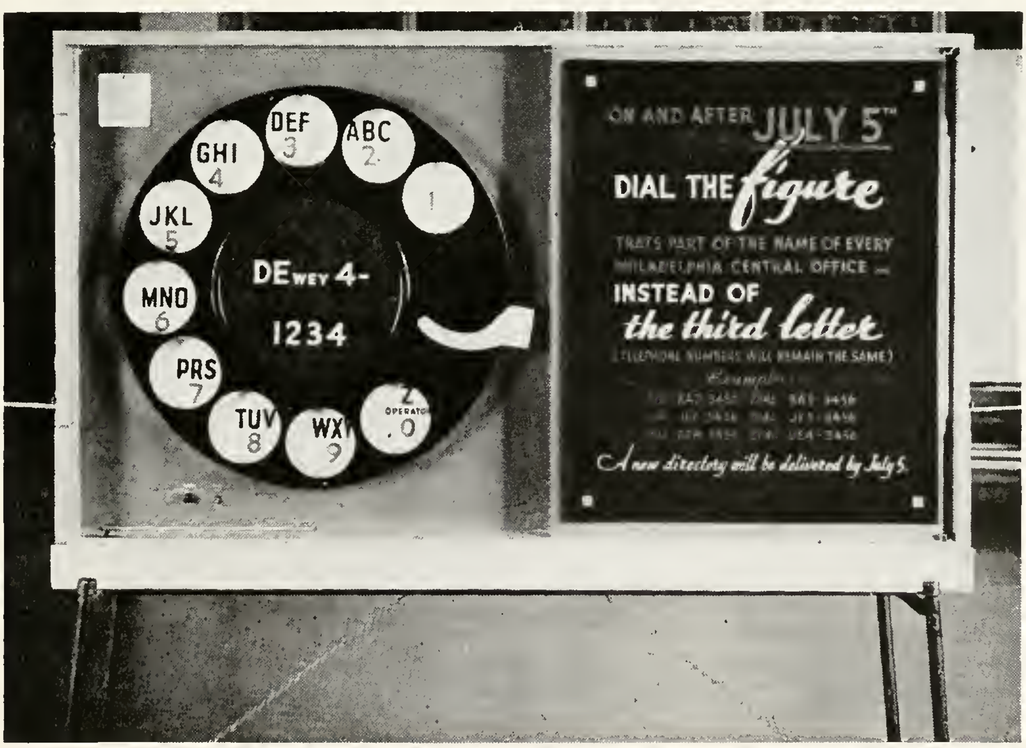
The nine radio stations in Philadelphia carried a total of 441 one-minute spots (7 hours and 21 minutes of air time) as well as 206 "station breaks" of 25 words each. The "breaks" were translated into Yiddish, Polish, and Italian for use on Philadelphia stations carrying foreign language programs.

Bill inserts going to Philadelphia customers told the story in the May, June, and July issues.

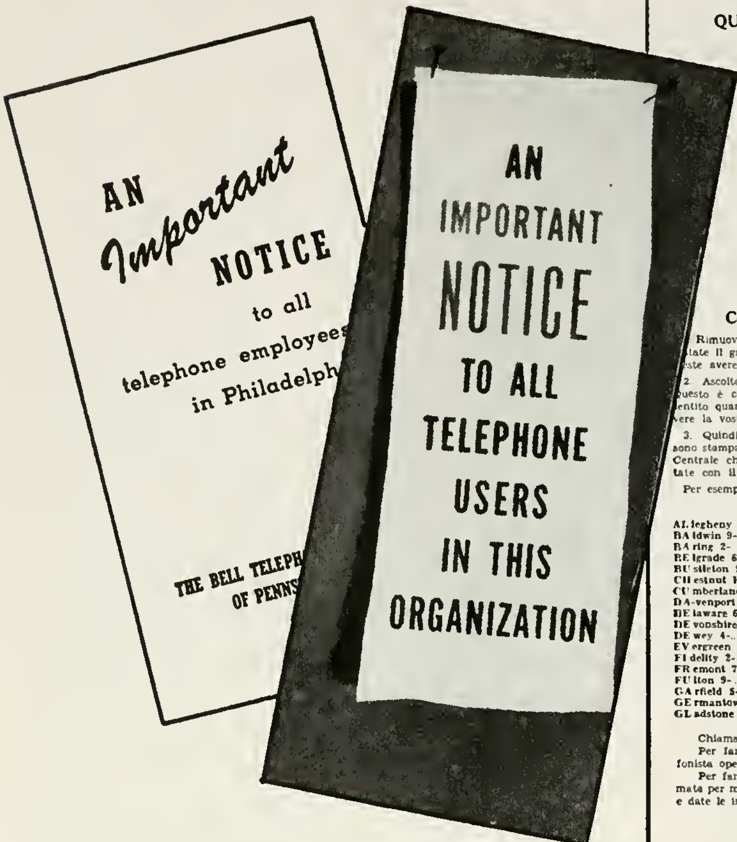
Even the blind—always great users of telephone service—were not forgotten. Through the Volunteer Service for the Blind, 3,500 code cards in Braille were sent to the city's sightless telephone users.

PERHAPS THE most important single piece of publicity in connection with the change was the letter mailed to all Philadelphia and Suburban Philadelphia customers just before the cutover. Letters were mailed to 355,000 Philadelphia customers—as far as we can ascertain, the largest single mailing ever made in the city—as well as to 125,000 customers in the Philadelphia suburbs.

One convincing bit of evidence that mail from the telephone company receives close attention from the public is the surprising number of returns



This exhibit was used during "open house" programs to demonstrate on a large dial the change from figure to letter for the third pull



Luglio, 1948

QUESTE INFORMAZIONI VI AIUTANO AD USARE IL VOSTRO TELEFONO A QUADRANTE

Come usare il quadrante—Per nttenere il Numero Telefonico Corretto

Rimuovete con attenzione il ricevitore. Se voi ...tate il gancio o sostegno del ricevitore, forse po...ste avere il numero sbagliato.

2. Ascoltate per il tono prodotto dal quadrante. ...uesto è come un continuo "hum" il quale viene ...entito quando l'equipaggiamento è pronto per rice...vere la vostra chiamata

3. Quindi girate nel quadrante i tre numeri che sono stampati qui sotto in fronte al nome dell'Ufficio Centrale che desiderate, ed immediatamente seguitate con il numero telefonico.

Per esempio: se desiderate chiamare PEnnypacker 5-3725, girate i numeri 7-3-5 ed immediatamente seguitate con i numeri 3-7-2-5

4. Se il numero che voi state chiamando include una lettera di linea in comune ("party line,") girate un numero addizionale per la lettera del "party line," come segue:

Per la lettera J, numero del quadrante 5.
Per la lettera M, numero del quadrante 6.
Per la lettera R, numero del quadrante 7.
Per la lattera W, numero del quadrante 9.

Per esempio: se desiderate chiamare MAnayunk 8-4352-W, girate i numeri 6-2-8 ed immediatamente seguitate con i numeri 4-3-5-2 e quindi col numero 9.

Uffici Centrali

ALlegheny 4-	AL 4	254	GRanite 2-	GR 2	472	POplar 5-	PO 5	765
BAldwin 9-	BA 9	229	GReenwood 3-	GR 3	473	RAcliff 5-	RA 5	725
BAring 2-	BA 2	222	HAncock 4-	HA 4	424	REgent 9-	RE 9	739
BElgrade 6-	BE 6	236	HOward 8-	HO 8	468	RIttenhouse 6-	RI 6	746
BUstleton 9-	BU 9	289	JEfferson 5-	JE 5	535	ROxboro 8-	RO 8	768
CHestnut Hill 7-	CH 7	247	KIngsley 5-	KI 5	545	SAgamore 2-	SA 2	722
CUmberland 8-	CU 8	288	LIvingston 9-	LI 9	549	SAratoga 9-	SA 9	729
DAvenport 4-	DA 4	324	LOcust 7-	LO 7	567	SHerwood 7-	SH 7	747
DElaware 6-	DE 6	336	LOmbard 3-	LO 3	563	SUmerion 6-	SU 6	786
DEvonshire 8-	DE 8	338	MAjestic 5-	MA 5	625	SPruce 4-	SP 4	774
DEwey 4-	DE 4	334	MAnayunk 8-	MA 8	628	STevenson 4-	ST 4	784
EVergreen 6-	EV 6	386	MArket 7-	MA 7	627	TEnnessee 9-	TE 9	839
FIdelity 2-	FI 2	342	MAyfair 4-	MA 4	624	TOrresdale 4-	TO 4	864
FRemont 7-	FR 7	377	MIchigan 4-	MI 4	644	TRinity 7-	TR 7	877
FUlton 9-	FU 9	389	MUnicipal 6-	MU 6	686	VIctor 4-	VI 4	844
GArfield 5-	GA 5	425	NEbraska 4-	NE 4	634	WAlnut 2-	WA 2	922
GErmantown 8-	GE 8	438	OFficial 3-	OF 3	633	WAverly 4-	WA 4	924
GLadstone 5-	GL 5	455	PEnnypacker 5-	PE 5	735	WIssahickon 7-	WI 7	947
			PIlgrim 5-	PI 5	745			

Chiamate telefoniche di Uffici Centrali, che non sono elencati in questa lista, sono chiamate Fuori-Città.

Per fare una chiamata per numero Fuori-Città girate nel quadrante il numero O Rosso per avere la telefonista operatrice e datele il nome della Città che desiderate e quindi il relativo numero telefonico.

Per fare una chiamata Fuori-Città ad una specifica persona, una chiamata per appuntamento, una chiamata per messaggio, od una chiamata per la quale si desidera che il costo sia riversato, girate nel quadrante 2-1-1 e date le informazioni riguardanti la chiamata alla telefonista operatrice.

Chiamate per Emergenza

In una emergenza girate nel quadrante il numero O Rosso per avere l'operatrice e dite { Desidero rapportare un incendio. / Desidero un poliziotto. / Desidero un'ambulanza.

E date alla telefonista operatrice il vostro numero del telefono.

Per Ufficio Federale di Investigazione .... Girate 7-4-6—5-3-0-0

Chiamate per Servizio

PER
Informazioni Directory .... Girate 4-1-1
Servizio Riparazioni .... Girate 6-1-1

PER
Assistenza .... Girate O Rosso
Ufficio Business .... Girate 6-2-3—0-0-5-0

Non vi è nessun carico per chiamate d'emergenza, o per chiamare Informazioni Directory, Servizio riparazioni o l'Ufficio Business.

FAVORITE TENERE QUESTA CARTA VICINO AL TELEFONO

Every opportunity was grasped to convey information to groups of persons who would be particularly affected by the number change

of the business reply card enclosed with the Philadelphia letter. This card, requesting a personal telephone directory for listing numbers with the new codes, was returned by 138,000 customers—about 39 percent of the total. PBX extension users accounted for 112,000 additional copies of the Personal Directory.

The Final Test

That this "saturation" campaign did a job was well evident when July 5th finally came.

At 7 A.M., July 5th, the announcement machine used for intercepting went to work. Customers who dialed the old three-letter codes which had been changed heard the recorded message, "Will you please dial the first two letters and five figures as shown in the new directory? Thank you."

But between 7 and 8 A.M. of the cutover day, only 22 percent of calls were dialed with the old codes, and by the busy hour the percentage had dropped to 12.

This good start in the early morning was most important. It made it possible to intercept all incorrectly dialed calls where the new code differed from the old up to 10 A.M. and practically all such calls between 10 A.M. and 12 Noon. After this time, it was possible to intercept all incorrectly dialed calls from Friday Noon until 10 A.M. Monday.

While only 5 per cent of the total calls in the city were incorrectly dialed, interception had to be discontinued in three offices between 10 A.M. and 12 Noon Monday because of the high volume of traffic. After noon on Monday, July 8th, it was possible to intercept *all* incorrectly dialed calls.

If the publicising of the change had been less effective and Philadelphians had been as slow to accept change as they are supposed to be—if, say, they had dialed the old codes on as much as 40 per cent of calls—only half of them could have been intercepted. This would have prolonged the transition period and might well have come close to putting some of the most heavily loaded offices out of service.

At first customers were inclined to "talk back" to the recorded voice when they were intercepted and to ask questions. Others attempted to dial again without first hanging up. So the recorded message was changed to, "Will you please hang up and dial the first two letters and five figures shown in the new directory? Thank you. This is a recorded message." This resulted in much less talking back to the machine and fewer attempts to dial without hanging up.

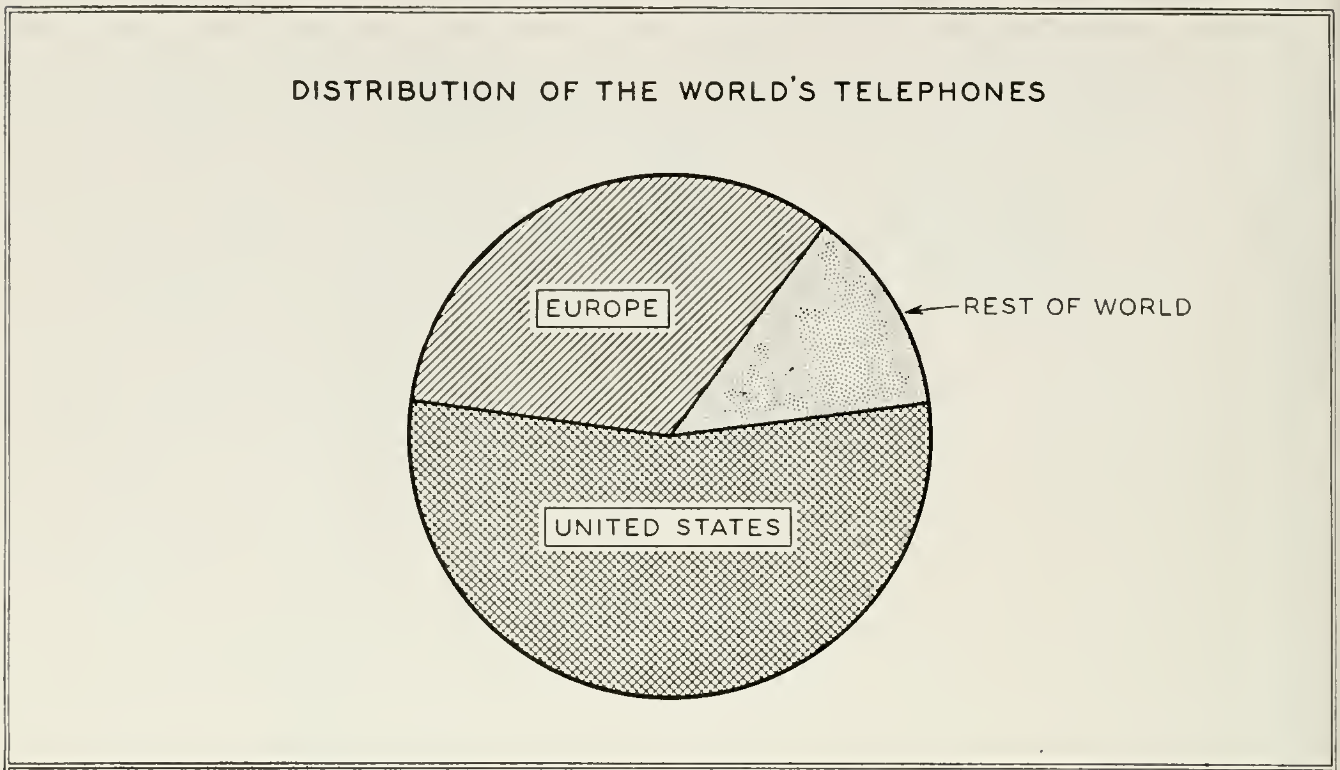
It wasn't long until "The Voice" of the intercepting machine had become something of a local celebrity. The girl who had made the recording was interviewed on a local radio program, and a Philadelphia columnist told of a lady who never dialed incorrectly except when she did so purposely just to hear the voice correcting her. The columnist's only suggestion, by the way, was that the recorded message should tack on something like, "Is that clear now, Toots? Toodle-oo," so that he could reply, "O.K., Babe."

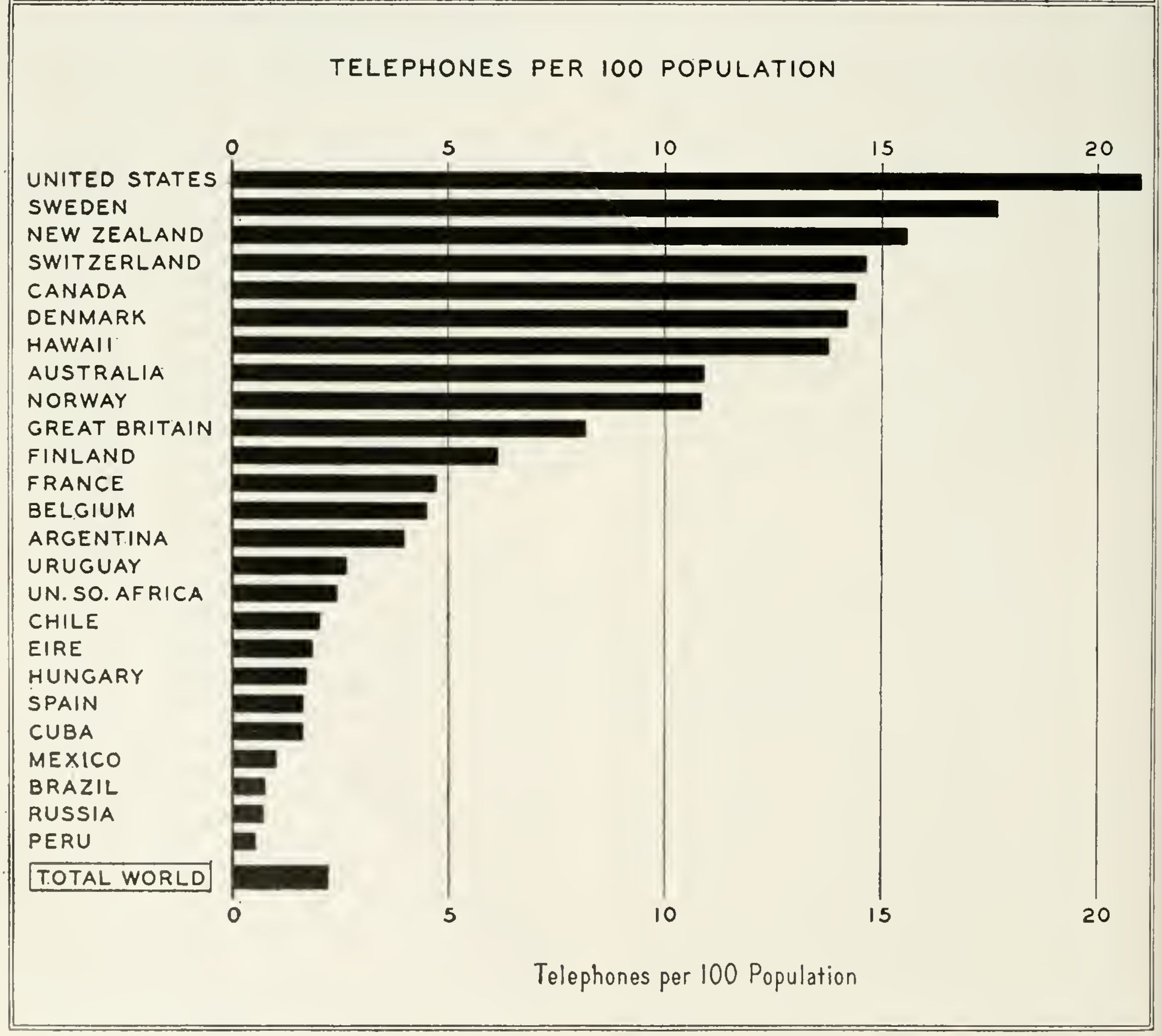
By the end of the first week following the cutover, Philadelphians were dialing the old codes on only 3.2 percent of calls; after two weeks only 2.5 percent; by July 24th, 1.9 percent. As this is written, they are dialing the old codes on only 1.2 percent of calls—slightly more than one call in a hundred.

So the next time you hear someone say that Philadelphians won't accept change, you can say, "That's not the way I heard it!"

Although Williams' shop was dingy and ugly, and crude in all its arrangements, from my first day there I was happy and contented. And when I grew more skillful in using tools and was entrusted with the construction of complete machines, I often felt an exaltation in my work akin to the ecstacies of my lonely walks. In the woods I felt myself a living part of all creation; now I was thrilled with the knowledge that I myself was creating as I made stubborn metal do my will and take the shape necessary to enable it to do its allotted work. I should have been surprised then if anyone had called those moments poetic, but I know now there was some noble poetry in my life at Williams' shop.

From "Exploring Life," the autobiography of Thomas A. Watson; D. Appleton & Co., 1926


DISTRIBUTION OF THE WORLD'S TELEPHONES
EUROPE
REST OF WORLD
UNITED STATES


TELEPHONES PER 100 POPULATION
0
5
10
15
20
UNITED STATES
SWEDEN
NEW ZEALAND
SWITZERLAND
CANADA
DENMARK
HAWAII
AUSTRALIA
NORWAY
GREAT BRITAIN
FINLAND
FRANCE
BELGIUM
ARGENTINA
URUGUAY
UN. SO. AFRICA
CHILE
EIRE
HUNGARY
SPAIN
CUBA
MEXICO
BRAZIL
RUSSIA
PERU
TOTAL WORLD
Telephones per 100 Population

Telephones in the Post-War World

James R. McGowan

At the beginning of the first peace-time year since 1941, the United States had approximately 28 million telephones, or 54 percent of the world's 51.5 million telephones. During the four war years, this country's telephones increased about 19 percent, despite shortages of materials and labor; while those of the rest of the world gained only four percent. If the telephone companies had been able to install all the telephones requested, there would have been another 10 percent increase in the United States during that period.

The latest available data in respect of the world's telephones are shown in the tables and charts on the accompanying pages, taken from a bulletin recently issued by the Chief Statistician's Division of the American Telephone and Telegraph Company. Similar bulletins have appeared each year since 1912, with the exception of the war years during World Wars I and II. The current issue, presenting data generally as of January 1, 1946, is necessarily restricted in scope, owing to conditions resulting from the recent war. As data concerning plant destruction or subsequent restoration are not available for many of the belligerent nations, allowance has been made for these factors in estimating continental totals.

The United States, with its telephone system operating wholly under private ownership, had 21 telephones for each 100 of the population, as compared with an average development of 2.2 telephones per 100 population for the entire world. Australia, France, Great Britain, Russia, and Sweden, which together comprise 12 percent of the world's population—or just about twice that of the United States—had, on the average, only three telephones per 100 population, or one-seventh of the telephone development ratio found in the United States. These countries reported the largest five telephone systems owned and operated by national governments.

The largest two urban telephone centers are still those of New York and Chicago, with 2,002,310 and 1,204,525 telephones, respectively. These telephones exceed in the aggregate the total number of telephones in Asia, Africa, and Oceania combined, even though these continental areas account for more than 60 percent of the world's population. In addition to New York, there are six cities of the United States, each with more than one million population, which have in total well over three and a half million telephones: more than all the telephones serving our good neighbors in the Western Hemisphere.

In foreign countries the telephones are mainly concentrated in large urban centers. In the United States, on the other hand, on January 1, 1946, the total telephone development for each 100 persons in communities having a population of *less* than 50,000 was 16. No one city in the United States contains as much as 8 percent of the total number of the nation's telephones, whereas the capital cities of Belgium, Denmark, and France each contain about one-third of their country's telephones. Over 29 percent of all telephones in Norway are in Oslo, while more than one-quarter of those of Sweden are in the Stockholm area.

San Francisco, with a density of 43.3 telephones for each 100 inhabitants, has a higher telephone development than any other city in the world. Among the large foreign cities, only Stockholm, with a development of 38.4 telephones for each 100 of the population on January 1, 1945, can approach San Francisco's leadership, telephonically speaking.

(Continued on page 184)

TELEPHONE STATISTICS OF THE WORLD

LATEST AVAILABLE DATA

Countries	Date of Statistics	Telephones		Telephone Wire		Telegraph Wire		Conversations		Telegrams		Telephones in Large Cities		
		Thousands	Per 100 Pop.	Thousands of Miles	Per 100 Pop.	Thousands of Miles	Per 100 Pop.	Thousands	Per Avg. Capita	Thousands	Per Avg. Capita	Exchange Area	Telephones Thousands	Per 100 Pop.
NORTH AMERICA:														
United States	Jan. 1, 1946	27,867.0	21.0	110,700	83.5	2,260	1.7	36,765,000	284.5	235,000	1.8	New York City*	2,002.3	27.8
Canada	Jan. 1, 1944	1,692.2	14.4	6,058	51.6	379	3.2	2,980,000	254.7	15,650	1.3	Montreal (1-1-46)	242.8	20.5
Mexico	Jan. 1, 1946	217.0	1.0	885	4.1	—	—	575,000	26.8	—	—	Mexico City	117.3	6.8
Cuba	Jan. 1, 1946	81.1	1.6	341	6.8	15	0.5	463,000	93.2	—	—	Havana	58.0	8.1
Puerto Rico	Jan. 1, 1946	25.8	1.3	76	3.7	—	—	58,000	28.5	—	—	—	—	—
Total	Jan. 1, 1946	30,100.0	15.4	—	—	—	—	—	—	—	—	—	—	—
SOUTH AMERICA:														
Argentina	Jan. 1, 1946	571.0	4.0	3,050	21.3	165	1.2	—	—	—	—	Buenos Aires (1-1-45)	346.7	9.7
Bolivia	Jan. 1, 1945	7.6	0.2	15	0.4	9	0.3	—	—	—	—	—	—	—
Brazil	Jan. 1, 1943	331.0	0.8	1,360	3.2	114	0.3	1,700,000	40.3	—	—	Rio de Janeiro	131.4	6.6
Chile	Jan. 1, 1946	109.5	2.0	382	7.1	—	—	369,000	68.8	—	—	Santiago	59.4	5.9
Colombia	Jan. 1, 1944	47.1	0.5	200	2.0	—	—	—	—	—	—	Bogota	16.5	4.1
Ecuador	Jan. 1, 1945	8.6	0.3	10	0.3	7	0.2	—	—	—	—	Quito	3.8	2.2
Paraguay	Jan. 1, 1945	4.2	0.4	11	1.0	4	0.3	—	—	—	—	—	—	—
Peru	Jan. 1, 1946	39.6	0.5	138	1.8	18	0.2	—	—	—	—	Lima (1-1-45)	26.1	4.7
Uruguay	Jan. 1, 1942	57.8	2.7	187	8.6	7	0.3	160,000	73.5	—	—	Montevideo	42.1	5.9
Venezuela	Jan. 1, 1942	36.1	1.0	120	3.3	8	0.2	214,000	58.6	—	—	Caracas	25.8	8.1
Guianas	Jan. 1, 1946	3.6	0.6	10	1.7	—	—	—	—	—	—	—	—	—
Total	Jan. 1, 1946	1,290.0	1.3	—	—	—	—	—	—	—	—	—	—	—
EUROPE:														
Belgium	Jan. 1, 1946	379.6	4.5	—	—	—	—	289,000	34.3	—	—	Brussels	138.7	13.7
Bulgaria	Jan. 1, 1946	44.9	0.6	—	—	—	—	—	—	—	—	—	—	—
Denmark	Jan. 1, 1946	567.3	14.2	1,630	41.0	—	—	960,000	241.7	—	—	Copenhagen	265.5	26.3

Eire	Jan. 1, 1946	55.1	1.9	194	6.6	20	0.7	56,000	19.0	2,607	0.9	Dublin	31.7	6.5
Finland	Jan. 1, 1946	243.7	6.2	—	—	—	—	—	—	—	—	—	—	—
France	Jan. 1, 1946	1,879.5	4.7	—	—	—	—	1,358,000	34.2	40,312	1.0	—	—	—
Great Britain	Mar. 31, 1945	3,925.0	8.2	18,500	38.5	—	—	—	—	—	—	—	—	—
Hungary	Jan. 1, 1944	256.9	1.7	580	3.9	—	—	340,000	22.8	—	—	—	—	—
Norway	Jun. 30, 1944	327.0	10.9	974	32.4	13	0.4	433,000	144.5	7,717	2.6	Oslo (6-30-45)	95.6	22.0
Portugal	Jan. 1, 1946	97.7	1.2	210	2.6	—	—	—	—	—	—	Lisbon	42.0	5.7
Russia	Jan. 1, 1939	1,272.5	0.8	2,000	1.2	—	—	—	—	—	—	Moscow (1-1-36)	144.7	3.5
Spain	Jan. 1, 1946	447.2	1.6	1,141	4.2	—	—	997,000	36.8	—	—	Madrid	95.4	7.9
Sweden	Jan. 1, 1945	1,168.1	17.7	3,929	59.6	8	0.1	1,596,000	243.3	6,000	0.9	Stockholm	310.5	38.4
Switzerland	Jan. 1, 1946	645.4	14.7	1,950	44.3	27	0.6	543,000	124.0	2,295	0.5	Zurich	102.6	27.4
Total	Jan. 1, 1946	16,980.0	2.9	—	—	—	—	—	—	—	—	—	—	—
ASIA:														
British India	Jan. 1, 1946	118.6	0.03	776	0.2	413	0.1	—	—	—	—	Calcutta (3-31-45)	28.5	1.3
Total	Jan. 1, 1946	1,500.0	0.1	—	—	—	—	—	—	—	—	—	—	—
AFRICA:														
Union of South Africa	Mar. 31, 1946	275.0	2.5	1,165	10.4	19	0.2	380,000	34.1	9,513	0.9	Johannesburg	72.1	11.0
Total	Jan. 1, 1946	430.0	0.2	—	—	—	—	—	—	—	—	—	—	—
OCEANIA:														
Australia	Jun. 30, 1944	799.7	10.9	3,670	50.2	200	2.7	715,000	98.4	34,721	4.8	—	—	—
Hawaii	Jan. 1, 1946	69.0	13.8	201	40.3	—	—	—	—	—	—	Honolulu	39.1	18.2
New Zealand	Mar. 31, 1946	265.8	15.6	—	—	—	—	—	—	—	—	—	—	—
Total	Jan. 1, 1946	1,200.0	1.1		—	—	—	—	—	—	—	—	—	—
TOTAL WORLD	Jan. 1, 1946	51,500.0	2.2	—	—	—	—	—	—	—	—	—	—	—

NOTES: The above statistics incorporate the most recent information available on August 31, 1946. Totals for the world and geographical areas are partly estimated.

* The telephone development (telephones expressed in thousands) of other representative cities in the United States was, on January 1, 1946:

Chicago, Ill.	1,204.5 telephones, or 34.5 per 100 population	Milwaukee, Wis.	215.6 telephones, or 27.2 per 100 population
Los Angeles, Cal.	591.0 " " 32.4 " " "	Minneapolis, Minn.	198.2 " " 35.8 " " "
Cleveland, Ohio	375.0 " " 31.2 " " "	Seattle, Wash.	190.3 " " 33.2 " " "
Washington, D. C.	364.4 " " 39.9 " " "	Denver, Col.	134.7 " " 36.4 " " "
San Francisco, Cal.	344.0 " " 43.3 " " "	Hartford, Conn.	90.8 " " 33.8 " " "
Boston, Mass.	232.0 " " 33.2 " " "	Omaha, Neb.	84 3 " " 31.2 " " "

Notes on Mobile Radio Service

H. I. Phillips

Wife—Central, can you get me my husband? He's out somewhere in his car.

Central—What's the number?

Wife—He's Wesley Finch and he drives a Buick roadster.

Central—I'll have to have the number.

Wife—I can't recall the number, but it's a blue car with red wheels and . . .

Central—You'll have to look in the auto-to-home phone book.

Wife—But we didn't get a book yet. It's not my fault if the company is so slow. The name is Wesley Finch, and it's a Buick with one front headlight bent. There's a cute little squirrel tail on the radiator.

Central—Sorry. I can't put through a home-to-car call that way.

Wife—Is that so? Well, we just paid $22 to have that phone put in and it's too bad if the company can't give us a little coöperation. . . .

Central—Do you wish "Information?"

Wife—What for? She wouldn't be out in the car with Wesley, would she? . . . Oh, here it is! . . .I just found the number on a desk pad . . . It's 78 & 4½ anti skid white walls. . . .No, that must be the tire number. . . .

[Ultimately the wife gets the number and gets the call through.]

Wesley (going around a curve)—Yes. Hello. Aw nuts! Why doncha look where ya going, ya big stumblebum.

Wife—Why Wesley!

Wesley—Hello, who's this? Scram, ya fathead! Nobody crowded ya!

Wife—Wesley! Such language! This is Mollie.

Wesley—Oh, hello, Mollie. Oh yeah? You and who else? Gwan go jump in the lake.

Wife—Don't you talk to me like that, Wesley Finch!

Wesley—Sorry, Mollie, dear. I wasn't talking to you. A big bum just gave me some lip. Go on honey. Have any trouble getting me?

Wife—Trouble! I could get you easier if you were in a runaway balloon. Look, I forgot to tell you this morning that Mr. and Mrs. Bunny—

Wesley—What missing money? Louder! There's a truckload of junk behind me and one of those 1926 Model T's ahead.

Wife—I say I forgot to tell you about Mr. and Mrs. Bunny who . . .

[There is now no answer. She jiggles the hook.]

Central—Number?

Wife—I had my husband on the phone but you cut us off.

Central—I didn't cut you off. He must have detoured.

Wife—Wesley wouldn't detour in the midst of a conversation.

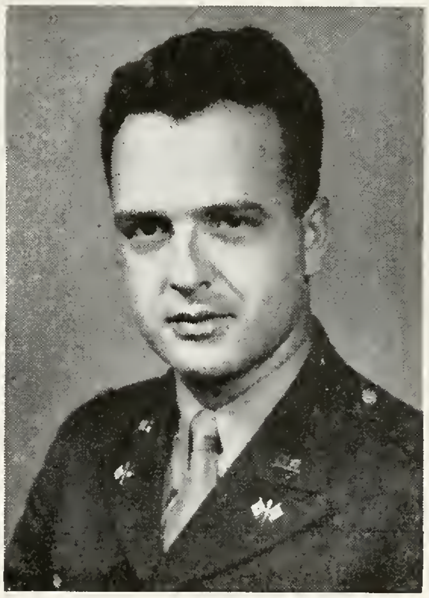
Wesley (suddenly)—Here I am, honey. I just went through a tunnel.

Motor Cycle Cop (pulling up unobserved)—Hey, you. Pull over!

Wesley—This is very rude of you, officer. Cancha see, I'm busy on the telephone!

From the SUN DIAL. Reprinted by courtesy of the *New York Sun*.

Harold S. LeDuc



James R. McGowan

Who's Who and What's What

(Continued from page 131)

A. T. & T. in 1943. In September of 1945 he was released from military service as Major General and Chief, Procurement and Distribution Service, Signal Corps, and was re-elected to his position as Vice President, Department of Operation and Engineering, A. T. & T. Company. Among the many forms of recognition which have been bestowed upon him may be mentioned the recent awards of the Distinguished Service Medal by the War Department; of the Most Excellent Order of the British Empire, degree of Honorary Commander; and of the Hoover Medal for Distinguished Public Service.

If Leon W. Germain exhibits a considerable degree of familiarity with telephone cables, their capabilities and their vagaries, it is probably because he has been working with them during most of his Long Lines career—and that began in 1909. By 1911 he was cable tester on the Boston-Washington duplex cable project—the first of its kind—and in 1914 he went to Chicago as chief cable tester on the Chicago-Highland duplex toll entrance project. He was subsequently division plant engineer, general plant supervisor, and division plant superintendent in several parts of the country. After 10 years as general plant superintendent of Long Lines' western area, Mr. Germain was appointed General Plant Manager of the Long Lines Department in 1940.

The "saturation" advertising to which Harold S. LeDuc refers in his article *Philadelphia Goes "2–5"* is primarily a cant expression, but the word does not greatly exaggerate the accomplishment. For it is no secret around Philadelphia that the operating departments of the Bell Telephone Company of Pennsylvania credit the campaign which Mr. LeDuc describes with much of the success of a major undertaking which was put across with a minimum of difficulty. Entering the General Information Department of the Pennsylvania company in 1926 as advertising assistant, he progressed through the public relations functions to become general advertising manager in 1941, and Vice President—Pubblic Relations last October, succeeding Peter L. Schauble.

After being absent from these pages since 1944, Telephone and Telegraph Statistics of the World put in a welcome appearance again, this time under the appropriate title of *Telephones in the Post-War World* and from the sharply pointed pencil of JAMES R. McGOWAN. Recently back with the Chief Statistician's Division at A. T. & T., Mr. McGowan spent more than four years of military duty with the Signal Corps in statistical and administrative work in Washington and with the Economics Division of Military Government in Berlin. During his nine years of Bell System service he has been busy with the statistics and economics relating to foreign telephone development.

IT IS *rather for us to be here dedicated to the great task remaining before us—that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion. . . .*

Those words of Abraham Lincoln are as full of meaning today as when they were first spoken at Gettysburg 83 years ago. We offer his immortal thought, this Armistice Day, both in tribute to our fighting men of World Wars I and II and as a prayer for lasting peace.

We in the Bell System know what war means. During the first world war, there were 24,900 stars in our service flag, and 276 of them were gold stars.

In World War II, 69,100 Bell System men and women served in the armed forces, and 1339 gave their lives. Throughout our organization are many who served in *both* wars.

So we pause tonight for a moment of grateful tribute to them—and to veterans everywhere—who took up arms to defend the faith, ideals, and integrity of our country.

From the Telephone Hour radio program of November 11, 1946

ume XXV • Number Four Winter 1946-4

Bell Telephone MAGAZINE

erican Telephone & Telegraph Company · New York

Bell Telephone *Magazine*

Winter 1946-47

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Co., *195 Broadway, New York 7, N. Y.*
Walter S. Gifford, *Pres.;* Carroll O. Bickelhaupt, *Sec.;* Donald R. Belcher, *Treas.*

Who's Who & What's What
in This Issue

It was just two years ago, in the issue of this Magazine for Winter 1944–45, that John J. Hanselman and Harold S. Osborne outlined the Bell System's plans to resume its rural telephone service program as soon as the end of the war should release the necessary men and materials. It is now about a year and a half since V-J Day, and Messrs. Hanselman and Osborne are able to give an interim progress report which sets forth an extraordinary achievement: installation of more than 400,000 rural telephones, in the face of real difficulties, during that period. Another way to say it is that the hardest two-fifths of a three-to-five-year objective of another million rural telephones has already been accomplished since the Japs cried "uncle" to Uncle Sam on the deck of the *Missouri* in Tokyo Bay.

Mr. Hanselman's Bell System career started with the Department of Operation and Engineering of the A. T. & T. Co., which he joined in 1921. In the years since, he has been successively an engineer in the rate section and a group head in several sections of the Commercial Division, sales engineer, and rate engineer. Since 1943 he has headed that Division as Assistant Vice President—Commercial. Mr. Osborne joined the A. T. & T. Co. in 1910 as an engineer in the then Transmission and Protection Department. Before becoming Chief Engineer in the O. and E. Department in 1943, he had been transmission engineer, operating results engineer, plant engineer, and assistant chief engineer.

Between May 10, 1909, when Joseph F. Farley was appointed a cadet in the U. S. Coast Guard, and January 1, 1946, when he was appointed Commandant with the rank of Admiral, a lot of water has gone under the keels of the vessels he has served on or commanded. Listen to the musical names of them: *Mohawk, Seminole, Onondaga, Yamacraw, Scally, Seneca, Gresham,*

John J. Hanselman

Harold S. Osborne

Admiral Joseph F. Farley

Francis M. Ryan

Hugh Moffett

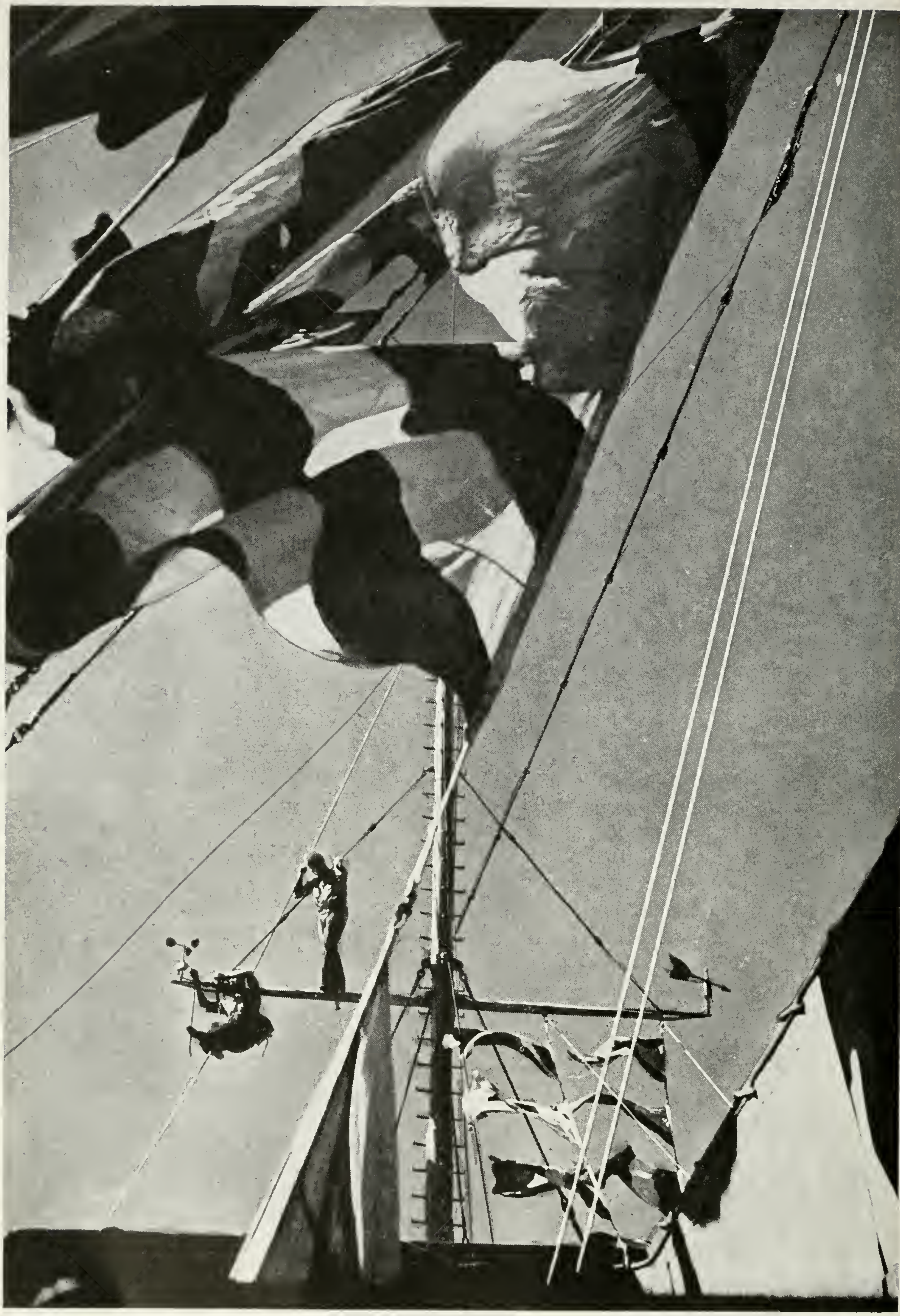
William A. Scheuch

Morrill, Mojave, McCall, Wilkes, Pontchartrain, Modoc. In between were tours of shore duty, of course—one including, as might be expected of the author of the article beginning on page 203, five years as Chief Communications Officer. That was followed by a year and a half during 1942–43 as District Coast Guard Officer of the Eighth Naval District, at New Orleans, which won him the Legion of Merit for exceptionally meritorious conduct in the performance of outstanding services. On his subsequent return to Coast Guard Headquarters in Washington, he served as Assistant Chief Operations Officer and then as Chief Personnel Officer until his appointment as Commandant. Among the organizations of which he is a member are the U. S. Naval Institute, the Society of Naval Engineers, the Society of Naval Architects and Marine Engineers, and the Newcomen Society. He is an active member of the Propeller Club, Port of Washington D. C.

THE PATTERN OF FRANCIS M. RYAN'S scientific interest was established at least seven years before he joined the Bell System in 1920. During that period he served as a ship radio operator, a radio inspector, and a college instructor in radio. From 1920 to 1936 he was a member of the technical staff of the Bell Telephone Laboratories (and its predecessor, the Engineering Department of the Western Electric Company), and again in 1942–43. From 1936 to 1942 and from 1944 to early 1946 he was Radio Engineer of the A. T. & T. Co. Since the last-named date, his title there has been Radio Coördinator. He is a Fellow of the American Institute of Electrical Engineers and of the Institute of Radio Engineers. Between the time his article was set in type and the MAGAZINE went to press, A. T. & T. announced its intent to build an experimental radio relay system, of the New York-Boston type Mr. Ryan describes, over the much greater distance between New York and Chicago—which seems to point up his reference to the *growing* use of radio.

THE INABILITY to understand how a telephone works which HUGH MOFFETT ruefully confesses may perhaps be due to an unfortunate experience he underwent as a youth, during his first visit to the metropolis of Kansas City. "They had dial phones," he writes, "everything being up to date there even at that time. I tried to call up an uncle, but failed because I was dialing all the letters of the exchange. Nobody had told me." Eleven years in newspaper work in the middle west were followed by appointment as a *Time* and *Life* correspondent in Denver in 1944 and trans-

(Continued on page 202)



Brisk wind aloft: Seamen aboard a Coast Guard ocean weather ship adjust an anemometer, so that its correct information may be incorporated in the weather reports radioed to shore every three hours. *See the article beginning on page 203*

With One-third of a Million Installations Made in Rural Areas in 1946, the Percentage of Farms with Telephones In This Country Is Greater Than Ever

Progress in Extending Bell Rural Telephone Service

John J. Hanselman and
Harold S. Osborne

IN THE YEAR JUST ENDED, the Bell System's operating companies added about 330,000 telephones in farm homes, country stores, and rural establishments of various kinds. This was more than three times the increase in rural installations ever made in any previous year in System history. Added to these are the more than 75,000 telephones installed in rural areas in 1945, bringing the total increase in rural telephone installations in two years to something more than 400,000. And last year alone, as those companies resumed their aggressive pre-war program for extending service to more and more farms,* they set nearly 300,000 telephone poles—enough to cross the continent about six times—and strung about 130,000 miles of wire.

The objective of the Bell System, as stated early in 1945, was to add another million rural telephones within three to five years after men and equipment became available. Already, in consequence of the whole industry's determined efforts, *a higher proportion of America's farms are enjoying the benefits of telephone service than ever before.* Even though war needs for telephone equipment had to come first during nearly four years of conflict, that proportion has risen from 25 percent in 1940 to the 40 percent estimated for the end of 1946.

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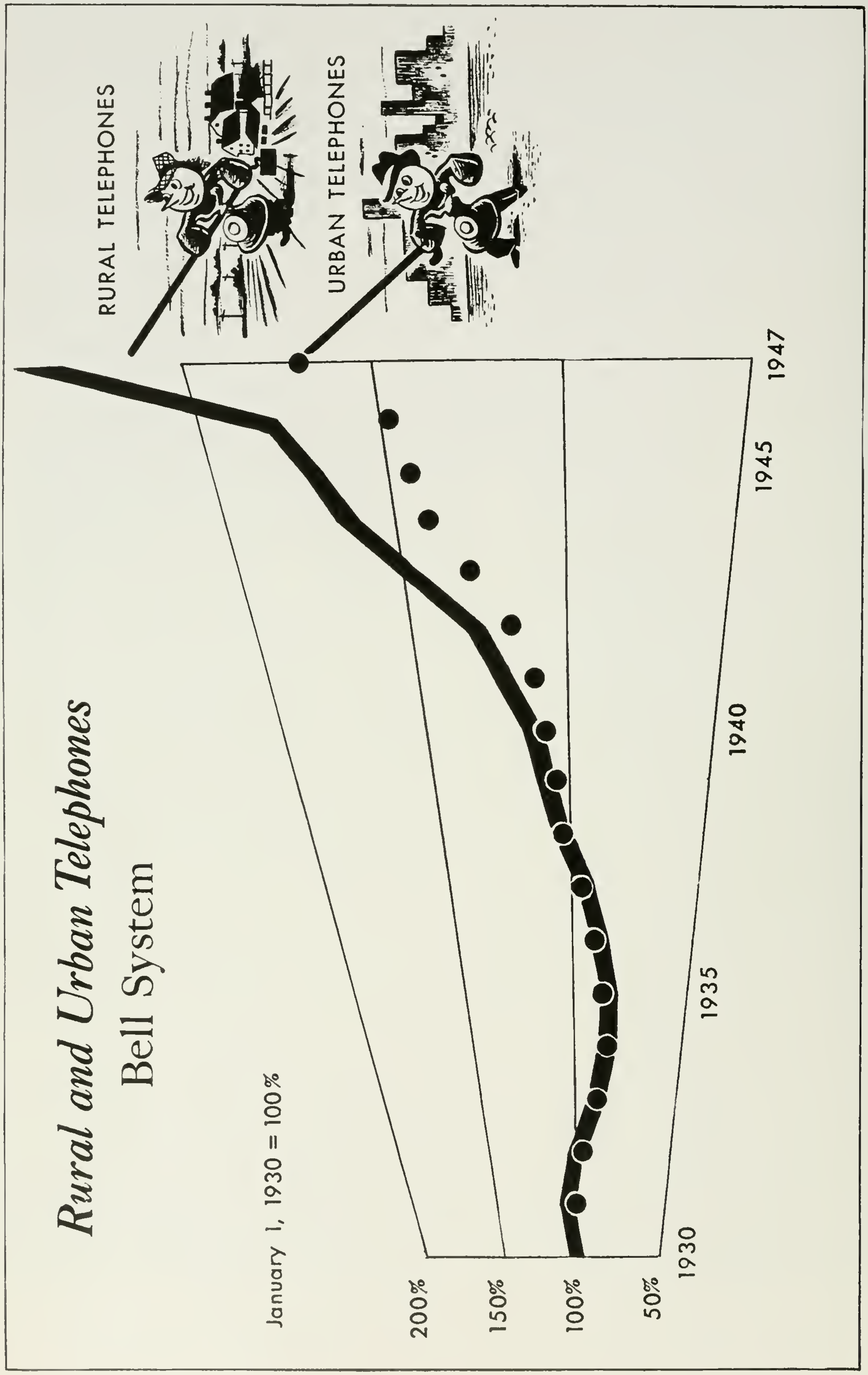
* See "More and Better Telephone Service for Farmers," MAGAZINE, Winter 1944–45.



The increase in rural telephones in the past two years has been unprecedented

Making Good the Promise

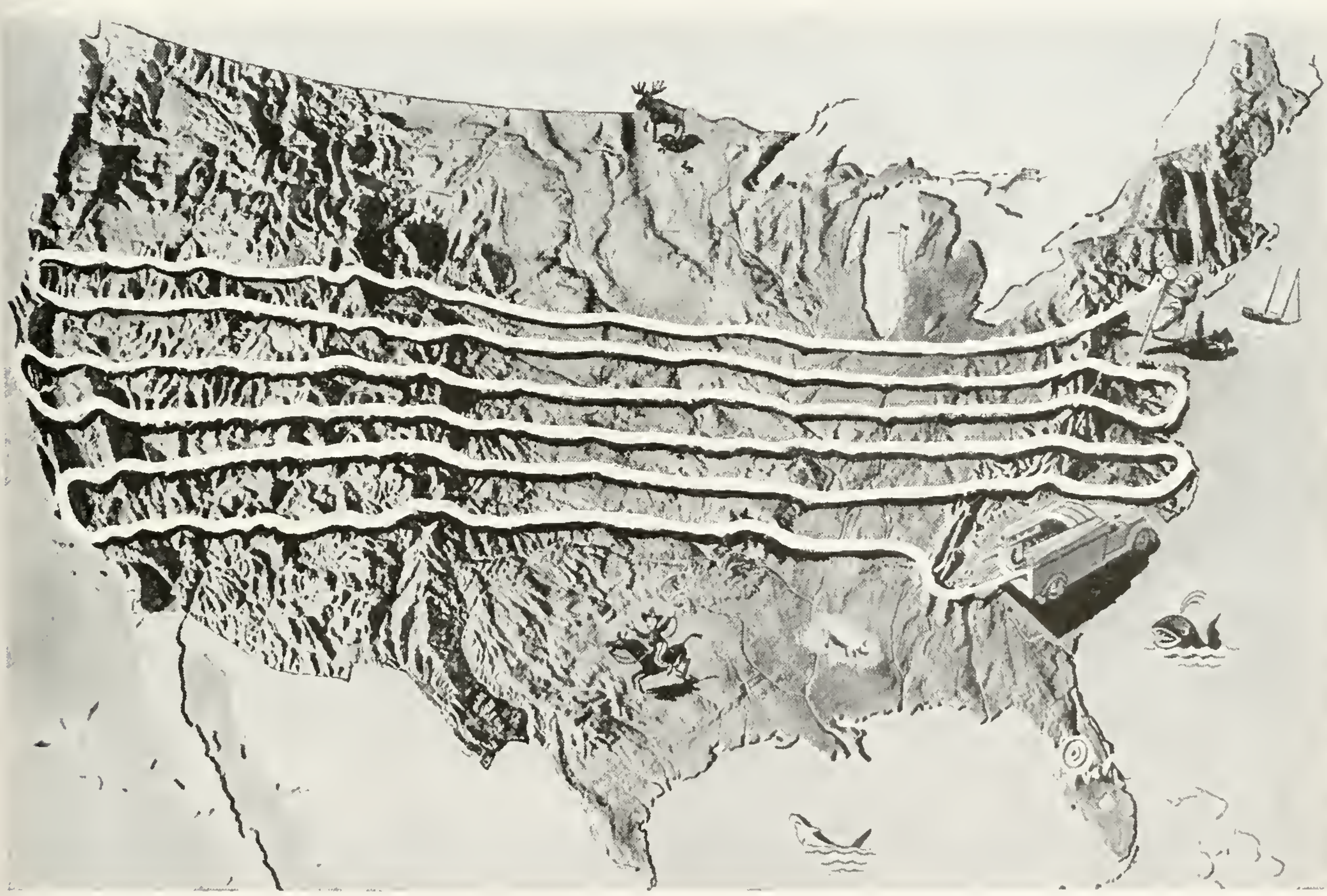
SUCH figures, impressive as they are, take on new vitality when illustrated by what the Bell System companies are bringing about in such rural areas as, for example, Springdale, Arkansas.

That locality had been served by a number of ground-return telephone lines owned by farmers thereabouts. Their lines had deteriorated, and the need for better service was urgent. The Southwestern Bell Telephone Company was asked to extend its improved facilities into the area.

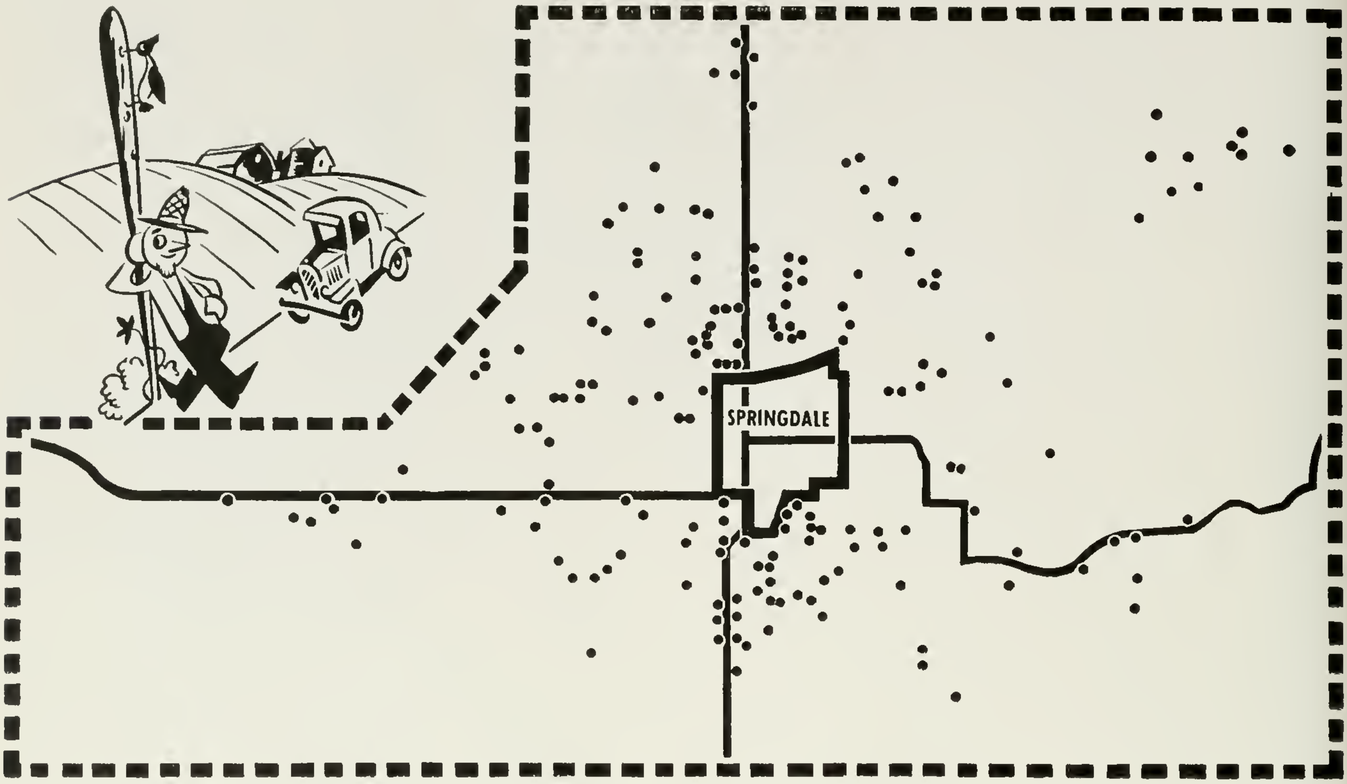
The entire area was surveyed, therefore, and plans were formulated to provide service on an area-coverage basis—as discussed more fully on a later page.

To the project were assigned a commercial representative, and an engineer with construction experience. These two, with the help of the Springdale manager on rights of way and similar matters, interviewed prospective customers and laid out the lines. In 37 working days they completed their interviews and the basic plans for building about 100 miles of new pole line and stringing more than 300 miles of open wire and 14 miles of cable to serve the area around Springdale. By the year's end, the whole job, which cost slightly more than $100,000, had been completed—and the number of customers had jumped from 196 to 517.

The diagrams on pages 196–197 portray more vividly than can those figures the results of the Bell Sys-



Enough telephone poles were set in rural areas in 1946 to carry a line across the continent about six times



The activity at Springdale, Ark., is typical of the Bell System's extension of lines to serve whole rural neighborhoods. At the beginning of 1946, telephones in the vicinity, as represented by the dots, were relatively few

tem's rural program as carried out effectively in one area—with lines extended to provide service to entire neighborhoods, so that all who apply for service can have it. Other examples of such coverage would but repeat the story.

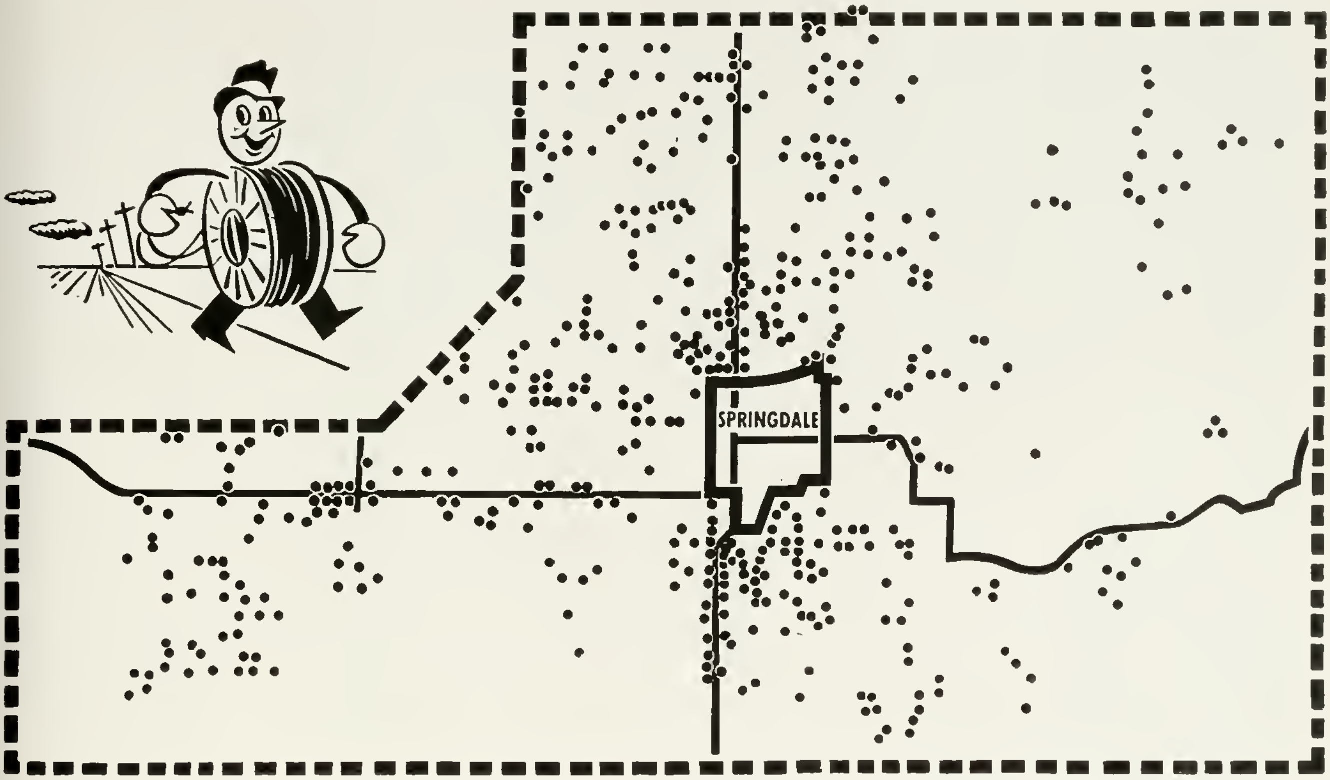
Manpower and Equipment

SUCH an undertaking as that at Springdale can go forward smoothly and productively because behind it there lies a coördinated plan.

Even before the war ended, a great deal of pertinent information was gathered together by telephone men who drove up one country road and down the next. Detailed maps showing the location of rural families along those roads were prepared, and thousands of present and potential telephone customers were asked to tell what they felt rural telephone service should include—what improvements and new features would make it more pleasing and useful to them.

On such facts as these have been built the working plans for extending and improving telephone service in rural areas. And to execute those plans promptly, specially trained forces have been added and have been assigned specifically to the rural job, under the direction of men of long experience. At each step of the way, from the planning to the final connection of the customer's service, the work is scheduled, responsibilities are assigned, and men are made available to accomplish the job.

An important feature of the System's program has been a substantial increase in the amount of new pole line which the companies will build for each new customer without



By the end of the year, as the result of a Southwestern Bell Telephone Company area-coverage project, there were two-and-a-half times as many telephones in service thereabouts

charge. Construction expense to the rural customer, therefore, has been greatly reduced and in most instances completely eliminated. Surveys made in more than 1,500 rural areas indicate that more than 80 percent of all rural families can get telephone service today without having to pay for pole line construction. The free construction allowance has been increased substantially—it is now usually half a mile per customer—and is being applied on an "area coverage" basis.

This means that where lines are being extended to serve a particular section, any unused portion of a half-mile-per-customer allowance is credited to other customers in the neighborhood who require more. For example, if 10 new customers live within four miles of an existing pole line, and 10 more live six miles farther out in the same direction, service can be extended to all 20 customers without a construction charge to any.

For customers who may still need to pay some costs for construction, the charges have generally been reduced, and most Bell companies offer a liberal plan for payment in small monthly installments over periods up to five years.

New Construction Methods

New methods and new machinery have increased considerably the practicable range of rural telephone lines.

One example of this is the use of a high-strength steel wire, developed in recent years, for building long-span pole lines and laying them out straight across private property to minimize the number of corners.

Another example is the use of a new power-driven machine for digging pole holes and placing anchors

When telephone service is planned for a rural area, the first step is to consult the people who live there. Often, as here, a Commercial representative interviews a farmer in his field about his need for a telephone

The unit consists of an earth auger driven by a gasoline engine through a flexible shaft. It is placed on a truck and the auger is raised and lowered by the truck winch line and derrick. Under favorable soil conditions, the new digger can bore holes as large as 16 inches in diameter to a depth of nine feet. Due to its lightness and flexibility of operating positions, it can be used on light-weight construction trucks instead of the heavy-duty trucks required with the older types.

Buried wire may be used in place of open wire where soil conditions are favorable and only one or two pairs will be required. The rubber-covered wire developed by the Bell Telephone Laboratories prior to the war has been improved considerably during the past year and is now undergoing field tests. It consists of a pair of 16-gauge copper conductors covered with rubber insulation, which is surrounded by a braided steel wire armor, over which is placed an outside jacket of tough, durable neoprene. Engineers are working on improvements in the truck-drawn plow which installs the wire in a furrow about two feet deep, and covers it over, in a single operation.

New Ways to Provide Service

In addition to the construction methods just described, some new rural telephones—particularly those remotely situated—are being connected by various recently devised methods. These include power-line and telephone-line carrier, "joint use," and radio-telephone.

Power-line carrier is a means of extending telephone service to farms remote from existing telephone lines but close to electric power lines. This is accomplished by using the power line simultaneously for power service and telephone service. The high-frequency telephone current "hitch-hikes" a ride along an electric power line and at a designated spot hops off onto a pair of telephone wires running to the customer's premises.

The equipment installed in a customer's house is not greatly different in appearance from that for most ordinary telephones in use today. The electronic apparatus is encased in a box slightly larger than an ordinary bell box. Utilizing house current, its receiving vacuum tubes are energized continuously so telephone calls can be received at all times. The apparatus at the central-office end of the power line is similar in design but necessarily a little more complicated. At this writing, seven power-line carrier installations are in service in six states. Five are operated by Bell telephone companies and two by independent telephone companies over the lines of four REA coöperatives and three private power companies.

ANOTHER new but similar method of voice transmission which is expected to become increasingly important in rural areas is telephone-line carrier. Toll circuits have for some time employed carrier systems to increase the number of long distance conversations which can be carried on pole lines. Today, carrier equipment similar to that developed for power lines is being used on rural telephone lines serving Norton Mills, Vermont, on the Canadian border, where an experimental project is being conducted by engineers of the New England Telephone and Telegraph Company and the Bell Laboratories.

Another method of bringing telephone service to more rural families is the joint use of long-span power-line poles by electric and telephone companies. "Joint use," as the industry calls it, is not new. Urban distribution plants have employed joint pole-line construction for years, but it was not extensively used in rural areas. New techniques and facilities have been developed since the war and have proved satisfactory in field tests. Power and telephone organizations are arranging for their widest possible application.

One of the most important features in the development of joint use is the high-strength steel wire previ-

Then a long-span pole line is built to bring the high-strength steel wires into the neighborhood ously mentioned, for it possesses sufficient strength to be used over the long spans commonly used on rural power lines.

Some potential telephone customers live out of reach of both existing electric power and telephone lines. This is particularly true in western United States, where there are vast stretches of ranch country. To reach these remote spots, Bell Laboratories engineers have been experimenting with radio telephony for rural telephones. Last August, engineers of the Mountain States Telephone and Telegraph Company and the Laboratories made trial installations of radio telephone equipment and other facilities at Cheyenne Wells, Colorado, which enable eight ranch families to be connected with any other telephone in the Bell System network.

The eight families live in widely separated locations, 11 to 21 miles from the Cheyenne Wells telephone central office which serves them. Four of the ranches are connected to the central office by short-wave radio; the other four are reached by comparatively short open-wire lines from one of the nearby ranches having radio telephone equipment. Thus the telephones form an eight-party line.

Transmitting and receiving equipment and other apparatus are installed at the ranch houses and the telephone central office. Calls are made and received in substantially the same way as with any ordinary telephone. Service so far has been satisfactory; and on the basis of this experience, the development of a standard system is being undertaken.

Improvements in Rural Service on the Way

PROVIDING telephone service to the waiting thousands of families in rural areas is at present, of course, the first order of business. So, although the Bell System program includes the reduction of the number of parties on rural lines to not more than eight,

Next, branch lines are brought to the farmers' homes

And finally the installer arrives with the eagerly awaited telephone

lines have been temporarily overloaded in order to give service to as many people as possible.

The program calls for not only the ultimate reduction in the number of telephones on a line, but also the replacement, whenever practicable, of the crank-type telephone by dial or other modern type of instrument.

Party-line ringing, too, is being improved. It is proposed to make arrangements so that the customer hears the rings of not more than half the parties on his line, and in many cases still further improvements can be made.

Activities to improve and modernize rural service are temporarily limited by the need to use available wire, cable, and central office equipment to extend service to new customers. Nonetheless, the objective still is to incorporate in rural service as many of the features of city service as practicable.

Service Station Lines

Service-station lines (also called farmer lines) are important in the rural picture. In 1946, more than 200,000 customers were served by such lines in Bell rural areas. Bell System "good neighbor" activities to advise and assist service station customers in improving the condition of their lines have been substantially expanded.

A booklet, "The Farm Telephone Manual," which tells in non-technical terms how to build service station lines and how to repair them and keep them in good working order, has been prepared and made available to all service-station organizations without charge. It has also been furnished to many independent and connecting companies.

What the Independents Are Doing

Paralleling the Bell System's rural program is the independent telephone industry's own accelerated program to extend telephone service in their rural exchange areas. Mr. R. A. Lumpkin, President of the U. S. Independent Telephone Association, has stated that figures of the independent companies indicated a gain of about 100,000 rural telephones for the year just ended. In an earlier statement, he had estimated that the independent telephone companies expected to spend more than $10,000,000 on rural plant construction during 1946.

What Lies Ahead?

MUCH has been accomplished in the past two years; much yet remains to be done. The pace of these activities will no doubt be accelerated. Rural construction projects exceeding those of 1946 are already fully engineered in anticipation of an increase in the supply of materials, and the Bell System's rural program moves steadily forward toward its goal of more and better telephone service for more people.

Who's Who & What's What

(Continued from page 191)

fer to Chicago in 1945 as a *Life* correspondent. Those who read the account of River Grove in the January 6 issue of *Life* will know why Mr. Moffett was asked to contribute a layman's account of the disaster there to these pages.

WHEN WILLIAM P. BANNING retired as an assistant vice president in the Information Department of the A. T. & T. Co., at the end of October in 1944, this MAGAZINE said of him, in part: "He looked upon work in the telephone business not as a job but as a profession, a service of a high degree of usefulness, rendered to the public on a high plane and, therefore, a profession of great possibilities of satisfaction to those who worked in it." That after his retirement he should choose to continue his painstaking labor on the definitive history of the establishment and early progress of Station WEAF is but another demonstration of his own continuing wish to render useful service. Those who worked with him during the preparation of "The WEAF Experiment" know the satisfaction he derived from so doing. The incident which constitutes Chapter VIII of his book is independent of any context, and so can be reprinted here for its own interest. A general estimate of the book, and a photograph of Mr. Banning, will be found on page 267.

IN THESE DAYS of crippling shortages, the salvage operations of the Nassau Smelting and Refining Company, subsidiary of Western Electric and official scrap agent for the Bell System, give a cheering example of thrift and ingenuity. Nassau's president, WILLIAM A. SCHEUCH, has devoted all his business life to metallurgy. He joined Western's research organization, the Engineering Department (later to become Bell Telephone Laboratories), in 1916. He transferred to the Hawthorne Works in Chicago in 1923; and as a member of the Engineer of Manufacture branch he served successively in positions concerned with metal research, secondary metals, heat treatment, casting, and by-products reclamation. In 1931 he came to New York as works manager of the Nassau Smelting and Refining Company's Staten Island plant, was elected vice president in 1939, and was made its president in 1946.

The Smallest of the Nation's Armed Forces Depends on Electrical Communications to Direct and Coördinate Its Many and Varied Duties and Responsibilities

The Coast Guard Operates Through Communications

Admiral Joseph F. Farley, USCG

In times of peace, the Coast Guard is unique in at least two respects: its functions and its responsibilities are more diversified, and in discharging them it is more dependent upon electrical communications, than probably any other Governmental operating organization. Whether for administration of its many scattered stations, for the handling of routine activities, or for the meeting of the countless emergencies to which it is summoned, the Coast Guard depends upon its widespread communications networks for essential information about any given situation and for the transmission of directions about action to be taken.

In carrying out its varied tasks, the Coast Guard makes use of the most appropriate or effective means of speedy communication. These include principally the telephone, telegraph, teletypewriter, radio telephone, and radio telegraph.

Almost any one of the many emergency situations which the Coast Guard is called on to meet will serve to illustrate the outstandingly important function of the Service's networks of communication facilities. But because it was a recent occurrence and attracted wide attention, let us consider how communication made possible the rescue of the 18 survivors of the Sabena airliner, en route from Ireland to New York, which crashed in the Newfoundland wilds on September 18, 1946.

The plane had been in radio communication with the Gander, Newfoundland, airfield during the night, but had not come in as expected. At about 3:45 on the morning of the 18th (New York time) Gander notified the commander of the Coast Guard base at Argentia, Newfoundland, by telephone, that the plane was overdue; and likewise so notified Stephenville airfield, at the other side of the great island.

Argentia immediately advised the Rescue Coördination Center located in the office of the commander of the Eastern Area headquarters of the Coast Guard. This message went by radio telegraph to the primary radio station at East Moriches, on Long Island, and thence by local teletypewriter circuit into the Area headquarters at 42 Broadway in New York City.

From here the report was also transmitted by direct teletypewriter to headquarters of the Army Communications System at Fort Totten, and to the Civil Aeronautics Administration at La Guardia Field. The Army checked immediately by A.C.S. radio teletypewriter with the landing field at Stephenville and also notified the airfield at Goose Bay, Labrador. The C.A.A. got in touch with Gander Airport through its own radio telegraph circuits.

Note that so far there has been no declared emergency: merely an *alert*. Yet within 20 minutes of the first message, airfields across Newfoundland and in Labrador had been put on notice of the obvious possibilities of *distress;* and three major agencies in this country had been notified, had made contact with their respective forces, and were keeping open the channels for the receipt of further reports.

Rescue at Gander: A survivor of the airplane crash in the Newfoundland wilds is removed from the scene in a Coast Guard helicopter

The Search Begins

When the missing plane's estimated gasoline supply was reckoned to have been exhausted, it was assumed that it had made a forced landing and Coast Guard search planes stood by at Argentia base until they could take off at daylight.

Fog made the quest difficult, and the discovery of several older plane wrecks added uncertainty. By radio telephone the search pilots in their planes asked Argentia to find out the color of the missing plane; Argentia queried New York headquarters by the same circuits already described; an ordinary telephone call to the air line's office in the city brought the desired information; it was routed back to Argentia; and from Argentia to the pilots still aloft—all in a matter of minutes.

A further complication arose from the circulation of unfounded rumors. One of these, that the plane had crashed in the sea near Newfoundland, was so persistent that New York headquarters had to radio Argentia to investigate. A Coast Guard plane was sent on an extensive flight in order to eliminate that possibility.

The wreck of the missing plane was first sighted and the existence of survivors determined about 10 o'clock that morning by a TWA transatlantic plane out of New York and making for Gander airfield. While circling the scene of the crash it summoned by radio telephone the Coast Guard detachments which were searching nearby, and these in turn notified the Gander, Argentia, and Stephenville airfields. By 10:18 a Coast Guard plane reported that it had located the wreckage and was attempting to land on a pond nearby.

This news was immediately flashed to the Coast Guard area headquarters in New York from the Coast Guard base at Argentia, to the C.A.A. at LaGuardia Field from Gander airfield, and to the Army from the Stephenville landing field—all by the communications facilities already described.

The rescue teams which made their toilsome way to the wrecked plane took "handy-talkie" radio telephones with them, and by this means kept in touch with the Coast Guard and Army planes. These in turn passed the information on to the airfields already listed, which transmitted bulletins to New York over the circuits the several Services were keeping open.

The Messages Which Brought Rescue to 18

Upon reaching the scene on September 20, an Army doctor with the first rescue team decided that many of the survivors would be unable to withstand any overland journey. The Coast Guard's New York Area headquarters immediately undertook to provide a helicopter—the only means for expeditious yet comfortable evacuation, since it could land in a small space close to the wreck and take off again with a patient on a stretcher. The request for a helicopter reached 42 Broadway via the "handy talkie"—plane radio—radio telegraph—teletypewriter route. These three things then happened quickly:

A telephone call over a Coast Guard circuit to the Coast Guard air station at Floyd Bennett Field gave orders to dismantle a helicopter in a hurry and prepare it to be flown to Newfoundland.

An ordinary telephone call to the Army provided a four-engine transport aircraft to get the dismantled helicopter to Newfoundland—an arrangement which emphasizes the co-operation practiced by these Services.

Finally, because the Coast Guard believes in having two strings to its bow, New York area headquarters made a long distance telephone call over Bell System lines to the Coast Guard air station at Elizabeth City, N. C., where a second helicopter was taken apart, and was picked up and transported in another Army C–54.

Within 10 hours after the call for a helicopter was received in New York, the one from Floyd Bennet Field had been taken apart, packed in an Army plane, and flown to

Gander airport. There it was reassembled and flown to the wrecked plane, and picked up the first survivor and carried her out to a waiting plane on Lake Gander which would take her to the Station hospital.

The helicopter from Elizabeth City arrived two hours later.

The successful removal of all 18 survivors from the scene of the disaster by helicopter and plane is too well known to need retelling here; nor need the point be labored that the use of a variety of communications facilities coördinated the activities of several agencies, kept all informed of actions taken and progress made, left the Coast Guard base commander nearest the scene free to act quickly and effectively, and yet brought help in a hurry when it could be used.

Had the doomed plane come down at sea, much the same basic procedures would have been followed. For the Coast Guard, which for many years has made rescue its business, coördinates all activities of search and rescue—which is, after all, but a modernized version of the Coast Guard's care of all ships at sea and the men who go down to the sea in them.

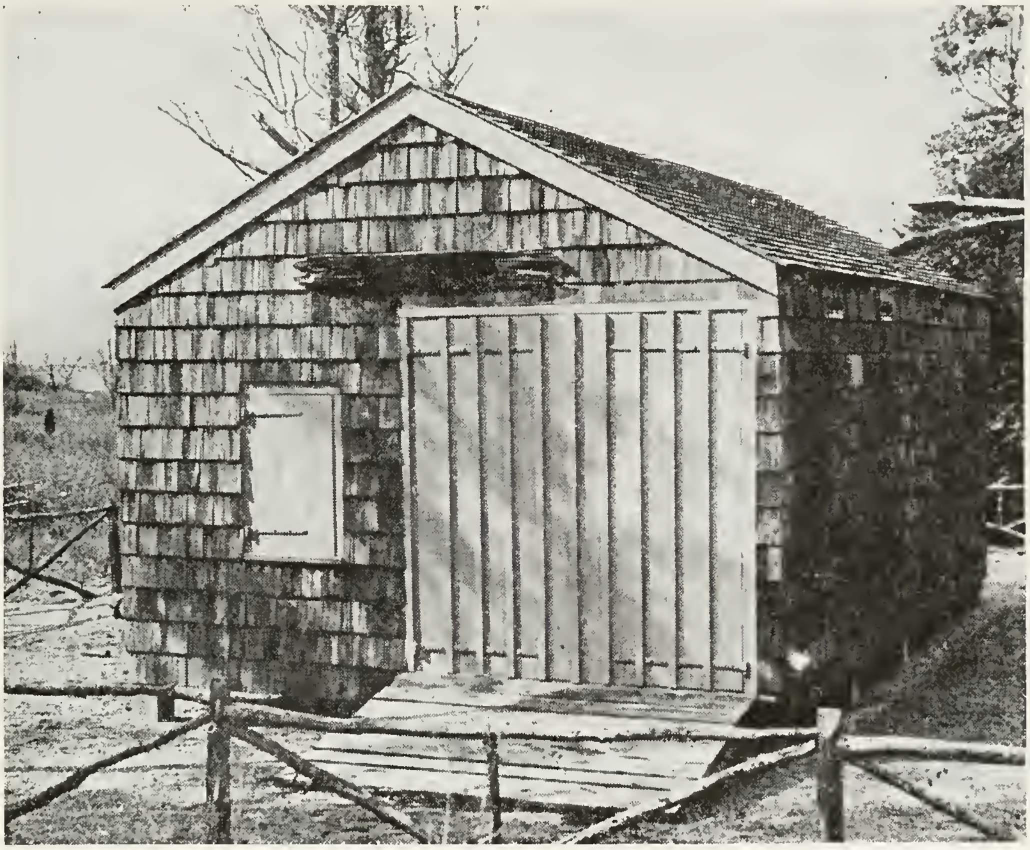
The Coast Guard a Union of Earlier Services

THE WHITE SETTLERS of this land arrived by sea, and since its earliest days the nation has been faced with maritime problems not only of shipwreck and navigation but with such others as smuggling and with questions of the standards of ship construction and operation. Separate agencies were set up to handle individual problems, but it was not long before the rapid growth of the country created an overlapping of these services.

Quite naturally then, the Coast Guard today is composed of three of these former agencies: the Revenue Cutter Service, the Life-Saving Service, and the Lighthouse Service. It has also taken over many functions of a fourth, the former Bureau of Marine Inspection and Navigation. This consolidation is quite logical, since all these agencies had jurisdiction over some portion of the government's program for the promotion of safety at sea.

TO ENFORCE the provisions of the Tariff Act of 1789, the Revenue Marine, later called the Revenue Cutter Service, was established the following year, commencing operations with ten wooden cutters. The first commission ever granted to a seagoing officer under the new Constitution went to Hopley Yeaton of New Hampshire in 1791 as "Master of a Cutter in the Service of the United States."

THE LIFE-SAVING SERVICE had its beginnings in the Massachusetts Humane Society, established in 1785 to provide relief for persons in distress on the sea as well as land. The Society built its first lifeboat station at Cohasset in 1807, but hundreds of ships were wrecked and much individual effort was expended inefficiently before Congress in 1871 saw the necessity of coördinating the administration and operation of the various life-saving activities. In that year the Life-Saving Service was set



The first lifeboat station of the original Life Saving Service—one of the forerunners of the Coast Guard

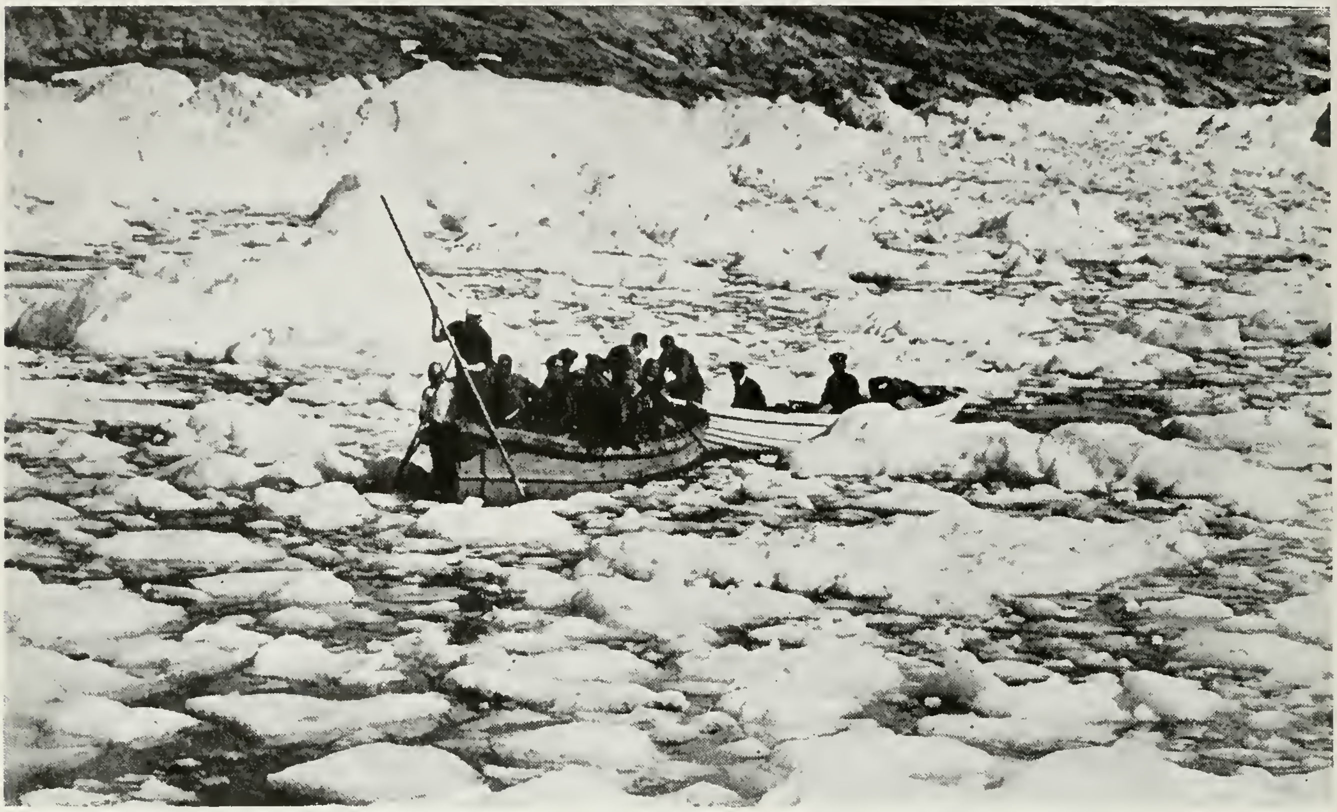
up within the Revenue Marine, but was divorced six years later to become a separate bureau under the Treasury Department.

Since maritime commerce was an essential part of their lives, the Colonies themselves undertook the task of constructing their own lighthouses, buoys and other navigational aids. The first lighthouse in the country was built on Great Brewster Island at Boston in 1716. This and all eleven others erected soon after were taken over by the Federal Government in 1789. After many years under the Treasury Department, the Lighthouse Service was placed under the jurisdiction of the newly created Department of Commerce and Labor in 1903.

The inception of the Bureau of Marine Inspection and Navigation lay in an investigation of several costly marine disasters conducted by the Treasury Department in 1824—although the first significant legislation passed was the Steamboat Act of 1852, which provided for the creation of a board of nine supervising inspectors to administer such marine safety laws as were then in effect. This board evolved into the Steamboat Inspection Service which, like the Lighthouse Service, went under the wing of the Department of Commerce and Labor in 1903.

The Coast Guard's Many Tasks

The United States Coast Guard, as such, was born in 1915 with the merger of the Revenue Cutter Service and the Life-Saving Service. In 1939 the Lighthouse Service was added, and early in 1942 the Coast



Coast Guard to the rescue: R.A.F. fliers being removed from the Greenland ice cap

Guard assumed a number of the duties of the former Bureau of Marine Inspection and Navigation—a move due undoubtedly to the exigencies of war.

Through these consolidations, the Coast Guard today has many varied tasks to perform for Uncle Sam.

Its scope of activity ranges from the Bering Sea and Alaskan waters to Greenland and the North Atlantic. It includes all navigable territorial waters and seacoasts of the United States, its territories and dependencies (except the Canal Zone) together with its lakes and inland waterways. Its shore units form a coordinated network of protective and marine observation stations along the coasts of the United States, Hawaii, Alaska, Puerto Rico, and the Virgin Islands.

The normal activities of the Coast Guard are myriad. It enforces Federal laws regarding smuggling, customs, immigration, quarantine, oil pollution, navigation, and wildlife reservations, and patrols marine regattas. It eliminates navigational hazards, fights waterfront fires, provides medical and surgical aid to American deep-sea fishing vessels, carries Government representatives and mail, and it collects statistics on weather and on loss of life and property at sea. Its functions also include the suppression of mutinies aboard merchant vessels, inspection of these vessels and the licensing of their officers, the examination of merchant seamen and issuing of certificates.

Most of the Federal work requiring the use of Government vessels in the Territory of Alaska is performed by the Coast Guard. It renders medical, dental, and general welfare service to the natives there. It patrols the Bering Sea and parts of the

North Pacific Ocean. In our great river valleys, it furnishes relief to the flood-stricken. It conducts ice-breaking operations on the Great Lakes, in the Hudson River, Long Island Sound, various New England harbors and in the upper reaches of the Delaware River and Chesapeake Bay. In the North Atlantic and Pacific it maintains weather observation posts and conducts the North Atlantic International Ice Patrol, keeping the sea lanes open and reporting drifting bergs.

Integrated into the regulatory and enforcement responsibilities of the service are the humanitarian obligations of the nation. Logically, the many jobs the Coast Guard has to do provide the primary reasons for the establishment of its facilities. In time of need, these can readily be utilized in performing its emergency and assistance missions.

To accomplish all these tasks, enormous "plant" is required. As of 30 June 1946, the Coast Guard maintained a seagoing fleet of 269 cutters and patrol craft of all sizes, including six 327-foot, one 304-foot, seven 255-foot, three 240-foot, four 165-foot, and twelve 125-foot cutters; three ice-breakers; 14 miscellaneous types; 35 lightships; and 93 tenders. In addition, there are 166 motor lifeboats and 1229 motorboats.

On land there are aviation search and rescue facilities composed of 11 air stations and 226 aircraft: the

Convoy guardian: A Coast Guard cutter on duty in the North Atlantic against the menace of Nazi submarines

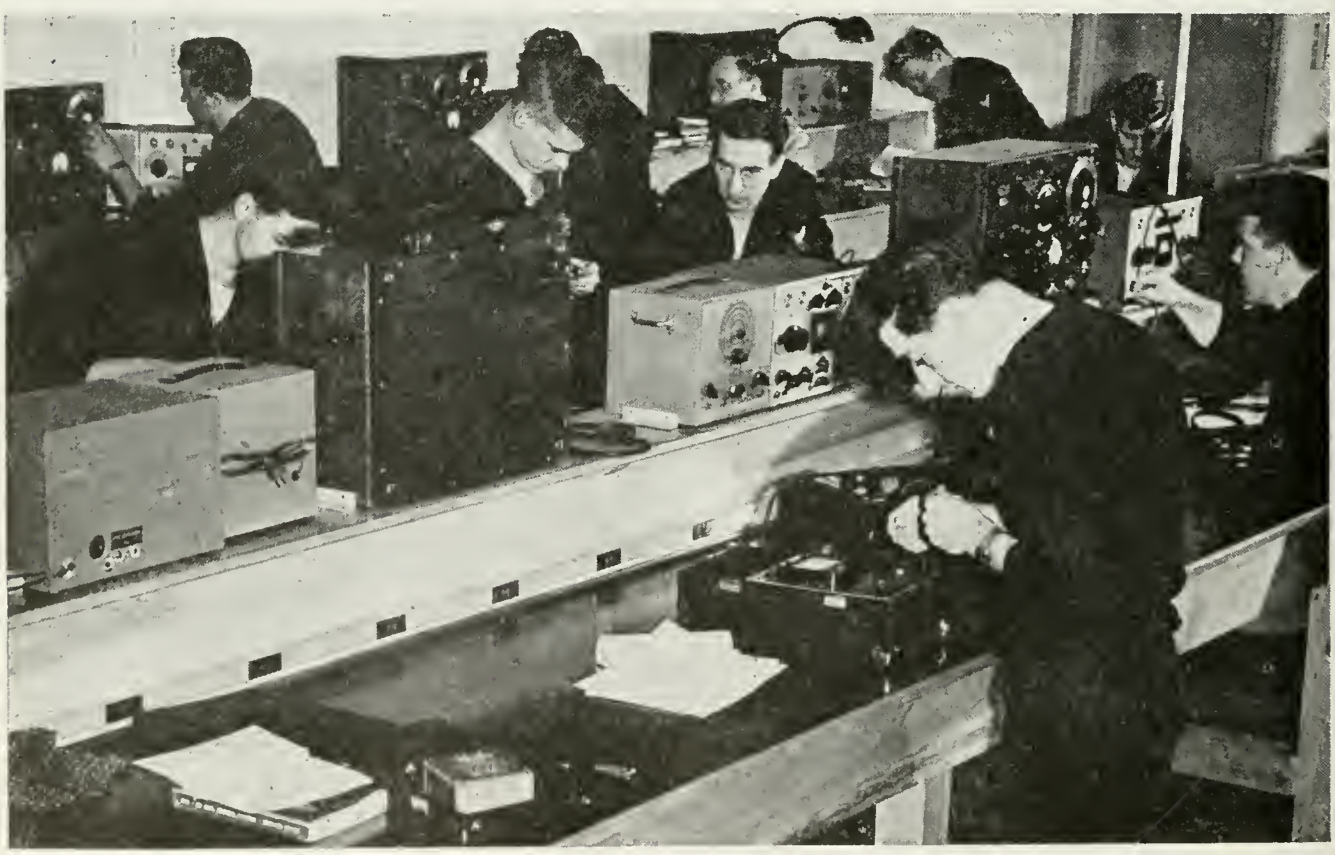
Academy at New London, Conn., for training officers; training stations at Groton, Conn., and Mayport, Fla. for the training of enlisted personnel; about 200 lifeboat stations; a shipyard at Curtis Bay, Md.; 11 repair bases; 47 depots; and two general and five district supply depots. Aids to navigation include over 500 light stations; more than 20,000 buoys; 190 radio beacons; 49 fixed LORAN (long-range navigation) stations, forming eleven chains; and 25 radio direction finder stations.

To knit together this vast, far-flung service, the Coast Guard has a communications network which binds all activities and units of the service into an efficient workable peacetime organization; yet it is so constituted that in time of national emergency it is readily integrated with the communications system of the Navy.

The Communications Network

THE LIFESAVING SERVICE (a major component of the present Coast Guard) made use of the telephone in 1878—the very first year in which telephone service was offered through commercial exchanges. The Army Signal Corps had run telegraph lines along stretches of the Atlantic Coast for its Storm Signal Service, and these had been connected with the lifesaving stations in 1876; and two years later telephones were placed on the telegraph line between Cape Henry and Kitty Hawk, so that the crews and equipment of the 12 lifesaving stations along this stretch of coast might be quickly summoned to meet a need.

This was the first use of the telephone anywhere in the world as an integral feature of a lifesaving sys-



A wartime class in radio training

tem, and it proved so effective that it was rapidly extended. Within the next decade the Signal Corps had interconnected 19 lifesaving stations on the New Jersey shore, nearly that many on the coast of North Carolina, all the stations between Cape Henlopen and Cape Charles, and several stations in the Great Lakes region. Then the newly organized Weather Bureau took over the telegraph feature of the storm warning service from the Signal Corps, and the Lifesaving Service absorbed the telephone lines.

While the telephone had thus demonstrated its value in linking the lifesaving stations along isolated stretches of coastline, it got its real start, as a system, with the program completed in 1918. This involved the expenditure of $1,200,000, which had been recommended by the Interdepartmental Board of Coastal Communications. This Board had been established by Executive Order in 1916 for the purpose of considering coastal communications with a view to improving and extending facilities for saving life and property, for the national defense, and for administration in time of war.

During this period of improvement, which involved much construction and reconstruction, the United States entered World War I, and the Coast Guard operated under the Navy. The original program was therefore considerably enlarged to meet military requirements.

It was at this time that the Coast Guard procured and laid hundreds of miles of submarine telephone cable—some of it to isolated island stations and lighthouses in the Atlantic and Pacific Oceans and the Great Lakes, which were then for the first time brought into quick communication with the mainland and the Coast Guard network. A cable testing and development laboratory near Washington, D. C., is now an important factor in designing submarine cable to meet the Service's particular requirements.

The Present Communications Network

In the happy interval between two wars, the telephone system, as well as other forms of communication, was further extended, until by 1940 the Communications Section was maintaining and operating several thousand miles of land wire telephone circuits and nearly a thousand miles of submarine and underground telephone cable. And there is now, for example, a continuous wire circuit—land line and submarine—extending along the Atlantic shore from the eastern end of Long Island, N. Y., to Morehead City, N. C.—a distance of approximately 700 miles.

During the war which began five years ago, this country's Atlantic and Pacific coasts were potential danger zones, and the Coast Guard's shore patrols were greatly augmented. To provide the ready communications so urgently required, hundreds of miles of rubber-covered telephone cable were purchased and were plowed in along the shore wherever conditions permitted that form of installations. Patrolmen carried telephones which they could plug into "jacks" provided at frequent intervals. Along much of the Pacific shore, the rugged terrain prevented that procedure, and there the installation of Coast Guard circuits became major construction projects presenting such obstacles as mountain ranges, rock formations, and vast forests.

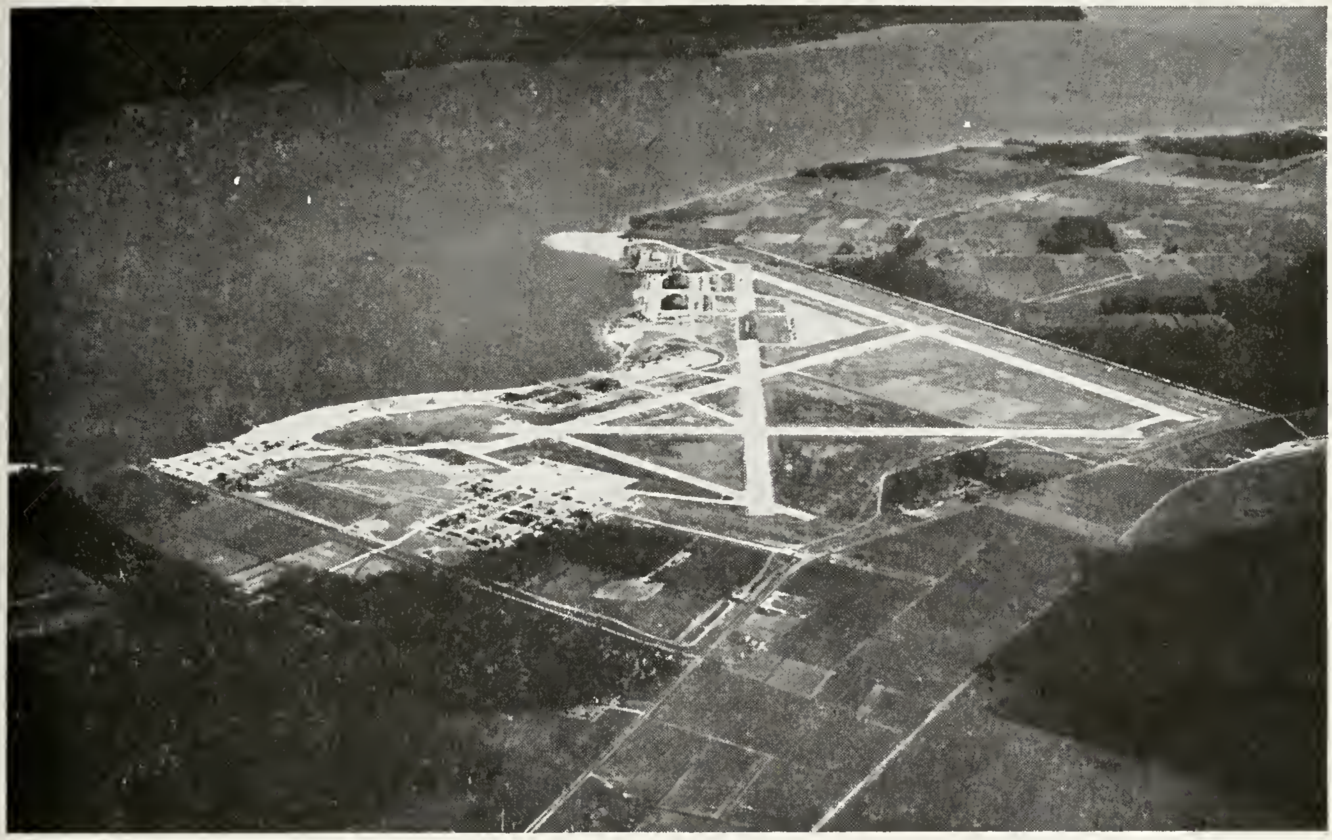
While many of those war-time installations were of a temporary or emergency nature, the Coast Guard still owns, maintains, and operates more than 21,000 circuit miles of telephone lines—including 2,737 miles of pole line, 909 miles of submarine cable, and 218 miles of underground cable.

Note those three words: owns, maintains, operates. They are used here advisedly. They point to a prime example of coöperation and coordination between the Coast Guard and the country's commercial telephone companies—including, obviously, those which comprise the Bell System.

It is really quite simple. Coast Guard circuits must, in the nature of things, run to many remote and isolated places where commercial telephone companies would have no reason to construct lines. So the Coast Guard builds and maintains and operates such lines—and connects each, at some point, into the Bell System network. At some places—islands, for instance, or fishing resorts—where the Coast Guard's is the only line available, civilians may make important calls over it into the commercial central office and beyond. Where the commercial lines do run, the Coast Guard uses them—and saves itself a lot of bother.

And the Bell System, for its part, lends a helping hand or an engineering diagram or the benefit of its experience where it is needed—and provides the Coast Guard with Bell System local and long distance telephone service as required. For 30 years the two organizations have played ball

Coast Guard installations: Foreground, a lifeboat station; background, operations building, transmitter buildings, and antennas of a primary radio station



A Coast Guard air station

together, amiably and successfully, on the basis of a few ground rules and a great deal of mutual confidence and good will.

It is worth recalling that for the Coast Guard, as well as for others, the telephone is a two-way path—inward as well as outward. It is the public's fastest way of getting help from an organization which specializes in giving it. Every Coast Guard station is at the end of a telephone line, and no call goes unanswered.

The telephone is a great coördinator, and direct lines run between each of the fourteen Coast Guard district headquarters and various other agencies: the Army, the Navy, the Civil Aeronautics Authority, the Weather Bureau, Bell System Coastal-and-Harbor radio stations; and others which might seek or give information or assistance. At Coast Guard Headquarters in Washington, this type of direct inter-communication is in itself a complete network.

No one form of communication could meet all the needs of so widely dispersed an organization, and the Coast Guard makes extensive use of the teletypewriter. Its private lines, which it leases from the Bell System, parallel the country's continental shores, and every district headquarters has several and every major coastal unit has at least one of the chattering teletypewriters. The eastern teletypewriter network extends from Maine and Canada along the Atlantic to Key West and along the Gulf to Brownsville, Tex. On the west coast the circuits parallel the Pacific from Seattle to San Diego. Communication between the eastern and western systems is effected through the Bell System's TWX (teletypewriter exchange) service.

Plowing telephone wires into the beach for the use of Coast Guard beach patrols

While the use of the teletypewriter in emergencies is fundamental, it serves other purposes as well. It gathers and transmits data regarding the locations of ships at sea; and it transmits weather information to C.A.A. stations and to Coast Guard radio telegraph transmitting stations for the guidance of mariners, for example; and of course it carries a good deal of administrative traffic as well.

Radio telegraphy—"wireless" as it was called in its infant days during the early part of this century—has grown through the years of peace and the years of war to occupy its now preëminent place as the means of maritime communication.

The Coast Guard, then known as the U. S. Revenue Cutter Service, pioneered in the use of radio afloat when in November, 1903, the U.S. R.C. Grant, operating in the Straits of Juan de Fuca and Puget Sound and engaged principally in the suppression of smuggling, successfully inaugurated the use of wireless telegraph for handling messages between the shore station at Port Angeles, Wash. and the Grant. Following urgent and repeated recommendations by the Secretary of the Treasury that wireless telegraph equipment be installed on all "first class cruising cutters," Congress on 4 March, 1907, approved the sum of $30,000 for installing equipment on not to exceed 12 vessels of the U.S.R.C.S. The Algonquin, in August and September of 1907, was the first of a number of cutters to be so equipped under this program. From that time on, the Coast Guard had kept constantly apace with developments and improvements, realizing clearly the value of having at its disposal the best in equipment and technique.

Two years after the Algonquin installation occurred the incident which gave radio telegraphy the impetus for its universal adoption and rapid growth. Off Nantucket Island the steamships Republic and Florida collided, and from the midnight darkness of the ocean was sent the first C Q D—the first radio call of distress. Four Coast Guard cutters in Atlantic waters intercepted that call, and a small boat from the cutter Gresham rescued the last survivors from the REPUBLIC as the ship went down. Radio had saved hundreds of lives, had introduced a new and potent factor of safety at sea. Today, no commercial vessel—practically speaking—ventures beyond sheltered waters without adequate radio equipment, and an increasing number of pleasure craft carry either radio telegraph or radio telephone installations.

It is scarcely necessary to say that Coast Guard vessels are completely equipped: the larger ones with every type of apparatus for transmitting, receiving—on many frequencies—monitoring, taking and giving bearings; even its small boats, such as motor lifeboats, have radio telephone equipment.

The other half of the Coast Guard's radio story is told in its shore installations: primary radio stations, secondary radio stations, and air radio stations, for communication principally with ships and aircraft at sea; and high-frequency direction-finder stations, the bearings from two or more of which can give a vessel's or aircraft's navigator a "fix" or position in a matter of seconds in case of actual or imminent distress.*

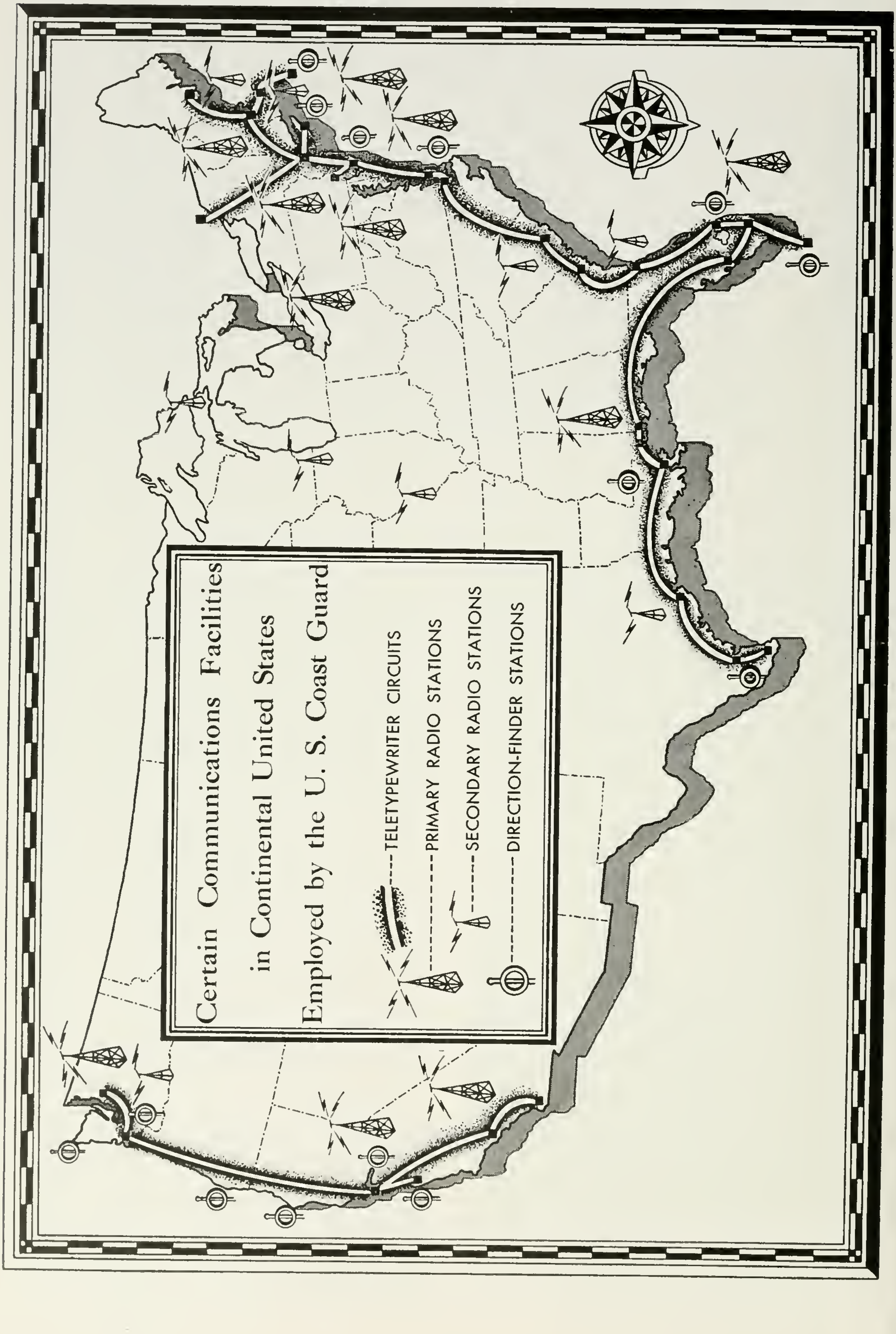
Building coastal telephone circuits in the Pacific Northwest sometimes involved major construction projects

Uses of Communications

SINCE communications enter into practically every Coast Guard operation, a complete discussion of communications would be tantamount to a catalog of the Service's activities. Instead, let us mention a few in which communications are of major importance.

By an agreement of long standing with the American Red Cross, the Coast Guard stands ready at all times, when called on, to assume responsibility for rescue work in inland areas beset by flood or hurricane. Routines exist for transporting men, lifesaving vessels, and other equipment—including communications

* The Coast Guard formerly furnished medium frequency radio direction finder bearings to the public for navigational purposes. This service was discontinued owing to the developed widespread use of shipborne direction-finder equipment whereby the navigator takes his own bearings on the numerous radio beacons operated by the Coast Guard at strategic points along the coasts.


Certain Communications Facilities
in Continental United States
Employed by the U. S. Coast Guard
TELETYPEWRITER CIRCUITS
PRIMARY RADIO STATIONS
SECONDARY RADIO STATIONS
DIRECTION-FINDER STATIONS

equipment—to the scene. Each district has at least one specially equipped truck which can be set up as a message center, receiving reports and information by radio directly from Coast Guard airplanes, talking with and directing Coast Guard lifesaving boats, making direct contact with the District Headquarters in case of need, and coördinating protective and rescue operations. There is close coöperation between the Coast Guard and the Bell System telephone companies in the area affected, and the record of lives saved and property safeguarded by the Coast Guard far from salt water is a proud one.

The war, and particularly the importance of aircraft, brought about many new developments in search and rescue at sea. In fact, among the duties with which the Commandant of the Coast Guard is charged as head of the Search and Rescue Agency are the coördination of research in and development of search and rescue equipment through joint studies; dissemination of information; and recommendations to appropriate agencies of the War, Navy, and other interested Departments. These responsibilities also include the maintenance of liaison with agencies of other United Nations concerned with these matters.

Such items as collapsible lifeboats, special food, clothing, and other survival equipment which may be dropped from planes, are now standard equipment on all search and rescue and on most other Coast Guard aircraft.

The Coast Guard communication research laboratory maintained at "Radio Washington," near Washington, D. C., has been very active in perfecting radio signaling devices for attracting rescuers. These include, among other projects, modification of the famous "Gibson Girl" emergency automatic transmitter so as to send out signals on two different frequencies, 500 kc and 8280 kc alternately, instead of only on 500 kc. The practicability as well as the greatly increased radius of reliable operation on the higher frequency was conclusively demonstrated by extensive tests under typical conditions which subsequently led to the adoption generally of the higher frequency for use by marine survival craft.

The laboratory has done much work in improving corner reflectors which are used for reflecting radar impulses sent out by searching craft and which might not otherwise detect so small an object as a rubber life raft. At the laboratory the Coast Guard is working on the development of a lightweight airborne emergency radio transmitter which could be turned on when a plane is forced to ditch and would automatically transmit its call letters, dashes, and SOS on 8280 kc to enable the high-frequency direction finder nets to determine the last position of the distressed aircraft. Other current projects include the development of an automatic alarm for use by aircraft which would place at their disposal the same means of summoning aid as now utilized by vessels.

These examples illustrate one phase of the laboratory's function: development of communications equipment, the need for which is recognized, to the point where commercial manufacturers can produce it to Coast Guard

Coast Guard communication installations. Left: Equipment at "Radio Washington," key station of the Coast Guard emergency network and in the handling of traffic for the North Atlantic Weather and Ice Patrols. Below: Teletypewriters at Eastern Area Headquarters in New York, showing at left part of the search-and-rescue plotting board

standard specifications. Equally important is its work of testing new equipment submitted to it for approval and of checking up on equipment purchased to see that it is as ordered and required by the specifications.

In addition to the work carried on by Radio Washington, the Coast Guard electronics test station at Fenwick Island, Delaware, contributes greatly to Coast Guard electronics by testing LORAN, RACON (radar beacan—aircraft), and Radio Beacon buoy equipment. This station in some measure made possible the successful use of LORAN equipment when that system was so urgently required by the armed forces during the war. The continuing need for improved electronic aids to navigation for commercial and military use indicates the important part this activity will continue to play in peacetime Coast Guard activities.

The Coast Guard Is An Armed Force

NORMALLY, the Coast Guard operates under the direction of the Treasury. But when war breaks out and the big guns start belching fire and smoke and steel in earnest, the Coast Guard immediately goes on a wartime footing under the Navy Department. The nucleus of our earliest Navy, as a matter of fact, was the Revenue Marine, whose armed ships were the backbone of this nation's defense in 1798 when war with France appeared imminent. Since then, the Coast Guard has fought side by side with the Navy in every one of this country's wars.

The war record of the Coast Guard has been portrayed in words and pictures throughout the world. Suffice it to say that certain of its peace-time activities were curtailed or suspended in World War II, while

U. S. Revenue Cutter Grant: The first vessel of the Revenue Service to be equipped with "wireless," in 1903 others were greatly expanded to meet the needs of the emergency.

Greatly augmented were the activities of port security, beach patrols, offshore patrols, ice-breaking, weather stations, search and rescue, electronic communications, navigation aids, underwater sound, and marine inspection. All seagoing cutters were assigned to convoy or anti-submarine duties. Coast Guard aircraft operated under Sea Frontier Commanders.

Total manpower rose from 25,000 officers and men at the outbreak of the war to over 170,000 by the end of the war. The establishment of the Women's Reserve, whose SPARS served in numerous communications billets ashore, aided greatly in releasing men for duty afloat, and the service was further augmented by some 65,000 temporary reservists. Many of the latter were former members of the Auxiliary, a volunteer non-military organization created in 1939 to train and instruct civilians using the high seas and navigable waters of the United States.

At the beginning of World War II, operation of the Coast Guard's communication system required some 80 officers and 1,000 enlisted men. At the peak of its wartime activities, operation of the system required over

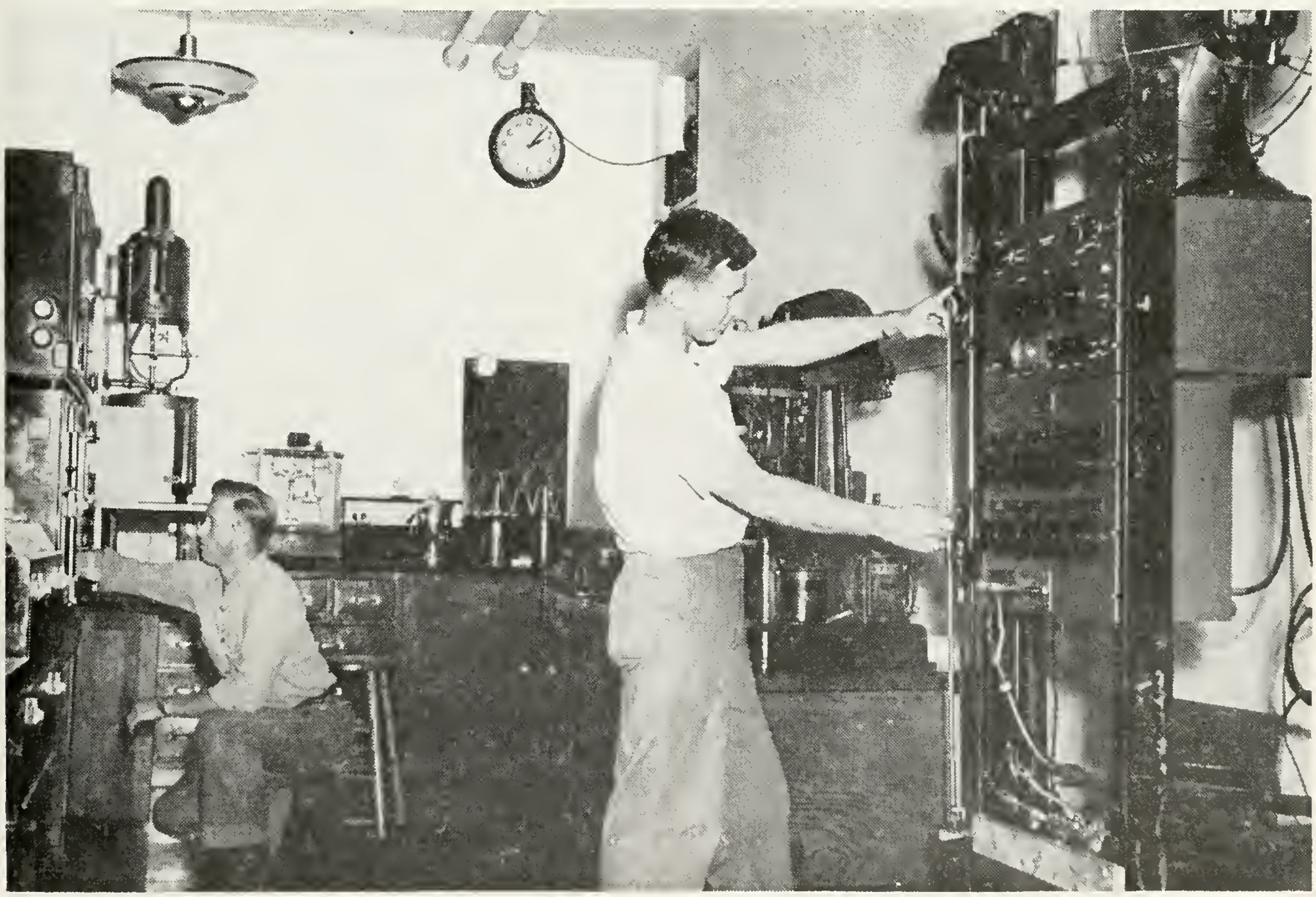
Mobile communication equipment. Coast Guard officer (in circle) is conversing over radio telephone equipment of the type installed in the trucks shown below

700 officers and 14,000 enlisted personnel.

The Coast Guard's long experience in handling small boats, both at sea and in the breakers along our shores, was recognized as of the greatest value for amphibious operations in both the European and Pacific theaters. Today the Coast Guard is proud to be able to say that its personnel operated landing-craft in every important amphibious assault made by our armed forces during the war.

In addition to the administration of its own communications, the Coast Guard has communications responsibilities at interdepartmental and international levels.

Its Chief Communications Officer represents the Treasury Department on the Interdepartment Radio Advisory Committee; the Radio Technical Commission for Aeronautics and its Executive Committee; the Radio Propagation Executive Council; and he is alternate for the Assistant Secretary of the Treasury on the Board of War Communications and the Telecommunication Coördinating Committee. The Coast Guard is represented on the committees of the Joint and Combined Communication Boards, and on the Provisional International Civil Aviation Organization. The Chief Communications Officer served as Chairman of the U. S. Delegation to the International Meeting for Radio Aids to Marine Navigation at London in May, 1946, and he was the Treasury Department representative on the U. S. Delegation attending the Five-Power Conference convened at Moscow in October, 1946, for the purpose of



Equipment in the cable testing laboratory at "Radio Washington"

Coast Guard manned LCIs crossing the English Channel for the D-Day invasion of the coast of Normandy

preparing material for the forthcoming International Telecommunication Conference.

A Quick Look Ahead

WHILE THE COAST GUARD is readjusting itself as rapidly as possible to its post-war strength, there will be various developments affecting the scope and emphasis of its program in the post-war period.

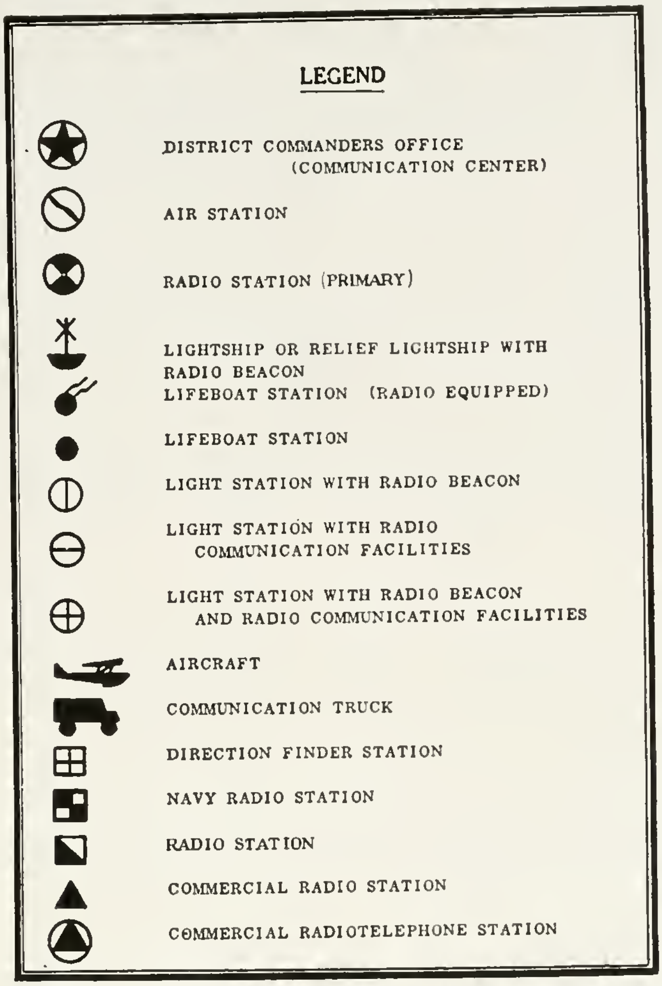
A remarkable expansion in transoceanic air traffic is predicted. Despite the many improvements in aircraft construction and operation, this expansion is certain to be accompanied by an increased need for the search-and-rescue activities organized by the Coast Guard. This will require not only more sea and air rescue craft but improved equipment for locating and communicating with vessels and aircraft in distress. Of no little value will be further extension of the Coast Guard's research and experimental activities relating to the helicopter.

The remarkable advances made in radio and electronic devices during the war will have a profound effect upon the Coast Guard's communications and aids-to-navigation facilities and services. New research and experimental programs will be required.

Improvements of its emergency radio direction finder facilities and the re-activation of stations currently inoperative owing to the lack of personnel are among the problems which currently confront this Service.

The continued expansion of LORAN is being effected for application to peacetime ocean navigation by air and surface craft.

Improvements of facilities at its coastal radio stations and afloat, in keeping with the extended sea frontiers of post-war operational requirements, are receiving their share of attention. Special study has been made to determine the post-war use to be made of RADAR by the Coast Guard, and effort has been made to help the Merchant Marine in obtaining the use of RADAR. The outcome of this study has resulted in the preparation of voluntary minimum specifications for use, if so desired, by maritime interests. These specifications have been favorably received by both operators and manufacturers. By keeping abreast of developments in the field of electronics, as well as by maintaining its traditional high standards throughout its wide-flung organization, the Coast Guard is living up to the slogan of constant preparedness which its banners so proudly bear: SEMPER PARATUS.



Symbols and legends from a Coast Guard communications chart of coastal waters indicate how large a part communications play in the activities of the Service

Index to Volume XXV Available

An index to Volume XXV (1946) of the Bell Telephone Magazine may be obtained upon request to the Information Department of the American Telephone and Telegraph Company, 195 Broadway, New York 7, N. Y.

A Salute to the Spirit of Service

Walter S. Gifford

Editors' note: The following is the text of the statement made by President Gifford of the A. T. & T. Company during the "Telephone Hour" radio broadcast on December 16, 1946.

A LITTLE OVER a year ago, on the Telephone Hour, I congratulated the men and women of the Bell System on the superb job they did in meeting the nation's communication needs during the war. There were 450,000 of them then and there are more than 625,000 of them now. Tonight I am sure you would all join me, if you were as familiar as I am with their extraordinary accomplishments in the face of great difficulties, in extending sincere appreciation to them for the record-breaking job they have done since V–J Day.

It is sixteen months since Japan surrendered. They have been months full of challenge to those of us in the Bell System. After nearly four years of concentrating on war, V–J Day found us seriously short of trained personnel and of equipment and facilities to meet the backed-up civilian demand for telephone service. There is perhaps less glory but certainly there is real satisfaction in peacetime accomplishments, and the accomplishments of the last sixteen months have been the most striking in the history of the System. In spite of shortages of critical materials and other difficulties beyond their control, the Bell telephone companies have installed more than twice as many telephones as they ever did before. They have added the record number of 3,800,000 telephones: almost equal to the total number of telephones in Great Britain, for example, which country ranks next to the United States in number of telephones. They have added more than seven hundred and fifty million dollars' worth of telephone equipment and facilities, and they have employed every ingenious device that could be thought of to provide the maximum amount of best possible quality of telephone service. Their slogan has been to find out how the impossible can be done and then do it. This is our American way in peacetime as well as wartime—it is the spirit that inspired the founders of our country and has made our country great.

With demands for telephone service greater than they have ever been, and with long distance calls more than three times what they were before the war, the service has been surprisingly good. But in spite of record achievements and in spite of doing our level best, we are greatly concerned that there are still over two million people waiting for telephone service and many who are not getting the kind of service they want.

The men and women of the Bell System can well take pride in what they have accomplished—but there is much yet to be done. With the spirit of service that is a tradition in the Bell System, I look forward to 1947 with high hopes that we shall make real progress in giving everyone the telephone service he wants when and as he wants it, and that we shall make real progress toward making the speed and quality of that service better than it ever was.

Radio Telephony Extends Service not only Overseas but Also to Vessels Afloat and Vehicles Ashore, and Overland to Meet Special Needs

The Growing Use of Radio in the Bell System

Francis M. Ryan

A TELEPHONE BELL rings in an automobile. The driver pulls over to the curb, takes the telephone handset from its mounting under the dash, and answers, "This is WJ6–6632." The call may bring important information, save miles of driving and hours of time, many dollars of expense.

Such calls are being made every day in many parts of the country.

Telephone service to motor vehicles is the latest addition to the many uses of radio in the Bell System. These include telephone service to ships at sea, to harbor vessels, and to airplanes, as well as overseas service connecting telephones in this country with those in the principal nations of the world.

Radio also is employed for certain domestic telephone circuits bridging water gaps or traversing difficult terrain. A recent installation of this type is a 28-mile radio circuit across the desert extending wire facilities to serve Death Valley in California. A similar circuit is being established to serve Timberline Lodge on the slopes of Mount Hood in Oregon.

The frequencies employed for these many Bell System radio services range from thousands of cycles per second, corresponding to wave lengths measured in miles, to billions of cycles per second, with wave lengths of fractions of an inch. By contrast, the dial on a standard frequency radio broadcast receiver extends from 550 kilocycles to 1600 kilocycles—a range of a little more than 1,000 kilocycles. The diagram on page 227 shows in compressed fashion (logarithmic scale) the range of frequencies employed in Bell System services compared with the standard broadcast frequency band. Without this compression, but em-

The antennas of the Death Valley terminal of the new radio telephone circuit loom over barren sands

ploying instead the scale used here to represent the broadcasting range, it would take a piece of paper 300 feet long to cover the frequency range within which Bell System services operate.

The characteristics of radio waves vary greatly with frequency. Some are suitable for one type of service, others for entirely different services. Generally speaking, waves of the lower frequencies hug the earth, while those of extremely high frequencies (micro waves) have characteristics similar to light waves. These micro waves are capable of spanning only moderate distances, as they travel in straight lines and require for their use line-of-sight conditions between transmitting and receiving stations without intervening obstructions. Over land they may be employed for longer distances by the use of relay or repeater stations along the route to be covered.

For transoceanic transmission, very low frequencies may be employed. But since sufficient numbers of such frequencies are not available to care for current needs, in-between frequencies are used which reach the other side of the ocean by bouncing down from conducting layers in the upper atmosphere which engineers call the "ionosphere."

Much of the story of research in the field of radio is of the exploration of waves of higher and higher frequencies, corresponding to shorter and shorter wave lengths. This continuing exploration has been necessary not only to provide frequency channels of suitable characteristics for the varied uses of radio, but also to provide an adequate number of channels.

Each step upward in frequency has required the development of new techniques for the generation and radiation of the waves and for their reception and utilization. As these techniques have been developed and waves in new frequency ranges have been put to experimental use by research engineers, their characteristics and field of utility have been determined. Development engineers, following close on the heels of the research engineers, have translated these new techniques into apparatus and equipment for new kinds of telephone services.

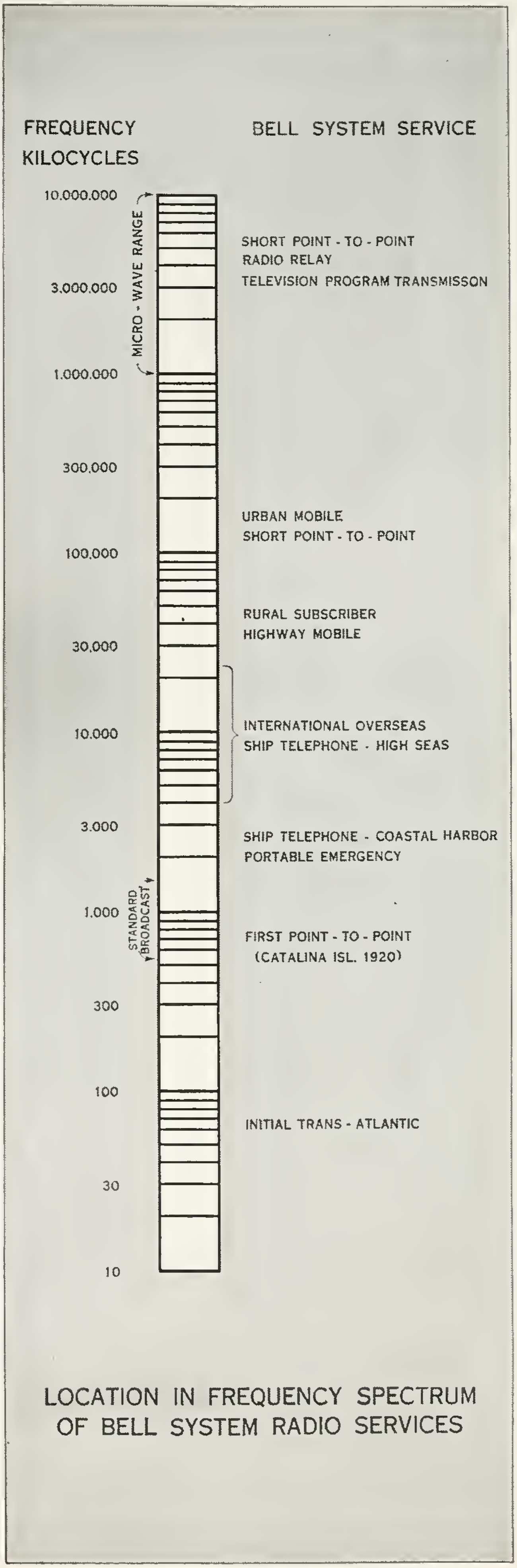
Early Experiments

THE POSSIBILITIES of radio in the field of telephony were strikingly demonstrated when in 1915 Bell System engineers transmitted the human voice for the first time across the ocean to Paris. In these experiments, frequencies of about 60,000 cycles per second, corresponding to a wave length of about three miles, were employed. To radiate waves of these great lengths effectively requires immense antenna structures, and the giant antenna of the Navy wireless telegraph station at Arlington, Virginia, towering 600 feet high, was borrowed for these experiments.

In the steady progression toward higher and higher frequencies, antennas have become smaller and smaller. For example, in a micro-wave system recently placed in service in the Bell System, the active antenna element is only 2½ inches long.

Commercial Service

THE FIRST regular day-in-and-day-out use of radio to provide telephone



A logarithmic representation of the radio frequency spectrum, showing to the right of the central column the location therein of various Bell System radio services. For reference, the standard broadcast band is also shown

The radio telephone station on Santa Catalina Island, established in 1920, was the first used to provide day-in-and-day-out telephone service

service began in July 1920, and was for the purpose of connecting the telephones on Santa Catalina Island, thirty miles off the California coast, with the general telephone network of the Bell System. The transmitting and receiving equipments were located in separate buildings. This radio-telephone circuit, which was in operation for more than three years, employed frequencies of about 700,000 cycles per second—700 kilocycles—corresponding to a wave length of about 1400 feet. This range of frequencies is now used for broadcasting.

These initial radio facilities were ultimately replaced by submarine cables. However, when additional telephone circuits were needed to Catalina Island in 1946, radio facilities were again installed, this time to supplement the cable facilities.

The radio facilities installed in 1946 are very different in character from those installed in 1920. The new system, which provides for eight simultaneous conversations, employs frequencies of about 4800 megacycles or nearly 5 billion cycles per second. This is a frequency 7000 times higher and corresponds to a wave length 1/7000 that of the original 1920 installation. This illustrates the vast strides that are being made in the opening of new frequency ranges and in developing the equipment, the techniques, and the "know how" necessary for their full utilization in telephone service.

Overseas Telephone Service

A VAST AMOUNT of research and development work was required before the technique of the intermittent one-way transoceanic radio-telephone experiments of 1915 was improved upon sufficiently to permit giving a reasonably reliable transatlantic telephone service. By 1927 this point was reached, and service was opened to London 20 years ago last January. For this service, frequencies in the same range (60 kilocycles) as the original overseas experiments were employed.

Shortly after this, the technique of employing higher frequencies (4,000 to 20,000 kilocycles) and shorter waves was developed. With these shorter waves, smaller antennas having directional properties became practical. The increased efficiency available through the use of these directional antennas, and the fact that these shorter waves were transmitted with relatively little attenuation, permitted the use of transmitters of more moderate power.

This technique made possible a wide extension of radio facilities for overseas telephone communication. Full advantage has been taken of it, and such facilities are now used by the Long Lines Department of the American Telephone and Telegraph Company to connect the telephone system of this country with those of the other principal nations of the world—except Canada, Mexico, and Cuba, which are reached by wire connections.

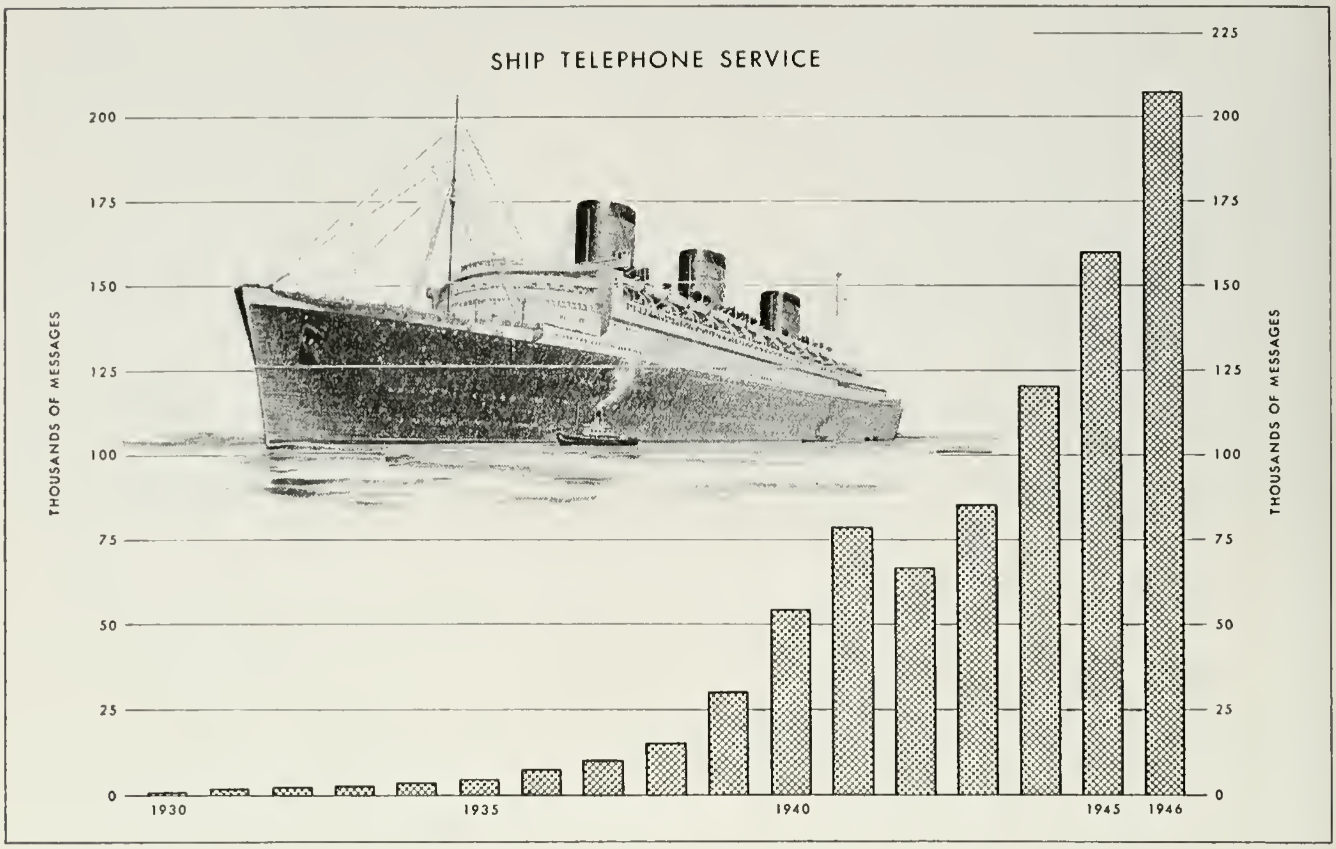
With the increased facilities available, improved techniques, and reductions in rates, the use of overseas radio-telephone circuits has grown to large proportions. At present this traffic is at an annual rate of approximately 500,000 messages.

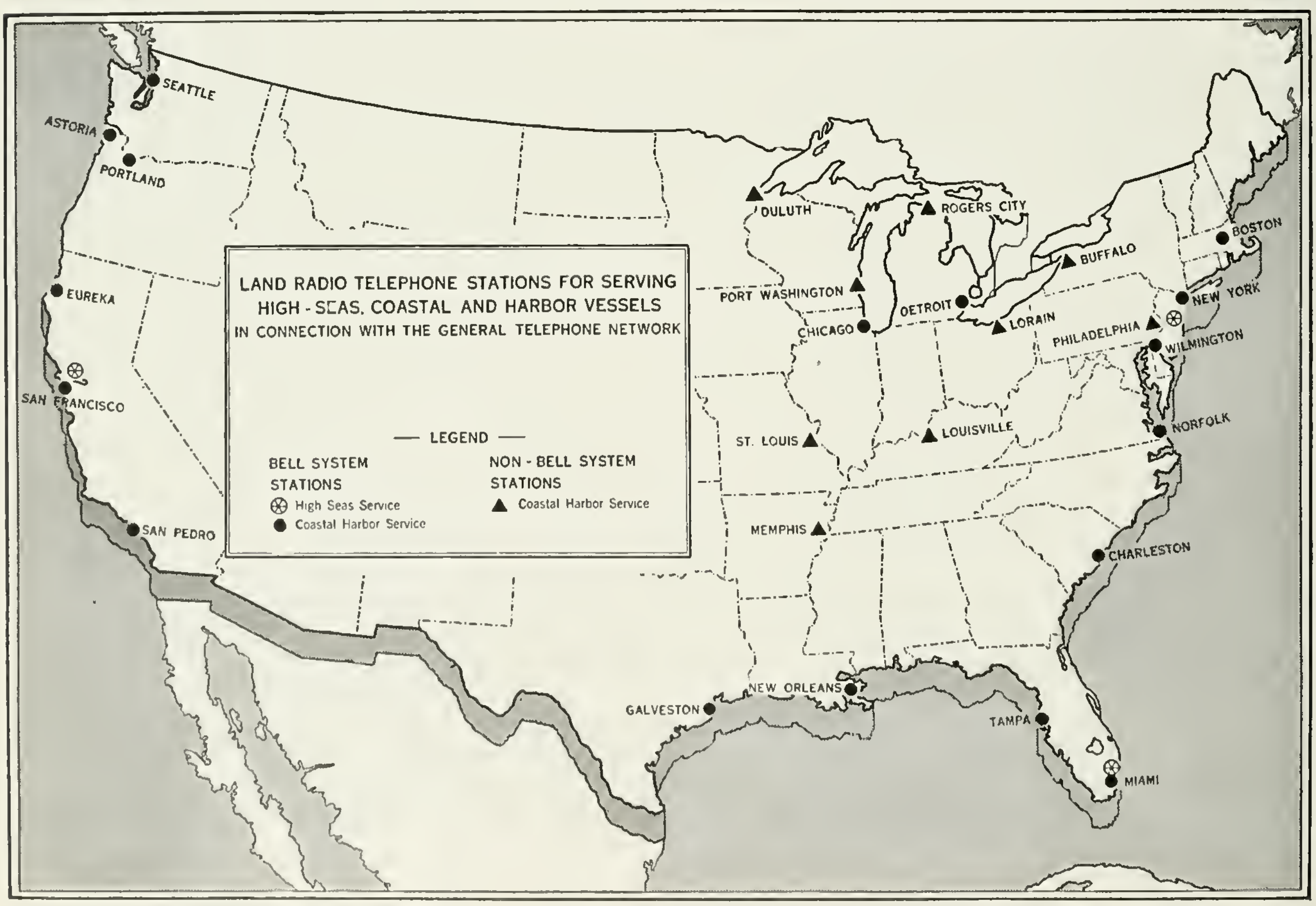
Ship Telephone Service

The development of ship telephone service has paralleled that of overseas service. For high-seas ships the service follows the pattern of the short-wave overseas service, and employs frequencies in the same general range. The shore station equipment for this service to ocean liners is located in the same buildings as that for overseas service.

To supplement this service, facilities have been provided for serving coastal and harbor vessels. They employ frequencies of about 2,000 kilocycles. The Bell System operates

This powerful modern tug is typical of the commercial vessels using coastal-harbor telephone service


SHIP TELEPHONE SERVICE
THOUSANDS OF MESSAGES
0
25
50
75
100
125
150
175
200
225
1930
1935
1940
1945
1946


LAND RADIO TELEPHONE STATIONS FOR SERVING
HIGH - SEAS, COASTAL AND HARBOR VESSELS
IN CONNECTION WITH THE GENERAL TELEPHONE NETWORK
— LEGEND —
BELL SYSTEM STATIONS
High Seas Service
Coastal Harbor Service
NON - BELL SYSTEM STATIONS
Coastal Harbor Service
SEATTLE
ASTORIA
PORTLAND
EUREKA
SAN FRANCISCO
SAN PEDRO
DULUTH
ROGERS CITY
PORT WASHINGTON
CHICAGO
DETROIT
LORAIN
BUFFALO
BOSTON
NEW YORK
PHILADELPHIA
WILMINGTON
NORFOLK
ST. LOUIS
LOUISVILLE
MEMPHIS
CHARLESTON
NEW ORLEANS
GALVESTON
TAMPA
MIAMI

This recently completed micro-wave radio station on Cape Cod provides telephone circuits to Nantucket Island

land stations of the coastal-harbor type in 17 locations on the Atlantic seaboard, the Gulf, the Pacific coast, and the Great Lakes; and additional stations are operated by connecting companies on the Great Lakes and the Mississippi River. The location of these land radio stations employed for ship telephone service is represented on page 230. This service is used by tugs, tankers, yachts, launches, pilot boats, ferries, freighters, and ocean liners: in short, every conceivable type of marine vessel. And the service of these stations has recently been extended to aircraft on a conditional basis.

Like overseas service, ship telephone service has continued to grow. The present traffic through Bell System stations is at an annual rate of more than 200,000 messages. The number of ship telephone messages handled year by year through these stations since 1930 is indicated on page 230 also.

Domestic Point-to-Point Services

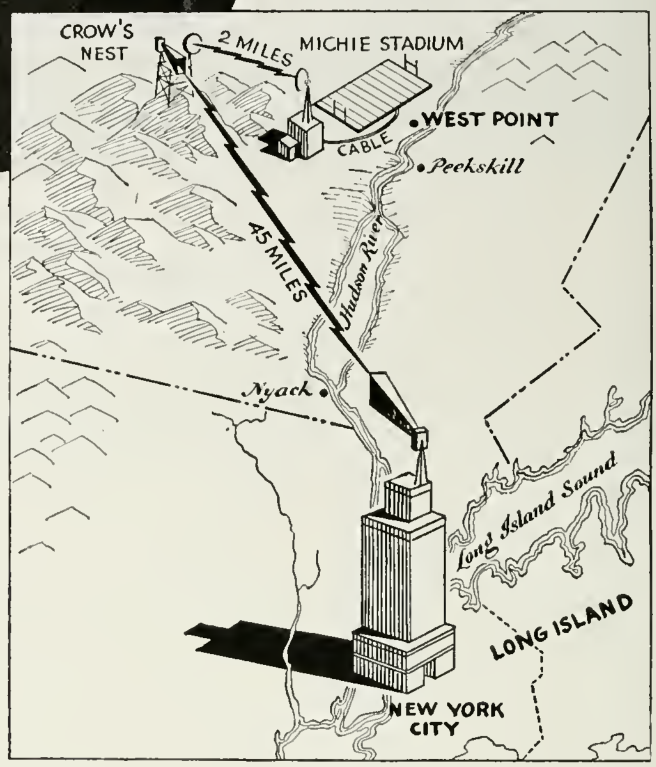
For communication with ships, radio is the only practical means. For telephone communication between fixed points on the earth's surface the situation is very different. For such cases the engineer may have the choice of using wire or radio facilities. The wire facilities may be one of many types: open wire or cable, voice frequency or carrier.* If the path crosses water, submarine cable facilities are required where wire circuits are to be used. Many factors affect the choice between radio and wire, including the quality of service attainable with presently developed techniques, the comparative costs and, in the case of radio, the availability of frequencies.

While the wire-circuit designer may feel, at least temporarily, the shortage of materials such as copper and lead, the radio engineer has seemed destined, in the design of some types of facilities, to a perpetual shortage of frequencies. For example, in the case of overseas service it is only by continually improving the techniques employed, with resultant economies in frequency use,

* See "The Messages Go Through in Many Ways," H. I. Romnes, Magazine, Autumn 1945.

that the additional circuits necessary for growth are being provided. That is because this service, which depends largely on waves bounced down from the upper atmosphere, necessarily operates in the frequency band between 4,000 and 20,000 kilocycles, which is very crowded with telegraph and telephone and international broadcasting services.

At the left is a micro-wave relay station installed temporarily to transmit television images of football games at West Point via Crow's Nest to New York. The diagram below illustrates the route



In the domestic field, the situation is quite different in that advantage can be taken of the greater numbers of channels in the higher frequency ranges which have been opened up by the development of new techniques. At the higher frequencies—as already mentioned—the characteristics of the waves approach those of light, and "line-of-sight" paths must be provided for their use. While this makes them unsuitable for overseas circuits for intercontinental routes, they may nevertheless be practically employed for domestic circuits, and numerous short radio circuits employing such frequencies are in regular use in the Bell System for bridging water barriers.

The earliest one of these circuits, which bridges Cape Cod Bay, operates at a frequency of about 60 megacycles. The circuits to Catalina Island already referred to, and similar circuits from Cape Cod to Nantucket Island, are the most recently established radio facilities for domestic point-to-point service, and operate on frequencies of nearly 5,000 megacycles. The system used in these recent installations employs a pulse type of transmission not unlike that used in radar systems, the intelligence being conveyed by a unique modulation system which varies the time position of the pulses. With this system, eight conversations are handled by transmitting, in effect, a sample of each, one after another in sequence, this process being repeated over and over.

Micro-wave Systems

The development of means of employing frequencies in the micro-wave

A micro-wave radio relay station of the New York-Boston experiment

range (frequencies above 1,000 megacycles, wave length below about one foot) has not only greatly increased the number of channels available but also made possible the use of the same channel simultaneously at stations separated by comparatively moderate distances. This becomes possible because of the limited range of transmission of such frequencies and the "searchlight" directive beams which it is possible to use when employing them. This greater directivity also enables the use of lower powers, with resultant economy.

Developments in this micro-wave range are widening the field of use of radio for domestic point-to-point communications. The Bell System has been actively engaged in developing the use of such frequencies since long before the recent war. In addition to the 8-channel micro-wave system for bridging water barriers to telephone service, another system operating in the 4,000-megacycle range is being experimentally tried out in the Bell System, with considerable success so far, for transmission of television programs from point to point. An example of the use of this system is the recent experimental transmission of television images of the football games at West Point to New York, where they were broadcast by the National Broadcasting Company. A single relay station, located on a mountain known as Crow's Nest,

An emergency radio telephone station. A pair of these compact stations can bridge a temporary gap in physical circuits to handle two-way conversations

Above: Installed on the roof of a truck cab is the equipment used in providing mobile radio telephone service

Below: A truck driver about to answer a telephone call which is reaching him through Bell System mobile radio telephone facilities

near West Point, enabled line-of-sight paths with good clearance to be employed over this 45-mile route.

Relay Systems

TELEPHONE ENGINEERS have long envisioned the employment of micro-wave radio relay systems for the transmission of bundles of telephone channels or television channels across the land in much the fashion that coaxial cables are now being employed. The attraction of such a system, with all facilities concentrated at the terminal and repeater points and no interconnecting cable or wires to install or maintain, is very great. Such a system, to be a candidate for general use, however, must meet very exacting transmission requirements, must be highly reliable, and must compare favorably in cost with wire facilities.

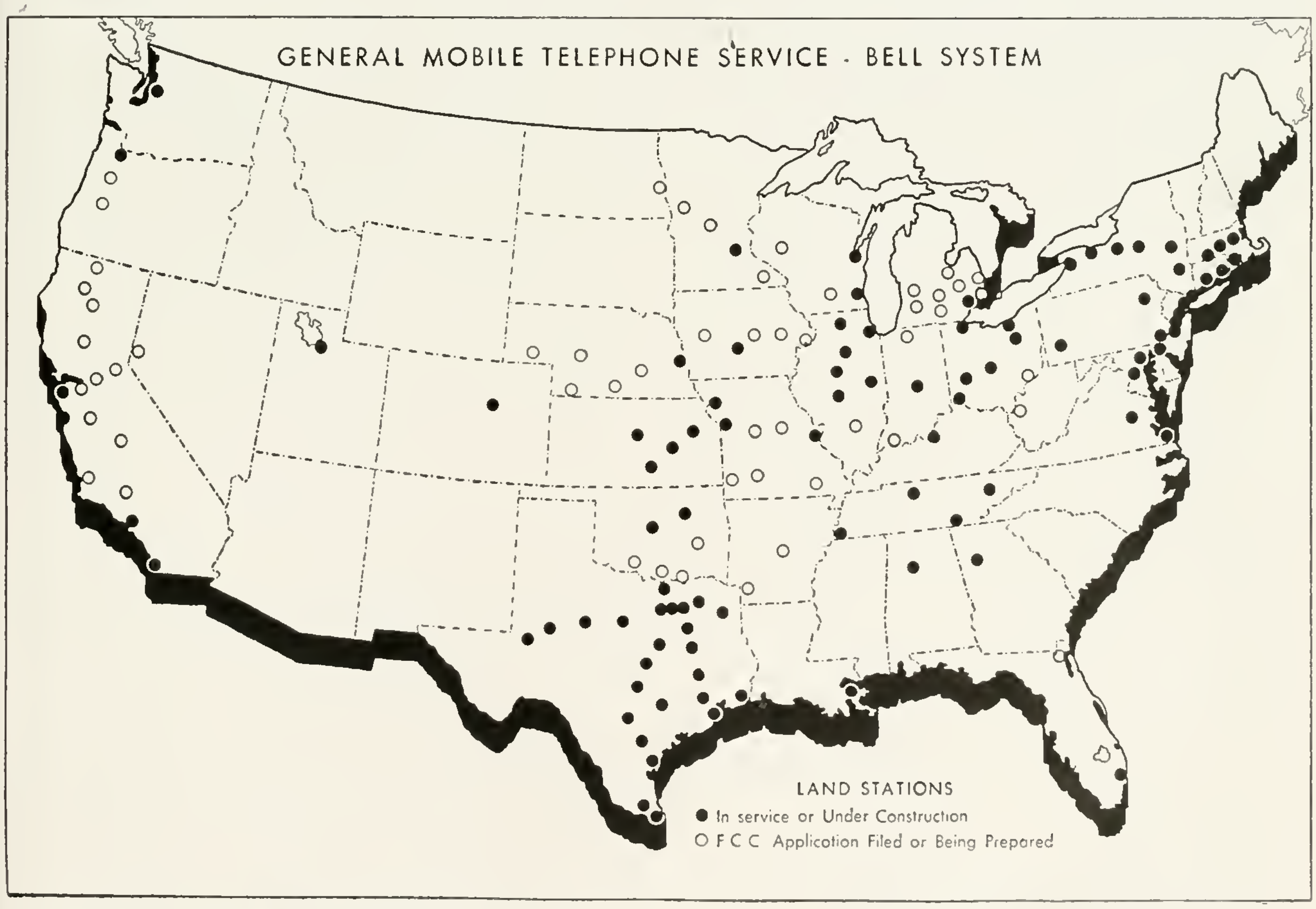
To assure full development of the potentialities of the radio relay type of system, a full-scale experimental installation operating in the 4,000-megacycle frequency range is being made between New York and Boston.

Seven relay stations will be located along the route. This system will be employed experimentally for television program and multiplex telephone transmission during 1947. Preliminary tests of model equipments by the Bell Telephone Laboratories, transmitting back and forth between New York and Murray Hill, N. J., have been successful and plans to install similar systems between New York and Chicago are now being made. Experience with these systems will aid in determining the future scope of radio relay systems in the long distance telephone plant of the Bell System.

Emergency Service

Radio, operating through space without intervening conductors, appears especially suited to emergency communication in times of storm or disaster. It has, in fact, found considerable application of this sort. A hundred 50-watt portable two-way radio-telephone equipments are in the hands of Bell System operating companies, and have been used effectively to restore communication when areas have been isolated by unusual storms. These equipments operate at comparatively low frequencies (about 2,000 kilocycles) as it is not usually possible in emergencies to operate from locations which would provide the line-of-sight paths necessary for the use of very high frequencies. The power for these emergency outfits is obtained from portable gas-engine-driven generators.

Some use has also been made by the Associated Companies of radio for emergency communication with



Spotted on this map are the locations where facilities for mobile radio telephone service are being established motor vehicles. The New York Telephone Company has operated such a system in New York City for six years which has been used by the Consolidated Edison Company. The New England Telephone and Telegraph Company has had a similar system in operation in Boston for some time which has been used by the traction company. These systems operate in the 30–40-megacycle frequency range.

General Mobile Telephone Service

UNTIL RECENTLY, the rules of the Federal Communications Commission did not make any provision for general public telephone communication with motor vehicles. Except for police and fire-department communications, such service was limited to utilities, welfare organizations, and similar organizations, and the nature of the message was limited to that essential to the preservation of life and property.

Recently, as an outcome of its extensive hearings on frequency allocation, the Commission has allocated a few frequencies to general mobile telephone service on an experimental basis. Provision is made for two types of service, *urban* and *highway*. The urban service, which operates in the 152–162-megacycle range, is employed for service in the larger cities. The highway service, which operates in the 30–44-megacycle range, is primarily for serving vehicles on intercity routes; but it is also to be used to serve local vehicles in the smaller communities along these routes where separate urban facilities are not warranted.

The Bell System companies have been quick to make use of the newly available frequency allocations to provide telephone service to motor vehicles on an experimental basis. Facilities for urban mobile communication have already been scheduled for installation in 46 cities, in 26 of which the facilities for the first channel have already been completed. The first city to have such service was St. Louis, where the initial channel was placed in service in June 1946. Additional channels are now scheduled for installation in several cities and plans for urban facilities are under consideration in numerous others.

Urban mobile service is finding ready acceptance by the public and is already being employed by many different types of users. These include power companies, trucking companies, gas companies, burglar alarm companies, taxicab operators, motor service organizations, physicians, manufacturers, contractors, ambulance operators, armored car operators, police organizations, newspapers, railroads, and broadcasting companies. Several hundred vehicles are already using the service regularly, and the number grows daily. The service is offered to water-borne craft as well as motor vehicles, and several have already been equipped.

The facilities for urban mobile service in a city include a 250-watt radio transmitting station with its antenna located on a high building or other elevation, providing transmission throughout the area to be served—which usually reaches out 15 to 25 miles from the station—and several radio receivers located at favorable points in the area. The radio receivers and the radio transmitter are connected to the telephone switchboard by wire telephone circuits and a special terminal equipment enabling the mobile service operator to handle the circuit in very much the same fashion as other telephone circuits are handled.

Facilities for highway service are also being established rapidly in many parts of the country. One route, between Chicago and St. Louis, is now in operation. Among other routes being equipped for this service are Boston-New York-Washington, Cincinnati-Cleveland, New York-Albany-Buffalo, San Diego-Los Angeles, and several extensive routes in the southwest.

On these routes the spacings of the radio transmitting stations will vary from about 25 miles to more than 100 miles, depending on the terrain. Many of the transmitters will be of 250-watt power output, others of only 50 watts. Associated with each transmitting station will be several receivers, as in the case of urban facilities. Highway mobile radio-telephone circuits will terminate on the long distance switchboard in cities or towns along the route and in the vicinity of the transmitting stations.

The map on page 235 shows the locations throughout the country where mobile telephone service is being made available.

Rural Service

Experiments are in progress to explore the practicability of radio for providing isolated subscribers with telephone service.* Employing modifications of the equipment which is used for mobile service, eight ranches in the vicinity of Cheyenne Wells, Colorado, are now being experimentally served by radio. Four of these ranches, ranging in distance from 11 to 21 miles from Cheyenne Wells, are reached directly by radio links; the other four are reached from one of these ranches by short wire line extensions. The operator at Cheyenne Wells makes connections with the radio subscribers in much the same manner as with other subscribers. Both local and long distance service is provided to them. This experimental installation of radio facilities for rural telephone service is giving experience which will be of value in designing radio equipment especially suited to this type of use.

Radio has already done much to increase the scope of the telephone service of the Bell System. What further uses it may be put to cannot be predicted. However, continuing research and development assure that the full potentialities of the radio method of transmission will be available to the Associated Companies. Their active participation in the use of radio in turn assures the full development of these potentialities.

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* See the article beginning on page 193.

Out of the Ashes of a Disastrous Conflagration Arose in Eleven Days a New Central Office Which Restored Service To 10,000 Silent Telephones

Crisis in River Grove

Hugh Moffett

Chicago Correspondent, Life *Magazine*

NOT LONG after a half-million-dollar fire destroyed the River Grove, Ill., telephone building, word reached the Chicago office of *Life* Magazine that an heroic task of quick restoration of service was being undertaken. A fire, even of that size, seldom is material for a national magazine. But before this fire had cooled, we learned, an army of Illinois Bell Telephone Company people, with help from other branches of the Bell System, had pitched in to give temporary emergency service to a population of some 50,000 "isolated" by the deadening of nearly 10,000 telephones. People in the River Grove area, moreover, and some of their neighbors in Chicago's west side who had been served from that building, had been promised complete service again in two weeks.

So *Life* photographer Wallace Kirkland and I went out to get a picture story.

I remember his first observation after we made a quick survey of the enterprise. We had seen a cool, determined group of traffic workers, crowded in a small business office; a crew of messengers hurrying about town delivering emergency phone calls; gangs of workers ditching, splicing cables, erecting semi-permanent Quonset huts back of the burned-out building; and doing a dozen other jobs simultaneously.

"Isn't it a pleasure," Kirkland commented, "suddenly to come across a force of people with their minds on only one thing—trying to get a job done in a hurry?"

We agreed it was a stimulating sight, and set about picking up a record of what had happened and what was happening.

First we took a look at the ruins—a two-story brick building with the roof fallen in on the valuable, hard-to-get telephone equipment. Charred chairs showed where the operators had sat—35 of them during daily

Firemen inspect the wreckage of the River Grove operating room

peaks—handling 45,000 calls a day. A few burned plugs and wires dangled from the blackened boards.

It was there, on the morning of December 14, about 3 A.M., that operator LaVonne Daczewitz had smelled smoke. Mel Holstrom, central office maintenance man, found the basement full of smoke. The fire department arrived quickly, later was joined by Elmwood Park, Franklin Park, Maywood, and Chicago departments. But it was no use—the five operators on duty had to be ordered from the building. The clock hands showed it had been stopped at 3:20.

It had been less than an hour after LaVonne smelled smoke, we learned, that calls organizing reconstruction went out from nearby suburbs.

The night before, Friday, had been a "night out" for many employees of the Illinois Bell in Chicago. They had stayed late at a Pioneer dinner or a plant union meeting, thinking to sleep late on Saturday. But they shook off pleasant sleep and rose up to meet the emergency. By 5:30 A.M. additional lights came on in Loop offices as engineers went into action. Telephone company cars and trucks began to roll in the darkness toward River Grove.

The challenge of the crisis spread quickly to the Western Electric Company's nearby Hawthorne Works, its Kearny (N. J.) Works, and its Chicago distributing house; and to the far-away offices of the American Telephone and Telegraph Company and of Bell Telephone Laboratories. They too had to supply help and material for River Grove. Later we observed the results of these widespread efforts; but from the ruins we followed the story to what had been the site of the first reawakening of phones in the suburb a few hours after the fire—a small telephone company business office two blocks away on Grand Ave.

In this office, designed for perhaps half a dozen persons, we found at least 75. They were plying plugs, pencils, screwdrivers, and numerous other tools and pieces of equipment, some of which I still cannot identify. In newspaper days I had seen many a crisis in the news room. The activity in that little business office approximated what would be my conception of the news coverage of election night, a kidnaping, a murder, and a flood, all rolled into one occasion. Girls worked at switchboard positions while installers were still connecting wires. Executives maintained direction while overcoated messengers scurried in and out. To one who can never understand why a telephone works anyway, it looked like multiple confusion. But we could see that it was getting results.

Establishing Emergency Service

COMPANY OFFICIALS found time to explain that a 50-pair cable led into this office. While the fire embers cooled, a two-position PBX had been located in a nearby warehouse and moved in. By about 9:30 A.M. the River Grove police and fire phones had been connected by magneto service. Before noon the first trunk lines were working off the PBX.

While these were being hooked up, Illinois Bell station wagons stood outside and mobile radio telephone units were working in them. For several hours they provided the only communications links between the on-the-ground and headquarters groups in downtown Chicago, and therefore were invaluable. Even after the first PBX lines were in, the units continued to handle part of the traffic in and out of River Grove until late in the afternoon of the first day.

Eight positions of PBX switchboard turn the telephone business office, a block from the destroyed central office, into a temporary operating room

Later, more cable and six more PBX units were added in the business office until finally a total of 286 lines were available for emergency service. Of these, more than 30 lines were for emergency outdoor public telephones. The booths were strategically located on street corners, near filling stations and other public places throughout the affected area for customers' convenience and protection.

This could take care of much of the essential business of the community, but home telephones remained silent. For them the company set up the messenger service manned by traffic and commercial people. The crises of day-to-day living continued to occur—deaths, births, accidents, empty fuel bins. A snowstorm with near-zero temperature contributed its bit to the emergency, and, incidentally, added greatly to the burden of the outside workers on day and night shifts.

As soon as the first wires were open, all incoming calls of an emergency nature were noted and ticketed. The messengers then drove to the addresses given to pass along the information. If a return call were needed, the messenger transported the customer to the business office or to one of the outdoor "fresh air" telephone booths.

Messenger Steve LaVan knocked on the door of Mrs. Arthur Rochelle to tell her of a request that her daughter call about the death of a friend. Messenger Robert French took word to Mrs. Hoyer that the baby of her sister, Mrs. Murphy, who lives out in the country without a car, was ill and must be taken to a hospital. LaVan drove to the Westlawn cemetery to inform Manager Carl Harris that a grave must be dug.

The stork, which was flying long before there were telephone poles for it to rest on, refused to recognize the disruption in River Grove. Messengers moved with the greatest of dispatch when an incoming call said "Baby expected in short time," summoning doctor or ambulance or providing a ride. There was speculation among the messengers as to whether any might yet serve as midwife. None did.

Edward Skicewiez, Milwaukee Railroad switchman, sighed wearily as he answered a messenger's knock. He had worked long hours and now, with a dead phone, was hoping to hole up for a good rest. But the call boy and the emergency service tracked him down.

During the first few days after the fire, the suburban residents drove or walked to stores. The routine errands which normally slip quietly along the phone wires came alive out in the streets. This drama of visible communication reminded us of the old rural party lines, where neighbors could keep well abreast of community comings and goings. In River Grove, when Mrs. Bernadine Sendler bundled up her five-year-old and walked four blocks into the wind and over the ice, it could be easily learned that she had run out of bottled gas for cooking.

We suspected there might be some old timers about who were chuckling at youth's new-found appreciation for the telephone, which, like the kitchen sink and refrigerator, has come to be taken for granted like the sun and the

These equipment engineers at Western Electric's Kearny Works discuss their blueprints of equipment used in the burned-out central office, in order to develop quickly specifications for equipment to replace it. Four of these men later went to River Grove to put their special knowledge to work on the spot

rain. It was evident that the subscribers, with rare exceptions, were taking the temporary loss of service with great good humor and understanding. Among the exceptions was the matron who insisted that a telephone messenger direct a veterinarian to give her a telephone bulletin on the health of her ailing Pekinese, at that time housed in a pet hospital. It is not recorded just how the dog felt that day.

Organizing the Attack

After our visits to the business office, where Kirkland contributed to the turmoil with light cords and flash bulbs, and some trips with the messengers, we spent part of a day at the site back of the burned building where the semi-permanent Quonset hut quarters were going up. The use of the land had been arranged before the firemen had left the scene.

In the office of an adjoining lumber yard the proprietor, S. H. Elizer, had a story to tell about the land. Feeding his little office stove with shavings and board ends against the stinging cold, he told customers how he had driven in from Memphis on the night following the fire. He was startled to see floodlights playing on his vacant lot, showing busy workmen in the early stages of erecting huts. When he learned that the telephone company had had a fire, and had been granted use of the land by his yard foreman, Walter Bell, Elizer shrugged: "That's fair enough."

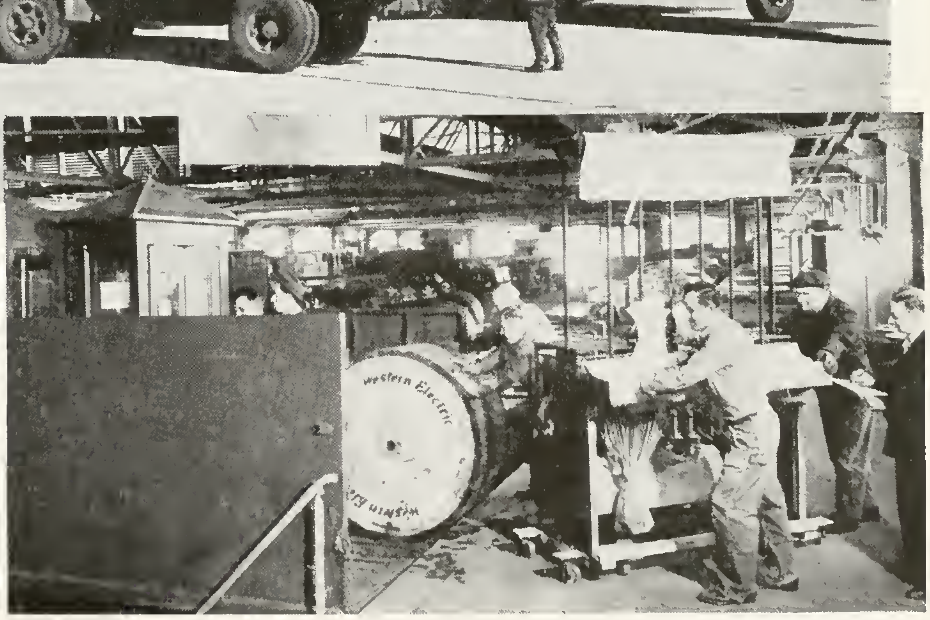
In and about the Quonset huts the System-wide enterprise and dispatch were becoming apparent, along with the tireless efforts of contractors and sub-contractors. The contractors eventually numbered 25. Telephone company workers numbered about 500.

While workmen built one end of a hut, telephone equipment was unloaded in the other, finished end of it. Company officials informed us that originally a rough sketch had been drawn up, calling for a 20′ x 60′ terminal room and a 20′ x 160′ operating room. An Aurora, Ill., contractor could provide the huts. The general contractor made his plans from the rough sketch. From longhand specifications, engineers phoned orders for equipment, completely circumventing the usual typewritten order and blueprint routine.

The Western Electric Company provided cable from its Hawthorne Works at nearby Cicero. From its Kearny, N. J., plant came more cable, plus forty switchboard positions, plus cable racks and switchboard equipment which was identified for us as "multiple." Railway express cars, trucks, and five cargo planes hauled from the east the equipment which we saw converging there in the huts. And Western Electric's Chicago distributing house kept a steady stream of supplies flowing to the scene.

Planning the Reconstruction

The over-all plan of reconstruction, we learned, included shifting of 2,600 phones on Lackawanna lines, which had been in the River Grove building, to the Merrimac office in Chicago. These phones served Chicago customers. But this shift required a mile of ditching, executed by a mechanical ditch digger through day, night, cold, and snow. When the ditching crew twice hit underground obstructions, the cable was



Above: A cargo plane is loaded with equipment for River Grove from Western Electric's Kearny Works. Right: More equipment is rushed aboard a truck at Western's Chicago distributing house

Equipment is going into these Quonset huts, behind the destroyed building, while the contractor's men complete the work of erecting them

laid along the surface and spliced in. Replacement of cable in conduit came later. It was a costly process, but the quickest way. In all, more than 15 miles of cable were necessary for the transfer of Lackawanna telephones to the Merrimac office.

We found a tremendous splicing operation going on in a manhole under a tent outside the old building. To permit more hands to splice in the small quarters, an excavation alongside the manhole had been made and shored up. Down we went to get a picture of Marty Quinn. He was working on one of half a dozen cables. It contained, he said, about 1400 pairs and 27 quads. Marty had to explain what quads were, and pretty soon he was talking about "phantoms." The discussion ended shortly after I told him I wanted Kirkland to get a picture of a "phantom."

In the telephone business, as in most, there appear to be some descriptive terms for workmen. I was disappointed when Marty said he should be identified only as a cable splicer. It would seem that one who can tie 1,400 pairs and 27 quads, and come out even, without a phantom left over, deserves a more romantic term.

As the work progressed, we were told of construction feats and improvisations. The No. 12 switchboards, it seems, are not tailor-made for offices as large as River Grove. But this type *was* available, and certainly there was no time to manufacture another kind. So numerous modifications were called for. To avoid congestion in the crowded huts, much forming and soldering was done in a nearby garage and an out-of-service dance hall and in Western's Chicago distributing house. When soldering on the main distributing frame became a bottleneck, the soldering was postponed and the wires were twisted into place. Frame and switchboard multiple arrangements were modified to make room for extra installers and plant men.

As the days passed, the daily total of stations in service moved to three-and then four-digit figures. Company officials who had predicted complete service in two weeks developed a fond hope as Christmas approached. The 12-hour and longer stretches by some employees began to pile up accomplishment. Many voluntarily canceled Christmas Eve plans at home.

On Christmas morning the night shift went out for a hurried breakfast, then rejoined the day shift. And so it was that at 11:30 A.M. on Christmas day the Illinois Bell Telephone Company could present to River Grove central-office subscribers an announcement of complete restoration of service—not two weeks but *eleven days* after the fire.

As the *Life* story was put together in New York a few days later, we could report the restoration. Those responsible for the reconstruction had found time to catch their breath and total up some of their efforts. There had been a half-million-dollar loss in the fire. Some $890,000 had been spent on the restoration of service, not counting the comparatively minor loss of business during the 11 days. Seven million feet of wire had been installed. There were a million hand-soldered connections—roughly, that is, in case anyone wants to count them and argue.

One of the "fresh air" telephone booths

By the first of the year, Illinois Bell people could assure River Grove that a new, modern telephone building was on its way. Finished, it will be an attractive, reinforced concrete structure with brick and stone walls. By Christmas of this year, customers will be dialing through the new office. They have learned to expect no less, after having seen the Bell System team "going to town" in those eleven days before Christmas, 1946.

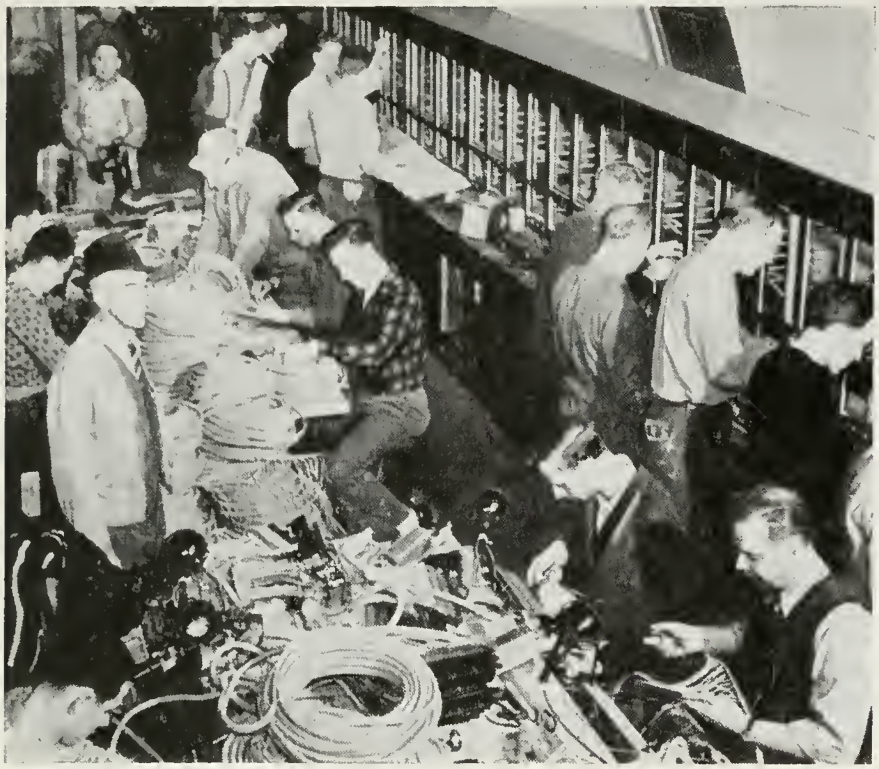
Editors' Comment

MR. MOFFETT tells the story from the point of view of the outside observer. That is what we asked him to do: to write it as he saw it.

But there is another story too, which in this MAGAZINE may appropriately supplement his.

It is the story of the organization *within* the System—the integration of different units—which made it possible to undertake to perform in two weeks a task which would normally require nearly a year—and then whittle down the two weeks to 11 days.

Involved were, primarily, the Illinois Bell Telephone Company and the Western Electric Company; and, to a somewhat lesser degree, the A.



Inside one Quonset hut, installers are working on the first of three rows of switchboard positions which are being installed as fast as carpenters can lay the flooring

Once more, as in many another crisis, Western Electric—the supply unit of the Bell System—demonstrated magnificently its ability to provide with breath-taking speed the equipment needed to restore service.

It may have been a fine stroke of luck that 40 sections of manual switchboard—previously earmarked for another Bell company's expansion program—were on the floor of the Merchandising division at Western's Kearny plant. But luck had nothing at all to do with Kearny's long-established file of detailed blueprints of every manual central office in the Bell System, from which those for the destroyed River Grove exchange were readily extracted. This made it possible to determine at once how best to install those 40 sections—at least for the present—and what other and how much equipment had to be replaced.

Not luck but organization and experience made it possible for some 250 of Western's central office installers to move from assignments in other places to connect those 40 new switchboard sections into the wire network—as well as an 11-position manual switchboard in Chicago's Merrimac exchange. So was it with Kearny's rush shipments of distribut-

T. & T. Company and the Bell Telephone Laboratories. That is a good Bell System team—and a shorter word for *integration* is *teamwork.*

On that bleak Saturday morning in River Grove there were many questions waiting for answers—the *right* answers. The tougher the problem, the more important was it that the answer be the sound one.

The experience and judgment within A. T. & T.'s O. & E. Department, and the technical knowledge of the specialists at Bell Laboratories, helped Illinois Bell executives and engineers to determine the *how* and the *why* of some of the policy decisions. The *what* and the *when* answers of Western Electric, with its Chicago distributing house, two of its three Works, its Installation division, and its headquarters organization all concentrating on the emergency, tied in with the *where* which the telephone company answered on the spot. And all meshed together like matched gears.

ing frames, power equipment, and 20,000,000 conductor feet of special cable produced in 36 non-stop hours. And so it was also with the hundreds of types of miscellaneous and indispensable items of equipment supplied instantly as needed by the Hawthorne Works and the Chicago distributing house.

As these supplies flowed into River Grove, the Illinois Bell Company—which of course bore the primary responsibility—was bringing in 500 of its own men and women from assignments nearby, contracting for temporary site and shelters and for unskilled jobs, and swiftly bringing orderly progress out of that chaos which is the first consequence of disaster to a city's telephones.

Those are, in brief, some of the activities which took place behind the scenes. They, and all else which occurred during the restoration there, demonstrate strikingly the advantages of the Bell System's form of organization. For while its manufacturing, supply, and operating units are accustomed to working together to make possible the Nation's telephone service, the benefits of that complete integration show most spectacularly during emergencies such as that which beset River Grove during those cold and strenuous days toward the end of 1946.

Somewhere in the Bell System there was dirty work at the crossroads—or so said a number of citizens in letters to the Federal Communications Commission during the war. They had heard transmissions of a definitely subversive nature emanating from our overseas stations on the New Jersey coast. Not only that, but the subject of these sinister messages seemed to be that supreme top secret—the Atom.

Alert interceptors had been able, for example, to pick up the following sentences:

"Magnetism is the quality which we attribute to the atom. We affirm that iron, nickel, gadolinium, gaseous oxygen, and, in fact, all substances are magnetic because they have magnetism in their atoms."

The source of this red-hot dispatch proved to be the overseas control room of the Long Lines building in New York. However, the gentlemen in this 24th floor hide-out were not engaged in nuclear fission. Their hands were unsullied by uranium.

The quotation above was merely a standard-speech recording, known for years to overseas technicians as the Juicy Atom Speech. It was used for trying out the overseas channels, and was no more than what the first line of the record described it: "This is a test transmission of the American Telephone and Telegraph Company."

From *Long Lines,* the magazine of
A. T. & T. Long Lines Department

West-to-East Transmission Tests Demonstrated in 1923 The Practicability of Overseas Radio Telephony as a Commercial Undertaking

"Hello, England": A One-Way Transatlantic Talk

William P. Banning

Editors' note: The following pages, constituting Chapter VIII of Mr. Banning's recently published book, "Commercial Broadcasting Pioneer: The WEAF Experiment, 1922–1926," are reprinted here as having special interest in connection with the 20th anniversary of commercial overseas radio telephony, which occurred on January 7, 1947. See also page 267.

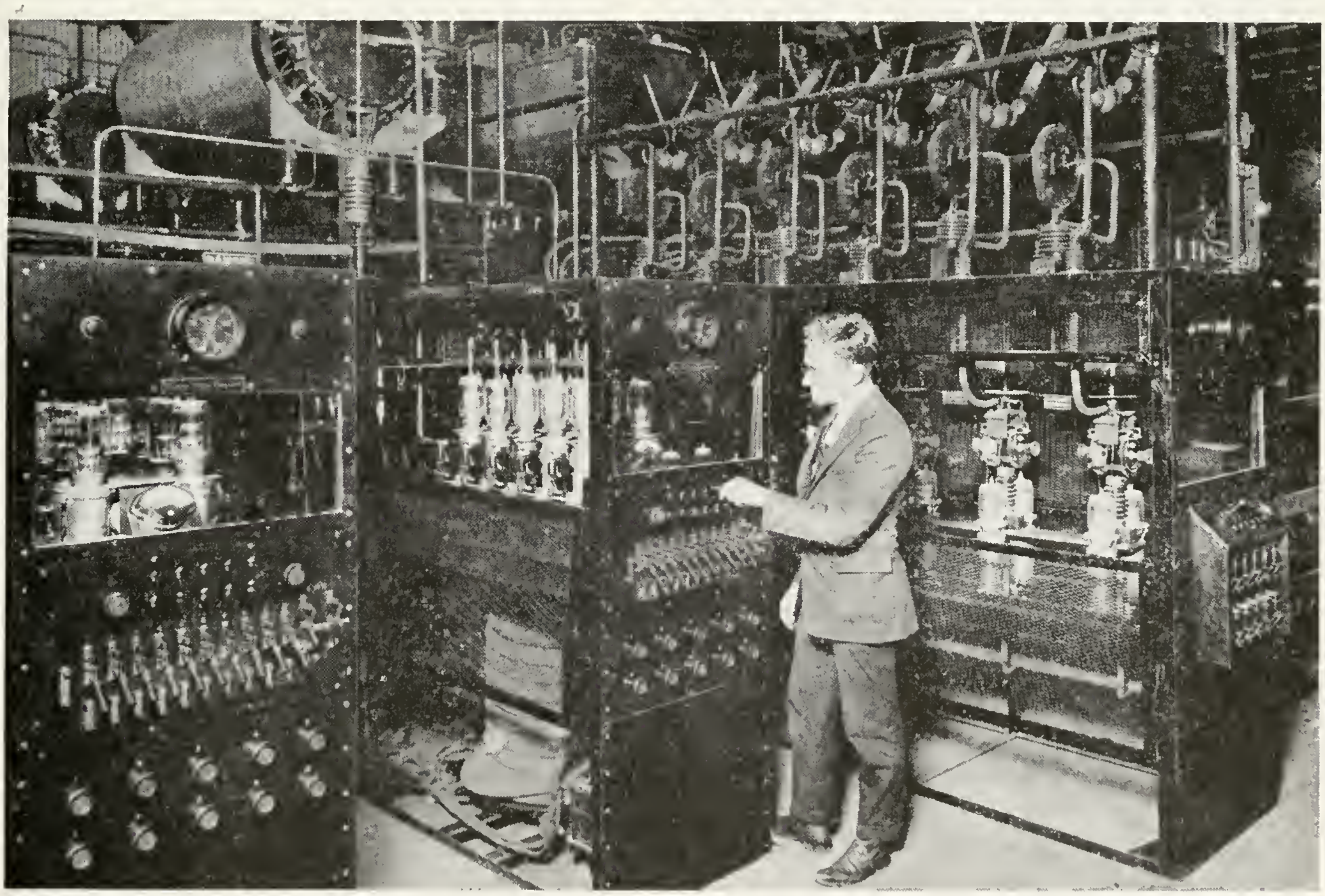
Since Bell System chronology records another "radio debut" in the headquarters building a few weeks before the dedication of the new WEAF studios, this résumé of broadcasting activities will be interrupted in order to include a brief and personal reference to it. The event was historic because it demonstrated the success of telephone engineers in developing a radio technique for extending telephone service overseas.

When these engineers first transmitted speech across the Atlantic in 1915, several hundred 15-watt tubes were necessary in the experiment in order to obtain sufficient power for transmission. Important research was begun after the war to develop tubes of substantial transmitting power, and a copper-anode water-cooled tube evolved which pointed the way to a solution of the problem of overseas telephony. This development work continued, and in 1922 a powerful water-cooled amplifier was installed in space leased at the R.C.A. transatlantic radio telegraph transmitting station at Rocky Point, Long Island, where an antenna was available. Telephone engineers went to England where, through the coöperation of British Post Office engineers, they were able to study and measure every variation in the transmission tests originating on Long Island. Since there was no suitable transmitting equipment on the other side of the Atlantic, these tests could be of only west-to-east transmission.[1]

January 14, 1923, was the day selected for a demonstration of the technique which had resulted from the long and detailed experimentation, and nine o'clock in the evening was the time set, since transmission was best in the hours of darkness. The only arrangements were that President Thayer and Vice-president Gifford, and Vice-president Carty, who had technical supervision of the demonstration, would speak, and that a distinguished gathering of scientists and others would be waiting, at two o'clock in the morning, at New Southgate, near London, to hear the voices from America.

The technical importance of the demonstration has, of course, been reported in many places. Other details, of the human-interest variety, are set down in the personal notes of the present writer, who was delegated to inform the press of the event and who was on hand during the day to observe the preparation. These notes refer, for example, to the D&R engineers who equalized and provided amplifiers for the wire lines connecting the headquarters building with the Rocky Point apparatus. They picture the afternoon scene in President Thayer's office where engineers sat before a special transmitter, reading aloud newspaper items or long

[1] The group of engineers in charge of the Rocky Point installation was headed by Mr. A. A. Oswald. Those who carried on the transmission tests in England were Dr. H. W. Nichols and Mr. H. T. Friis. Later in the year Dr. Nichols was awarded the Fahie Premium by the Institution of Electrical Engineers in London for a lecture before the Institution on Transatlantic Wireless Telephony.



Transmitting equipment for transatlantic radio telephony, installed at Rocky Point in 1923 by telephone engineers. The picture shows the water-cooled tubes referred to in the second paragraph of the narrative

President Harry B. Thayer of the American Telephone and Telegraph Company speaking in a one-way radio telephone test to England, January 14, 1923

lists of words, while cablegrams arrived at intervals from London reporting "60% intelligible," then "70% intelligible"— then "80% intelligible"—the percentage climbing higher as daylight faded.

In the notebook also is the record of a conversation in the office of Vice-president Carty, who had remarked about six o'clock, after giving some final instructions, "Now I'll get a little nap." "What!" said this astonished publicity manager, "Aren't you nervous? Can you really sleep?" "There's nothing to worry about," was the answer. "The tests are what I expected. There was sleet on the wires just before we opened the first transcontinental line, but I slept, on that very sofa, for 30 minutes. You see, I knew that line was being watched—by telephone men."

And besides such random jottings, the notebook also records historic messages, together with an incident which, though inconsequential, still stands out in the writer's memory. Before nine o'clock arrived there were many reassuring messages "100% intelligible," and promptly on the hour Mr. Thayer laid aside his cigar and began to read the words addressed to an audience 3,000 miles away on another continent.

Eleven minutes later came the cabled message:

"Thayer got through to all." Signed, GILL [2]

As the tests proceeded, other cablegrams arrived in thrilling sequence:

To General Carty at 9:14 P.M. Purves [3] recognized Carty. Signed, GILL

To General Carty at 9:21 P.M. Audience wants some local color. Going fine. Press wants pause between speakers and clear announcements of names. GILL

To General Carty at 9:26 P.M. A few listeners have trouble with the American language. General impression fine as far as we can judge during intermission. Signed, GILL

To General Carty at 9:35 P.M. I have listened with great interest and pleasure to the far-flung voices of Mr. Thayer and Mr. Carty. Of Mr. Thayer's message, I recog-

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[2] Mr. Frank Gill, Chief European Engineer of the International Western Electric Company and also President of the British Institution of Electrical Engineers, who was in charge of technical arrangements in England.

[3] Engineer-in-Chief of the General Post Office of Great Britain.

nized every word. I missed a little of Mr. Carty's but recognized absolutely his well-known intonations. Send best respects and warmest good wishes to our friends in the A. T. & T. and W. E. Co. Signed, PURVES

To General Carty at 9:36 P.M. For Mr. Thayer. I heard every word you said and recognized your voice perfectly. Signed, WILKINS[4]

To General Carty at 10:01 P.M. Representatives of British press congratulate A. T. & T. Co. and Radio Corp.[5] on their epoch-making experiment, the success of which has exceeded their expectations, and in which they see the dawning of a new era in long distance speaking which will be of the greatest value to the press of the world. PRESS REPRESENTATIVES

To President Thayer at 10:10 P.M. I have just listened to your radio telephonic message which I have heard very distinctly. I congratulate you and all those connected with the research which has led to this achievement. G. MARCONI

To General Carty at 10:45 P.M. To your engineers the most sincere fraternal greetings from their British confreres. Signed, GILL

To General Carty at 10:58 P.M. On conclusion of these most successful and historic tests which have made a profound impression, all those assembled at the London end wish to congratulate most heartily the A. T. and T. Co. Signed, GILL

To President Thayer at 10:58 P.M. Heartiest congratulations on what has been achieved and on the complete success of its demonstration. Your voice was just like a personal talk. Would not have missed it for world. Signed, KINGSBURY[6]

To General Carty at 10:58 P.M. Loud speaker now being used. Good results. Great enthusiasm. Signed, GILL

To General Carty at 11:00 P.M. Your interview on loud speaker came through fine. Signed, GILL

To General Carty at 11:01 P.M. There is only one word—magnificent. GILL

With communications history thus being made every moment, the press representatives were invited to come downtown for the news. Yet when they arrived, there was little to give them but a technical explanation of the test and copies of the congratulatory messages as they arrived.

This chronicler sensed that the newspaper men did not fully realize the import of the occasion and reported with disappointment to Vice-president Gifford that they seemed unimpressed. "I know what's the matter," said Mr. Gifford, "they want evidence! General Carty has that door closed to keep out noise, but I'm going to open it so these men can see what's going on!" And, beckoning to the skeptical reporters, he opened the door to the President's office, disclosing a smiling man with a sheaf of telegrams in his hand, speaking into a strange-looking transmitter. "That's Mr. Thayer, gentlemen," said Mr. Gifford, quietly, "and he's talking to England!"

And so, among the memories of an eventful evening, is that unplanned, informal scene—a prideful president saying for his colleagues, "Thanks for your message," and a group of newspaper men clustered at his door, listening intently, and almost unbelievingly, to words that were flashing across the sea, heralds of a service to reach all parts of the globe.

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[4] Mr. F. H. Wilkins, Vice-president and European General Manager, International Western Electric Company.

[5] The American Company had announced the experiment as "coöperative" because of contractual relations with RCA and because of the use of certain large RCA antennas on Long Island.

[6] J. E. Kingsbury, author of *The Telephone and Telephone Exchanges* (London, 1915) and a director of Western Electric, Ltd. of London.

Opportunity

Leroy A. Wilson

Editors' note: The following excerpts are from an address by Vice President Wilson of the A. T. & T. Company at a special convocation of honorary societies at Denison University.

Opportunity must be taken hold of, cultivated and made to bear fruit. The responsibility is yours to accept this challenge and to meet it effectively.

By effectively, I mean for the benefit of society. There have been over the ages, many examples of men banding together for the common good. Too often, however, there have also been leaders who have used their ability and their following for selfish ends with insufficient regard for the rights and welfare of others. We all know well that that is not the kind of leadership which the Christian concept asks us to assume. Neither is it the kind which will enable us to maintain our national heritage of freedom.

In the years ahead, the roads we shall follow will be the roads that we build, and they will lead where we want them to take us. Where do we want to go? In the direction of a free, vigorous and healthy national life—with plenty of room for enterprise and for individual development of character and judgment limited only by a proper regard for the rights of others and a solid respect for the virtues of competitors? Or do we want to move toward a narrower life in which freedom of action is sacrificed, in which individual character and judgment is subordinated for uncertain assurance of physical security for clothing, food and shelter, but little else; in which man becomes the servant of a system rather than the master of his own affairs?

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None of us, of course, is unaware that there are discords within this land of ours today. Much of it is expressed in intemperate, even belligerent language. And we have our prophets of doom. In my judgment, however, we have too solid a basis for faith in our heritage and in our way of life to allow ourselves to be dismayed by any problem that confronts us.

Just consider our economic position alone, in contrast with that of most of the rest of the world. In our system of free private enterprise, we find the greatest hope for the greatest well being of the greatest number of people. American industry and labor have performed as no others have yet been able to do. The American worker commands the highest pay and has the highest standard of living in the world. He is free to live, to move around, to worship, to express himself, and to earn a living in a vocation of his own choice. Equally important is his opportunity to rise from the ranks to the top of his vocation. Most of our leaders in industry, in science, in the professions and in public life—in fact, in all phases of the constructive work that has made this nation great—have come up through the ranks. Their lives bear testimony to the opportunity which is presented to every American boy and girl. There is no ceiling on your opportunity; there is only the limitation which your own ability places upon it.

All these things mean that we have something that exists in the United States of America to a degree that has never been reached before anywhere. We have attained it under our American system of democratic government and free enterprise which in turn has sprung from the initiative, the spirit of fair play and the common sense of all the people. That being so, it behooves us all to preserve the vitality of that system—to contribute toward it for the greater good of all—and to face the future with confidence.

This country, its people and enterprises, this University, have come to their splendid position out of the rugged endeavors of pioneers—early pioneers and modern ones still pioneering. Free men and women in a free land seized their opportunities and brought miracles to pass, spurred on by the belief that all men are created equal and entitled to life, liberty and the pursuit of happiness. They were determined to achieve those things—for themselves, their families and their fellow countrymen—and they have done so. That determination should never be surrendered.

Success is often attributed to such qualities as knowledge, judgment, energy, patience, imagination, and so on. These are all excellent qualities, but I doubt that by themselves they give the real answer. For years this question of what constitutes success has intrigued me personally, and I have tried to arrive at my own definition. To me, success depends on two simple things—first, the ability of the individual to analyze a situation and decide what should be done, and second, his or her capacity and courage to get it done. To say it even more simply, if you can learn to know what you are fitted to do, and then do it well, then surely your life will be a success.

Under this way of thinking, your success will not be measured by any particular achievement, or by your place in the social scale, or by the rank attached to your job. Rather, it will be measured by your own inner feeling when you ask yourself, "Have I made full and able use of head, heart and hand in the thinking, the understanding of others and the action that could reasonably have been expected of me?"

Opportunity, in capital letters, beckons you in a greater degree than ever before to exercise the kind of leadership that will help this nation along its fortunate and happy way.

Memo To a Girl at a Switchboard

Harold W. Stephens

WHERE WERE YOU *when Christmas came, Miss Susie-at-the-Switchboard?*

Where were you when the bells rang in the New Year?

Where, through the holidays in between?

I asked your friends who saw you.

One saw you on the streets, part of the merry Christmas and New Year throngs.

One, paying a round of holiday calls, your arms laden with gifts.

Another saw you at church.

Still another saw you out with a fellow with broad shoulders, who reached for your hand as the two of you walked along.

What they saw was as it should be, Susie.

That's what's done at Christmas and New Year's today, and you're of today, every vivid inch of you.

You're alert and modern, in step with this new year of 1947.

But, tell me, did your friends see everything?

A doctor told me they didn't.

He made a call on Christmas Day.

It was an important call, for a life hung in the balance.

A stranger said they didn't.

He was hundreds of miles from home, and lonely with the holiday happiness about him, but through the telephone he paid a visit home.

And even as the bells tolled in the New Year, someone who needed help reached for the telephone.

Someone handled those calls, Susie, and thousands more like them.

Shall I ask you who?

YOU'RE STRICTLY 1947, *Miss Susie.*

A bright path and ready laughter are your heritage and your right.

But you are also wise beyond your years, for you know that these things are not all.

DID YOU KNOW, *Miss Susie-at-the-Switchboard, that a picture of you was painted, back years ago before you were born?*

That's true—and more than any other picture ever painted, it has captured the significance of telephone communication for all time and all people.

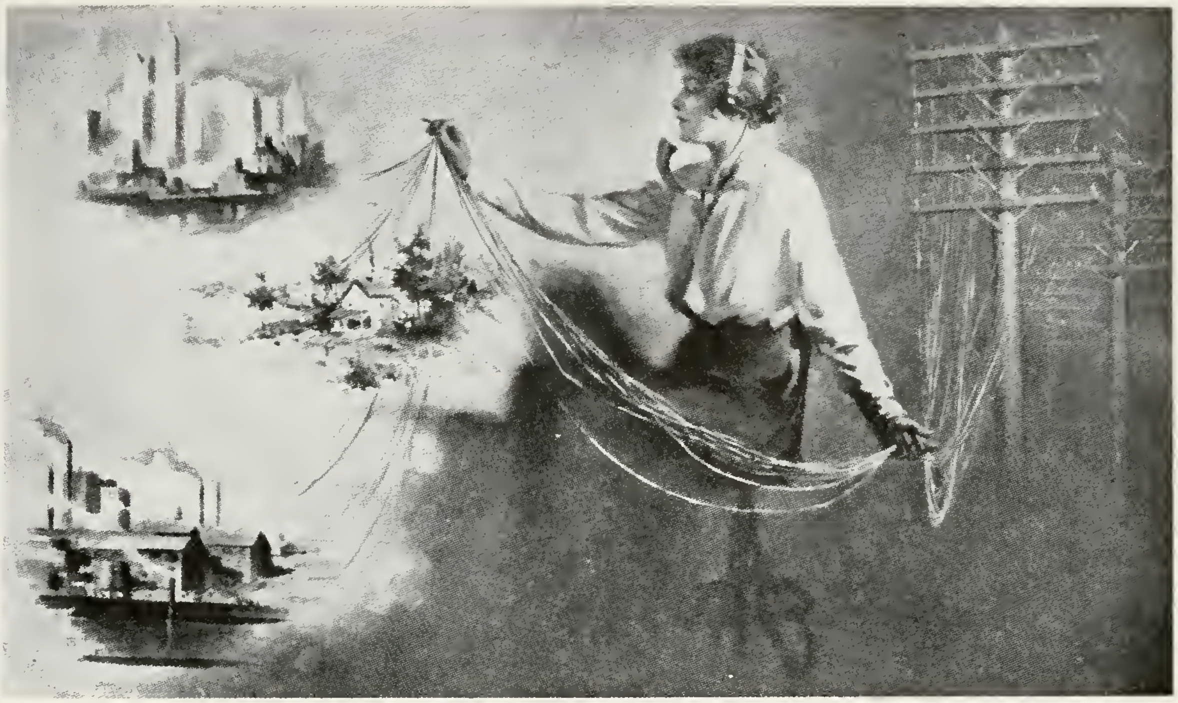
It is called "Weavers of Speech."

A line of telephone poles emerges from a shadowy mist.

The wires sweep down to the left hand of the central figure—that's you, Miss Susie!—and rise again to her right, as she feeds the lines of communication to people everywhere.

Age-old folk tales tell of Fate as a weaver, spinning the threads of destiny and weaving them into the pattern mankind must follow.

In the darkness, from which the telephone lines come to your hand,



WEAVERS OF SPEECH

". . . a picture of you was painted, back years ago before you were born"

unseen are all man's efforts to create an ideal of communication, on which he might build his future.

There are the smoke of his first signal fires, the naked runners trained to run for miles, the messengers on horseback, all of these and many more.

Progress rests on communication, and man's search for an ideal has been endless.

Into your hands come the telephone lines.

They are the fruit of his efforts and the threads of his destiny, which your hand weaves into the pattern of a better world.

It is as though you held a lantern high, and in its rays new life is forming, new growth springing up.

Where there was darkness, now there is light.

IT IS *a great picture of you, Miss Susie.*

It tells a great story—one so big mere words cannot make its import clear.

That took paint on canvas.

It is a timeless story, too, one even more true today than when the picture was painted.

That's what makes it a great picture.

And you're a great gal, Susie.

Today is a bridge over which all our yesterdays cross to make tomorrow.

You're crossing it with your chin up, eager, and alert and ready for laughter, but you're aware that these things are not all.

You carry your share of the load.
And that's what makes you great!

Mr. Stephens is on the staff of the *Southern Telephone News* of the Southern Bell Telephone and Telegraph Company, and his "Memo" is reprinted from that publication.

A Subsidiary of the Western Electric Company Salvages and Reclaims Millions of Pounds of Metals and Materials Important to the Telephone Business and the Nation

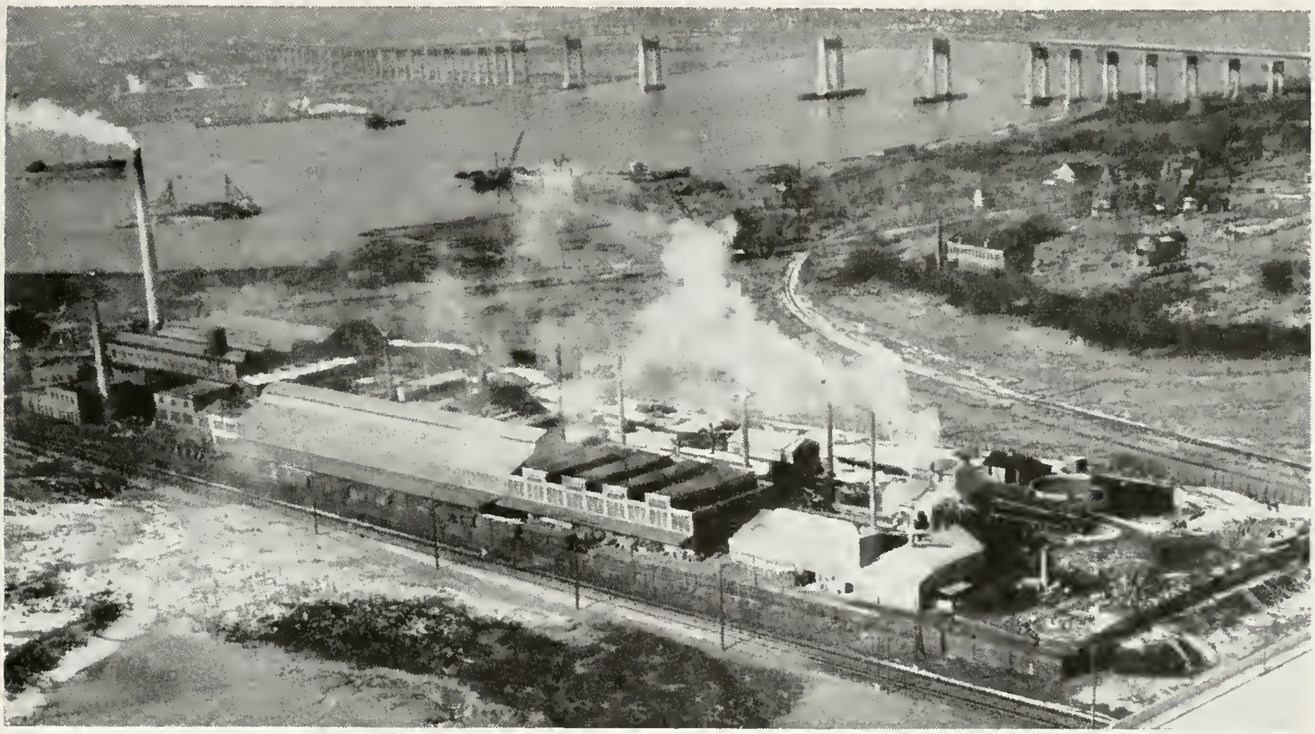
Nassau—The Bell System's Conservation Specialist

William A. Scheuch

PRODIGAL USE of the nation's raw materials during four years of war has focused serious attention on declining national reserves of lead, copper, iron, zinc and many other resources vital to industry. Although our country has been drawing extensively from its natural resources for less than 100 years, there are signs of ultimate depletion within the foreseeable future. Now, as never before, industry in the United States is looking to its scrap heaps and junk piles for substance to help feed the machines of peacetime production.

Though the conservation and reclamation of used materials has been a habit of long standing in the Bell System, the careful husbanding of the by-products from manufacture and the recovery of basic raw materials from equipment retired from service throughout the System are assuming added importance.

To the Western Electric Company's subsidiary, Nassau Smelting and Refining Company, falls the major responsibility for collecting, sorting, and reclaiming the millions of pounds of scrap materials resulting from Bell System operations each year. Literally, there is gold in those piles of scrap—gold, silver, iridium, and other precious metals. But more important than precious metals to the telephone industry are the huge quantities of lead,copper, zinc, iron, steel, and aluminum. Because they resist corrosion, lead and copper are particularly important in the manufacture of telephone equipment to assure flawless performance over long periods of time. And many other products, like rubber, paper, plastics, burlap, and rope are obtained from salvaging everything from tiny switchboard lamps to worn-out trench diggers.



An aerial view of the Nassau Smelting & Refining Company at Tottenville, Staten Island, N. Y. In the background is the Kill van Kull, above which the Outerbridge Crossing stretches to New Jersey

In 1945, a comparatively low year, the Nassau organization handled 105,122,000 pounds of "Bell System" scrap. Included in this amount was enough lead to cover 1,600 miles of 1¼"-diameter cable, enough copper to produce 72,000 miles of open line wire, enough iron to build seven modern destroyers of the Bristol class, enough paper to print four and a half editions of the *New York Times*. There were 1,475,000 pounds of aluminum, 942,000 pounds of plastics, and 883,000 pounds of nickel and nickel-base alloys.

All told, the value of scrap for the year totalled $3,835,000. Contributing to this tidy sum were such divergent materials as cinders from Western Electric power plants, sold for thirty cents a cubic yard, and iridium from contact points in telephone sets and switchboards, sold at $125 an ounce.

In simplest terms, scrap is any material no longer needed in its existing form. Improved methods of manufacture, design of new equipment, and changes in tools and machinery all add to the scrap piles. In this sense, accumulation of scrap is a sign of progress.

A Nation-wide Organization

Today Nassau Smelting and Refining Company is a far-reaching network covering all Western Electric plants and distributing houses and closely linked with the Bell System's operating telephone companies. It's a highly coördinated team of experts including chemical engineers, metallurgists, sorters, furnace men, investigators, salesmen, market analysts and shippers to the number of 400. That so small a group can handle the disposal of so large a volume and variety of Bell System scrap speaks well for their efficient methods. Actually, almost everyone in the Bell System contributes indirectly to the scrap job—even the office worker who tosses a sheet of paper into the wastebasket.

Nassau grew to its present stature from a small organization at the Western's Hawthorne plant in 1916, when for the first time a central group was charged specifically with converting the by-products of telephone manufacture into useful raw materials. Up to that time each manufacturing department had handled the scrap piles built up by the residue from busy screw machines, punch presses, and other production processes.

The wisdom of the decision to centralize scrap control became increasingly apparent as the telephone business rapidly expanded following World War I and during the boom 'twenties. The volume of scrap reclamation grew in proportion. In 1927, the newly built Kearny, N. J., plant relieved Hawthorne of handling telephone scrap originating east of Pittsburgh. The scrap piles were mounting, and so was the knowledge of how to get the most out of them. Secondary metals, as the trade calls reclaimed scrap, were becoming an important source of raw materials for the telephone business. It was time for Western Electric to shop around for a "home" for scrap, where the "know how" of reclamation was already at work.

Following a careful survey of available facilities, Western Electric purchased in 1931 the Nassau Smelting and Refining Company at Tottenville, Staten Island, N. Y., a long-established concern equipped with furnaces and facilities to handle refining on a large scale. The new Nassau company took over Kearny's scrap activities, and in addition began processing most of the non-ferrous scrap metals resulting from Western's manufacturing operations. Gradually Nassau's job grew, and in 1941 the company became responsible for disposal of all Bell System scrap.

THE NASSAU ORGANIZATION consists of two main parts: the smelting and refining plant in Tottenville, S. I.; and a special department called the Bell System By-Products Organization, which maintains representatives at each Western Electric plant and distributing house and serves as liaison with the telephone companies.

Almost in the shadow of the Outerbridge Crossing at the lower tip of Staten Island, the storage bins and railroad sidings at Nassau are bulging with bales of wire, reels of cable, boxes of assorted metal parts, all garnered from the four corners of the Bell System. These scrap products are purchased by Nassau from Western Electric and the telephone companies at prices depending on the metal content and the market value of refined metal. To balance out the company's operations, Nassau also purchases scrap materials, such as shell casings, and machine scrap of numerous varieties from other industries. During a normal year, Nassau buys about half of its secondary raw materials from the Bell System and half on the outside. Likewise, half of the metals refined by Nassau return to the Bell System for re-use in the manufacture of telephone equipment, while the remaining portion is sold to other industries in the form of bronzes, zinc dust, and other products which have limited use in telephone production.

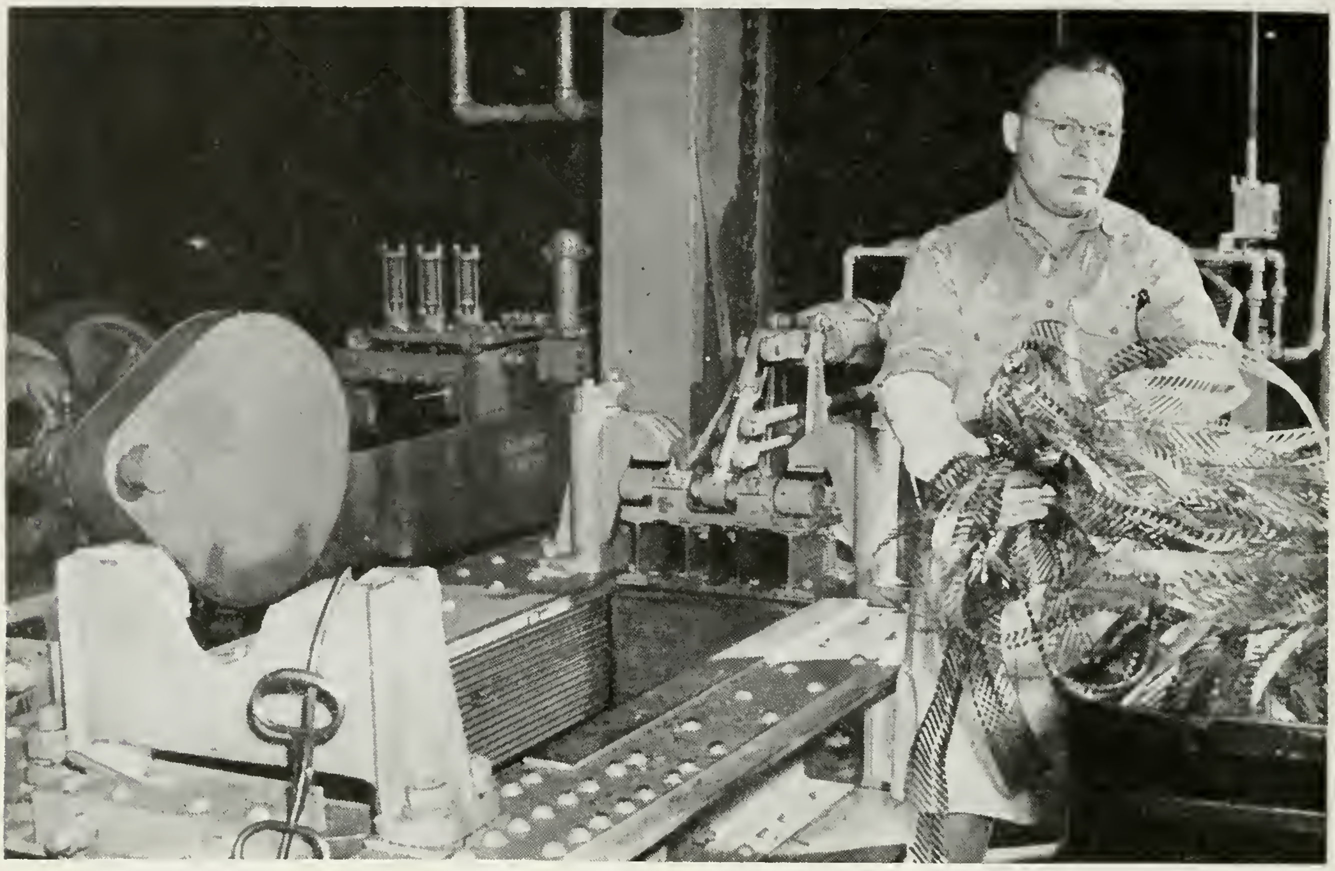
A load of scrap telephone cable is weighed at a Western Electric Distributing House before shipment to Nassau Smelting & Refining for processing into some new form of raw materials

Classifying, Sorting, Refining

One of the secrets in reclaiming for the Bell System is careful sorting and classification. Scrap gets a preliminary "going over" at the various Western Electric factories and distributing houses. In some cases, scrap material accumulated at telephone companies is shipped directly to Nassau under the supervision of the local Nassau representative. At Western's Works locations, Nassau representatives assist in setting up efficient methods and routines to guarantee a minimum of waste. They are always on the alert to devise new methods of saving scrap at the source. They assist in setting up routines for keeping each class of waste material in separate containers—the brass in one barrel, copper in another, nickel silver in another.

The same procedure applies to retired telephone equipment dismantled at the various distributing houses. From long experience and analysis of manufacturing operations, Nassau men can estimate the quality and quantity of scrap expected from that source. Most telephone plant scrap consists of recurring items, too, like switchboard apparatus, cable, handsets, relays, and the like.

Nassau men divide anticipated accumulations into classes, based on a physical and chemical analysis of each class. First there is a general group consisting of about 14 different items —aluminum, brass, bronze, copper, iron, steel, and so on. Each of these 14 is broken down into sub-classes covering specific alloys or kinds of material. There are eleven different kinds of aluminum, for example, 17



An operator in the reclamation department of one of Western Electric's Works loads scrap metal into a baling machine. The Nassau company supervises the reclamation and disposal of all scrap material throughout the Bell System

of brass and 49 of copper scrap. In all there are about 200 different classifications covering the millions of pounds of non-ferrous scrap each year. This careful segregation increases the volume and purity of reclaimed material.

A good example of thriftiness is the salvage of cutting oils from machine lathe turnings. Sometimes those steel or brass curlicues carry oil equaling as much as one-quarter of their total weight; and to produce dry turnings and salvage the oil for re-use, turnings are passed through centrifugal separators. By this process alone, the Hawthorne plant salvages 45,000 gallons of cutting oils annually. The disposal of such by-products comes under Nassau's guidance.

After preliminary sorting at factories, distributing houses, and at telephone company locations, scrap is carefully packed, labeled and shipped. As each truck or freight car rolls into the Nassau yards, sorters start grading the scrap into classes which will best fit current demands. They can tell at a glance in what bin or barrel to throw each piece of scrap. When old metal is covered with dirt or corrosion, they may scrape the surface with a file or drill out samples for closer identification. They detect the presence of ferrous metals with a magnet. With practiced hand and eye they quickly dismantle telephone and switchboard apparatus down to the last nut and bolt.

They put lead covered cable through stripping machines. They pile jumbled wires into a baling machine and take out a compact cube of almost solid metal which is comparatively easy to handle. In fact, when dismantlers and sorters are through with a carload of junk at Nassau, it is marked and stored, ready for the furnace operators.

The chief refining processes at Nassau—that is, "cooking" the sorted scrap in huge furnaces, kettles, and crucibles according to exact recipe, and molding it into smooth billets, ingots, solder, and wire bars—provide a colorful show. They also provide a rare lesson in conservation.

Governing all Nassau scrap operations is the endeavor to preserve the purity of the various metals as long as possible and to extract every possible use from them. The principle is the same as that of a frugal boarding-house landlady who cooks a roast for Sunday, serves cold cuts Monday, meat pie Tuesday, stew Wednesday, and hash on Thursday, with the dog finally getting the bone. Nassau scrap men, however, would salvage the bone.

Carrying along that analogy, let us say that Nassau produces a quantity of copper having the highest practical purity. From this a ringer coil for a telephone set may be made at a Western Electric factory. This coil goes into service and years later returns as scrap. The copper reclaimed from the coil will contain more impurities than originally because of the addition of soldered terminals. This product can be refined economically, however, into material suitable for manufacture of power terminals. After serving its time in this form, it can again be refined to copper metal suitable for castings, and so on down the line through the various copper-base alloys. Finally it reaches the "hash" or slag stage, when it becomes so diluted with other elements that the cost of reclamation exceeds its value. But Nassau men will still find a use for it. For instance, they might sell it to an outside purchaser for making insulation material. If the slag is not saleable, they dump it into nearby marshland owned by the company, and thereby reclaim the marshland.

The Chief Metallurgical Processes

The chief metallurgical processes at Nassau fall into three general classifications: the white metals department (tin and lead-base alloys); the red metals department (copper and copper-base alloys); and the zinc department. One of the most important jobs right now is reclaiming cable, because of the present scarcity of lead and copper. Let's take a look.

Large cables, returned to Nassau after years of service in the Bell System, go through the stripping machine which cuts the sheathing, as a knife slices through a ripe melon, and separates the lead from the paper-insulated copper wires. The very small cables go through "sweating" furnaces, where the temperature of the furnace is adjusted so that the lead will run off and the copper remain. The lead is then poured into big kettles and refined into material used for lead covering on new cable.

Some of the older type of cable has a lead-tin alloy sheath. This lead sheathing is fed into a reverbertory (oil flame) furnace, where the tin is separated from the lead. The tin-free lead is then kettle-refined, alloyed with antimony, and used for new cable covering. The tin oxidized from this material goes into an electrical smelting furnace to be reduced to metal. This metal is refined into solder in huge 30-ton kettles. The dross or residue from the electric furnace is put into a reverbertory furnace and smelted down for use in copper-base products.

Lead cable sleeving, which Nassau makes in many sizes and of several alloys, is a prime example of long range planning for efficiency in reclaiming Bell System scrap. Knowing that each length of sleeving probably will return to Nassau at some future time after serving in the System, Nassau has long since "tagged" each piece of sleeving with a series of identifying ridges running lengthwise. These ridges tell what alloy has been used; and when at some later time the sleeving returns to Nassau, a sorter merely runs his fingers over the ridges and sorts the pieces according to the composition thus disclosed, and with a minimum of effort.

One of the most exacting processes in the red metals department is the refining of copper and the casting of wire bars. The entire operation cycle takes 24 hours to complete: eight hours for charging the furnace with a hodgepodge of metals; eight hours for refining; eight hours for casting and for preparing the furnace for the next cycle.

The refining is done in a reverbertory furnace which seems large enough to roast a full-grown moose. Certainly it's hot enough and it growls as though in a constant rage. Oil under high pressure feeds this inferno at the rate of 150 gallons each 24 hours and generates heat of over 2000 degrees Fahrenheit.

Like a chef anxiously watching his broth, an attendant wearing thick safety glasses and heavy fire-proof gloves periodically thrusts a long ladle into the molten mass and brings it out full of copper. By looking at the sample metal, the "chef" knows when it is right. To make doubly sure, however, he sends this sample

Into the furnace go these remnants of worn out telephones, and out will come brass billets "brew" to the Nassau laboratory, where it immediately undergoes a test. If it does not meet specifications exactly, the chemist calls the furnace man by telephone and tells him what adjustment to make.

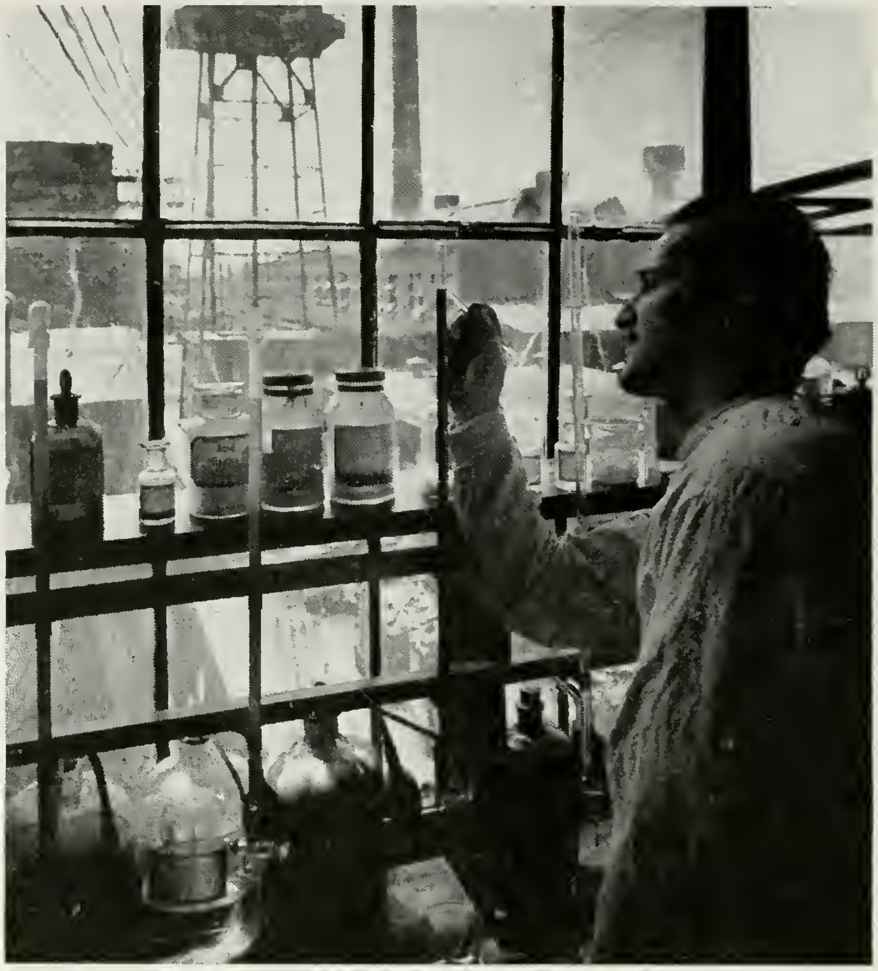
To meet Bell System standards, copper wire bars must contain a minimum of 99.93 percent copper. When this purity is assured by laboratory check, the molten metal is cast into bars weighing 250 pounds.

In the casting of composition bronze ingots, molten liquid, looking like orange juice, is poured through four spouts from an immense ladle into moulds passing beneath on a conveyor. Four moulds about the size of a bread pan proceed abreast on the conveyor. A workman tips the ladle and four golden streams fill the moulds. The ingots begin to change color immediately. After they travel a few feet, they are showered with water. In five minutes' time they change from a terrifically hot liquid into cool, solid ingots of bronze weighing 25 pounds each.

"Mining" metals from the mountains of scrap material that flow into Nassau each year is as carefully controlled as the production of primary metal. Nassau's inspectors, metallurgists, and chemists guard the quality of finished products. Nothing passes them until it meets the approved metallurgical standards. They check the scrap material before it goes into the furnaces; they control the refining operations to guarantee the proper composition of the product; and, finally, they test all finished products in accordance with the customer's specifications.

In the chemical laboratory, all kinds of devices are used to keep operations going smoothly. There are usually so many chemical operations going on simultaneously that a system of automatic timers and bells

Copper, brass, lead, and even precious metals are recovered at Nassau through the refining qualities of incandescent heat



Reclamation and refining operations require careful laboratory analysis. Here a chemist tests a sample in Nassau's laboratory

is used. When a chemist affixes a "loaded" beaker over a burner, he sets the timer. When the desired time has elapsed, a bell rings. No guesswork here. Every minute counts. To save precious time in handling hot beakers, the laboratory uses containers made of a special glass which can be raised to terrific heat and instantly cooled by water without shattering.

No Interlude from War to Peace

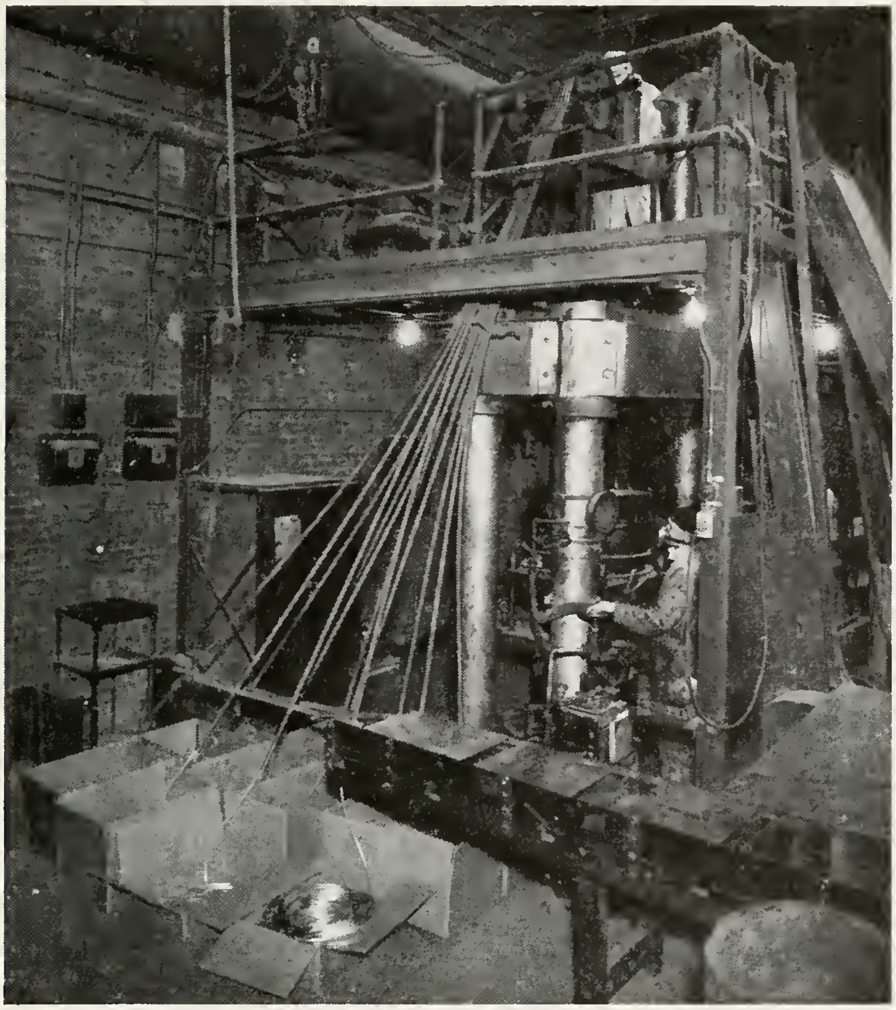
In war and peace Nassau is jealous of time. With hardly the loss of a stride the Nassau plant changed over from tremendous war production to the mighty task of reclaiming scrap for the Bell System expansion program. The 20-odd furnaces and dozens of kettles and crucibles are still cooking 24 hours a day, often seven days a week.

The voracious demands of war cut down the output for telephone use to a thin trickle. In 1944, Nassau supplied only 10 million pounds of "reborn" metal to the Bell System (as against 75 million pounds to foundries for war production) or about 12 percent of the total output. Before the war, Nassau had supplied an average of 50 to 60 percent of its total production to the System.

As soon as victory was assured, Nassau began repairing, overhauling, and reconverting furnaces to whip up production of staple telephone raw materials like lead, solder, copper wire bars, and ingots. The output for the Bell System began to climb. At the end of the first two months of 1946, Nassau had supplied 2,448,000 pounds of finished material for telephone manufacture, or about 33 percent of its total output. At the end of the seventh month the output for Bell System account had jumped to 47 percent: 19 million pounds of processed metals out of a total of 40,627,000. And week by week production for the System continues to climb.

The By-Products Organization

Natural by-products of Bell System operations from coast to coast



A dozen streams of wire solder pour from the pipes of this solder press at the Nassau plant and coil neatly into containers

include a long list of substances, from pinpoints of precious metals to locomotives from the Manufacturer's Junction Railway which serves Western's Hawthorne Works. The list includes rubber, plastics in a hundred forms, all sorts of paper, typewriters, automobiles, cinders, and most other materials which the Bell System uses and discards in the course of its daily operations.

The disposal of this varied and miscellaneous scrap is the job of Nassau's by-products organization. The work of the by-products men is highly technical, involving a detailed knowledge of materials, markets, shipping, and scientific processes of reclamation. They work on the principle that there must be some use or purchaser for any scrap item, no matter how low it falls in the scale of market values.

All replaced equipment in the factories of Western Electric or in telephone exchanges is not necessarily scrap. A machine which is replaced in one department may be serviceable in another part of the plant. Nassau's representatives take over the disposal of all equipment and machinery not usable by the Bell System.

The field representatives of the by-products group serve as advance scouts and liaison men. They supervise the collecting, classifying and disposal of scrap in local areas. They watch local markets and report new developments to headquarters. They work closely with the scrap agents of the Bell telephone companies in terms of the supply contracts which Western Electric maintains with each company.

In the course of a day's business, one by-products man may arrange for the sale of impregnating compounds (composed of paraffin and beeswax) to a processor for making industrial waxes. Another may find a purchaser for scrap fibre shearing, to be made into necktie pressers, insulators, washers, or toy parts. Still another may be selling cork shavings to be processed into insulating material. Old telephone booths are in great demand for manufacture into high grade picture frames.

In disposing of cast-off material, by-products men first try to find purchasers within the Bell System. If there are no bids from the System, they find outside purchasers. This method of procedure sounds simple enough. The execution of it, however, demands highly specialized knowledge and resourcefulness.

Toward Maximum Use

As the Bell System's team of experts in conservation, Nassau sees a continuing and increasing challenge in the days ahead. To them the depletion of our nation's mineral resources places new emphasis on the necessity for efficient salvage procedure. They see themselves as an element in the national program to conserve the materials so vital to our economy. More specifically, the men and women at Nassau recognize their responsibility in speeding "reborn" raw materials into telephone production. Nassau is constantly devising new techniques and improving methods for extracting the last bit of value from Bell System scrap and for channeling urgently needed metals back into service in the shortest time and with a minimum of loss.

Reclaimed, refined, and molded into wire bars, copper by the ton at Nassau awaits shipment to Western Electric, where it will be drawn into copper wire

Commercial Broadcasting Pioneer: The WEAF Experiment, 1922-1926

A Book Review

WEAF IS NO MORE. The call letters which for nearly a quarter of a century designated a radio broadcasting station famous for its pioneering achievements ceased last November to have meaning. WNBC is the name now. But even as the old name goes down into history, we have today an excellent record of the years when the station was the experimental radio broadcasting medium of the American Telephone and Telegraph Company.

This is the newly published "Commercial Broadcasting Pioneer: the WEAF Experiment, 1922–1926," by William Peck Banning. In this fine work of research and interpretation, the author has not only set forth the facts about the A. T. and T. Company's creation and operation of WEAF, but he has so displayed them against the contemporary scene that their social and economic as well as their technical importance becomes clear.

The author, as many who will read the book already know, was a member of the A. T. & T. Company Information Department for 24 years, and for 17 of those years before his retirement in 1944 he served as an assistant vice president. He was a keen observer of many of the events he describes and was acquainted with many of the principal figures concerned in the rapidly expanding enterprise. Personal recol-

William P. Banning at work on the manuscript of "The WEAF Experiment" at his home shortly after his retirement from the A. T. & T. Company in 1944

lection thus aided the exhaustive inquiry which makes the book an authoritative document.

It is Mr. Banning's conclusion that the A. T. & T. Company's four-year experiment with WEAF aided the development of radio broadcasting in three unique, constructive, and important ways.

The first of these, he believes, was in the scientific and technological field. Basic contributions here were to be expected from an organization which had transmitted one-way speech through the ether to Paris and Honolulu as early as 1915. Among them was the establishment of network broadcasting.

The second, the author feels, was the emphasis on a high standard of radio programs.

The third was the determination of the means whereby radio broadcasting could support itself: "toll broadcasting," as it was first termed. This concept of making broadcasting facilities available by selling time on the air was the contribution of A. T. & T. President Walter S. Gifford—then executive vice president—and set the pattern for broadcasting as we know it today.

"The experiment was continued . . . until its animating idea had been proved," says Mr. Banning in his *Author's Preface*. "When it was over, and Station WEAF passed to new ownership, public hospitality to broadcasts of every type had been tested, network broadcasting had been established, and the economic basis upon which nationwide broadcasting now rests had been founded. A trail had been blazed that thereafter could be followed without hesitation. A self-imposed service of investigation had answered the question, 'Quo vadis, radio?' "

Mr. Banning has avowedly written "for the record" and in order that telephone people throughout the Bell System may have access to a significant chapter of communications history—a chapter which is little known to a younger generation while it fades from the memory of those who knew of or participated in events as they happened. His book will be of special interest to all who had any connection, direct or indirect, with the creation and early operation of WEAF; to others who want to know or to be reminded of how radio got to be what it now is; and perhaps to yet others who have a nostalgic fondness for the days when radio was a new magic and commercials were not jingled.

Mr. Banning's book includes the era during which WEAF first brought to millions of delighted listeners such radio favorites as Graham McNamee, Roxy and his Capital Theatre gang, Billy Jones and Ernie Hare—the Happiness Boys, the A. & P. Gypsies, the dance music from the Rose Room of the Waldorf, and many another. It ends with the sale of WEAF in 1926—the logical sequel to the A. T. & T. Company's conclusion that radio broadcasting was a one-way service in the entertainment field and therefore not compatible with its principal business of furnishing the nation with two-way communications service.

J. S. B.

Commercial Broadcasting Pioneer: The WEAF Experiment, 1922–1926. William P. Banning. The Harvard University Press: Publication of the Business Historical Society. xxxiv + 294 pages + index. 6 charts, 2 tables, 30 illustrations. $3.50.

Alexander Graham Bell
1847 1947
CENTENNIAL

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