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VOLUME XXI, 1942

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WE SHALL JUSTIFY THEIR FAITH
A STATEMENT BY PRESIDENT GIFFORD

TELEPHONE LINES AND AIR DEFENSE

"FREQUENTLY REPRINTED DIRECTORIES" FOR THE INFORMATION SERVICE

ACROSS THE ROOF OF THE CONTINENT

BILLS FOR 13,000,000 CUSTOMERS

THE MOBILIZATION OF SCIENCE IN NATIONAL DEFENSE

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE MAGAZINE

Continuing the Bell Telephone Quarterly

A Medium of Suggestion and a Record of Progress

"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."

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195 Broadway, New York, N. Y.

"SERVICE TO THE NATION IN PEACE AND WAR"

Placed in the lobby of the American Telephone and Telegraph Building in New York after the first World War, this bronze and marble group is today both a symbol and a pledge

WE SHALL JUSTIFY THEIR FAITH

A statement broadcast over a nation-wide radio network on December 15, 1941, eight days after the attack on Pearl Harbor

By WALTER S. GIFFORD

President, American Telephone and Telegraph Company

WE are at war, and I am here tonight to congratulate the men and women of the Bell System for their magnificent handling of the extraordinary demands for telephone service during the past week.

While we of the Bell System — and there are 400,000 of us — are used to meeting emergencies, we know we now face the greatest of all times: an emergency that will require long sustained effort.

I am confident that we shall live up to our tradition that the message must get through, no matter what the obstacles or discouragements. Your achievements under the strain put upon you last week demonstrate that fact. To win the war will take courage, resourcefulness, and hard work. We must and shall win, come what may. Our fellow citizens are counting on us to do our part — and we shall justify their faith.

TELEPHONE LINES AND AIR DEFENSE

Operation of the Aircraft Warning Network, and Co-ordination of Defense Against Enemy Air Attack, Depend Upon a Carefully Designed System Using Existing Communication Facilities

By JUDSON S. BRADLEY

Operating in the United States today is the most extensive system of intelligence ever devised for military use: the aircraft warning network. Upon this system, operated by military personnel and many thousands of civilian volunteers, depends in no small part the defense of this country against attack by air.

This article is, in general, an account of how the aircraft warning system operates. More particularly, it is an explanation of the importance of telephone communication facilities in warding off or defeating an attempted attack through the air. It is written now in order that every telephone worker in the land may have personal satisfaction in the knowledge that the industry of which he or she is a member is contributing, zealously and effectively, not only to the prosecution of the war but specifically to the protection of our shores against aerial assault: assault which may come at any moment on stealthy wings.

Before describing the role of the telephone, however, a brief explanation of the organization of our Army air forces may help to make the picture clear.

All combat units of the U. S. Army Air Forces stationed in the United States form what is designated as the Air Force Combat Command. This is organized into four Air Forces: the First, the Second, the Third, and the Fourth Air Force. Each operates in an area which represents approximately one quarter of continental United States: the north-east, north-west, south-east, and south-west. The Air Force in each of these four areas is composed of three combat elements: the Bomber Command, the Air Support Command, and the Interceptor Command. There is also a Service Command, charged with logistical arrangements.

The Bomber Commands are offensive striking forces, their function entirely aggressive.

The Support Commands coöperate closely with ground combat forces, and are the air partners of the team which, with mechanized ground units, has proved so effective abroad.

The Interceptor Commands, co-ordinating with the Anti-aircraft Artillery Corps, are responsible for the defense of this country against attack through the air. This they ac-

GUARDING OUR SHORES
Interceptor-pursuit aircraft in flight along the coast

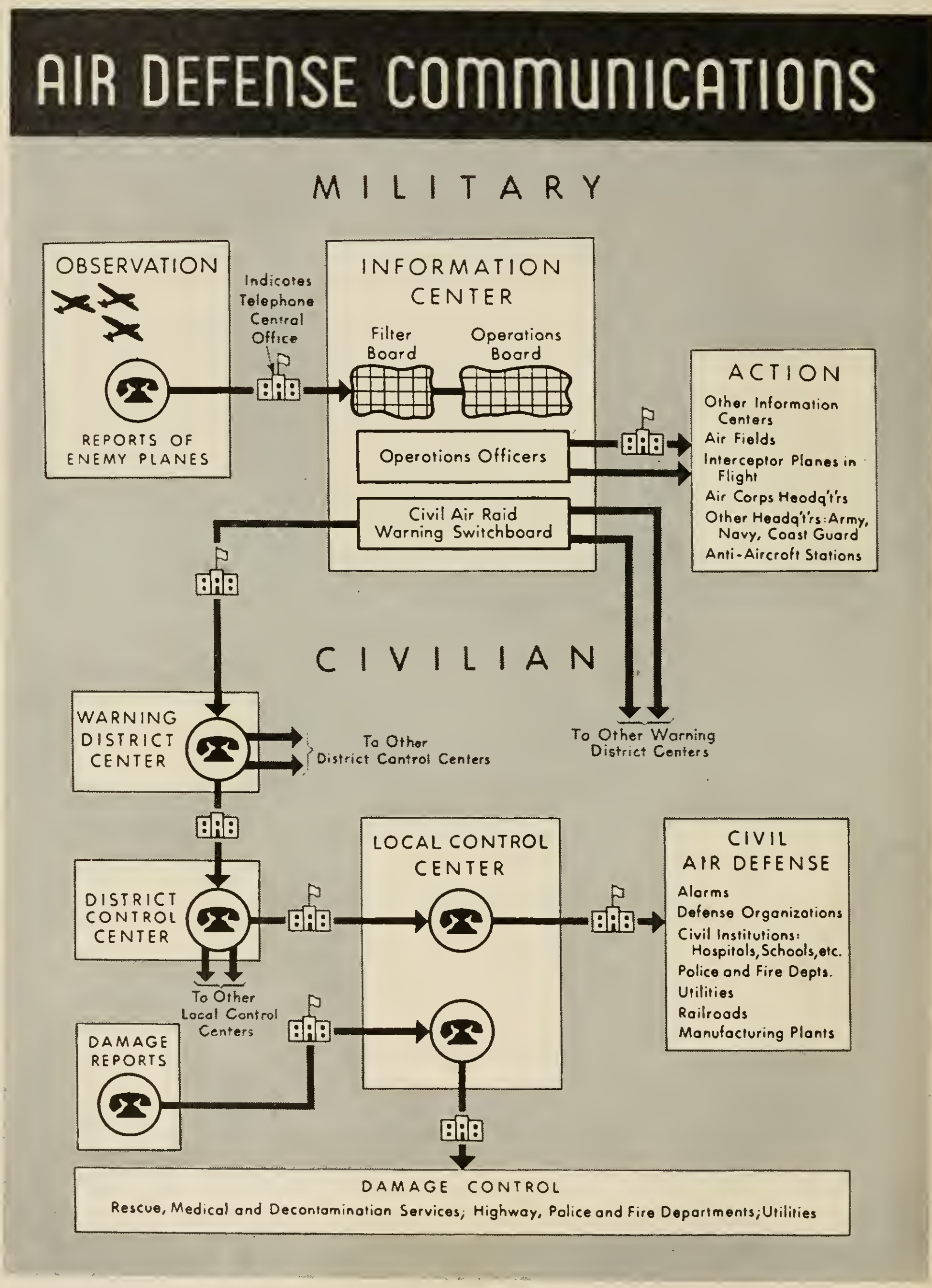
complish by destroying hostile aircraft in the air and by limiting their effectiveness by forcing them to high altitudes or away from their objectives. The means employed are, of course, interceptor pursuit squadrons and anti-aircraft artillery. They are also responsible for giving air raid warnings to civilian authorities and for ordering blackouts.

It is with the Interceptor Commands, and their use of and their coordination with and by the telephone, that the following pages deal.

How the System Works

DEFENSE against enemy air attack begins with the warning network. Radio locators are indispensable in detecting the approach of aircraft from the sea and in locating airplanes in the air. Over land, there is a vast system of civilian observation posts which swiftly report any planes, over the existing network of commercial telephone lines, to Army "filter centers." There the telephoned reports are evaluated, and the "filtered" reports are passed on to information centers, where the course of approaching aircraft is plotted, much as a yachtsman lays out on a navigation chart the course for his day's run. The Control Officer, from the information thus visually before him, takes appropriate measures to meet the situation thus presented: orders the necessary pursuit planes into the air and gives them the course to follow to intercept the enemy; perhaps calls into action anti-aircraft batteries; orders air raid warnings to areas likely to be endangered.

That is a quick look at the general



"TELEPHONE LINES AND AIR DEFENSE"

Only the upper portion of this diagram represents military activity. The lower part shows how the telephone serves Civilian Defense as well scheme. It has been brought into existence because, instead of necessitating a constant patrol in the air, it is an effective method of interception while conserving the air forces available.

THIS plan of air defense was not devised over night. The idea of the civilian ground observer system was conceived a decade ago, and has been tried out, with the coöperation of the telephone companies, in successive maneuvers since its inception. Early experiments were crude, but each test brought improvements and refinements.* Today, upon the ground observer system depends in large part the efficacy of the Interceptor Commands which, day and night, are guarding our shores.

The system parallels in many respects—although with important differences—the air defense which, by the outbreak of the war in Europe, England had brought to a high degree of efficiency.

The interception system has several advantages.

It permits pursuit squadrons to operate from "ground alert"—in readiness to take the air against definitely located targets only. Estimates are that each plane on ground alert is the equivalent of 16 on patrol missions.

The system enables the formation leader to devote himself to combat action, since navigation and direction are done for him on the ground and sent to him by radio telephone up to the moment of contact with the enemy force.

* See "A War Game Test of Telephone Service," BELL TELEPHONE QUARTERLY, January, 1939; and "Another War Game Test of Bell System Services," QUARTERLY, July, 1940.

The system also makes it possible to give adequate air-raid warnings to Civilian Defense authorities in time to permit them to take whatever measures the situation calls for.

The Aircraft Warning Network

LAND area of continental United States comprises 2,977,128 square miles. All of it, except for certain inland areas in the west, has been ruled off, on small sectional maps, into units one mile square. In each unit has been placed a symbol indicating the presence or absence of a telephone in that area. Telephones of the Coast Guard, Forestry Service, and similar agencies have been indicated. The telephone companies, Bell and independent, did that job, and turned the maps over to the Air Corps' four Interceptor Commands.

That was the start of the present ground observer network. On these maps, starting with an indicated telephone, Air Force officers laid circular templates scaled to an eight-mile diameter, and drew overlapping circles. At some point within each of these circles an observation post was carefully selected and a trustworthy citizen appointed chief observer. To obtain this enormous organization, aid of the Office of Civilian Defense, State Defense Councils, and the American Legion was enlisted. Each chief observer appointed his deputy observers, and obtained enough volunteer observers to insure constant coverage of the post—24 hours a day, seven days a week.

So, day and night, those observation posts which have been activated by the Army are manned by these patriotic civilian volunteers. Each of these

OBSERVERS ON DUTY

Day and night, at authorized observation posts in city, town, and country, thousands of civilian volunteers peer into the sky and report airplanes seen or heard

thousands of posts has its code name; each observer has his instructions—or hers, for many women are among the watchers.

An observer at an authorized observation post, seeing or hearing an airplane, or several, goes to the telephone, says to the operator "Army Flash," gives the telephone number of his post—and initiates a train of events which are astounding both in their complexity and in the speed with which they are executed. Speed is of the essence, since the flight observed may be hostile aircraft approaching an objective at hundreds of miles an hour. And so carefully coördinated are all the elements involved in defense against air attack that in operating today they exhibit in high degree the team-work which makes the system effective.

THE telephone operator, receiving the "Army Flash" call (and screening out any such call from an unauthorized telephone), connects the observer, either directly or through her toll center, over regular commercial circuits to the regional Interceptor Command filter board terminating at a point on the filter board corresponding with the observer's own location. The value of this arrangement will be apparent from a description of operations at the filter board.

The filter board, near a city selected because of its tactical location and its telephone facilities, is a very large map of the area it covers, so mounted that it becomes in effect a table. It is marked off into squares designated by code names and numbers. These codes correspond with those of the observation posts in the area. Around the map sit the plotters: all civilians, all volunteers. To them come the calls from observation posts, each call routed directly to the plotter nearest the mapped location of the post.

Receiving a signal light and an "alert" tone at her position, indicating a "flash" call, a plotter, equipped with a telephone operator's set, answers "Army, go ahead, please," and receives the report from the observer at his post.

The observer reports only non-technical facts, as instructed by the Army: number of planes seen or heard; whether single-, bi-, or multi-motored; apparent altitude; distance from the observation post; and direction of flight.

The plotter adjusts a marker to represent the information just given her, and places it on the map at the proper coördinate location of the reporting observation post, pointing in the reported direction of flight. This is accomplished in a matter of seconds, and the plotter is then ready at once to receive a call from another observation post.

This operation, it must be understood, takes place many times in rapid succession as one observation post after another reports—since the speed of planes is great and observers are located only a few miles apart. It takes but a moment for the markers on the map to make a definite line. Also, reports of a flight from successive observation posts corroborate each other, and thus of themselves rule out an occasional discrepancy on any one report.

THE markers, having so swiftly become a line, are now as swiftly evaluated by a "filterer," who places on a small stand nearby cards describing the observed flight, and replaces the markers with arrows indicating direction. To show the speed of the flight, the color of the arrows is alternated at regularly timed intervals.

FLASH MESSAGE FORM

Call your telephone central and say: "ARMY FLASH ________ (Give your phone number)"
Central will connect you with an Army Information Center.
When you hear: "ARMY, GO AHEAD PLEASE", you say: "FLASH"
and continue message you have checked on form below, in the order indicated:

1	2	3	4	5	6	7	8
NUMBER OF AIRPLANES	TYPE OF AIRPLANES	ALTITUDE OF AIRPLANES	WERE AIRPLANES SEEN OR HEARD?	YOUR OBSERVATION POST CODE NAME	DIRECTION OF AIRPLANES FROM O. P.	DISTANCE OF AIRPLANES FROM O. P.	AIRPLANES HEADED TOWARD
(Number) FEW MANY	SINGLE-MOTOR BIMOTOR MULTI-MOTOR	VERY LOW LOW HIGH VERY HIGH	SEEN HEARD		NW N NE W E SW S SE	(Miles)	NW N NE W E SW S SE
					If airplanes were directly over O. P. cover columns 6 and 7 by reporting: "OVERHEAD"		Omit if it will cause delay in report.

RPB—7-2-41—3,000,000

OBSERVER'S REPORT FORM

Information about aircraft seen or heard is telephoned in this order to "plotters" at the designated "filter centers"

The information about each airplane flight in a filter area, having been thus evaluated or "filtered," is now ready to be transmitted instantly over private telephone lines to an Army information center.

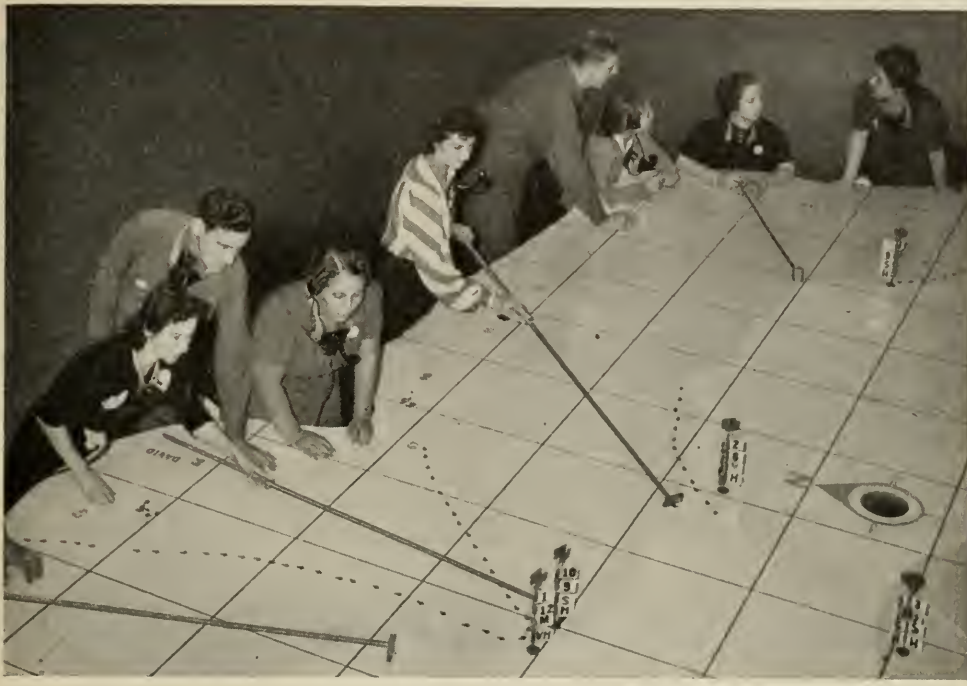
The heart of the aircraft warning system is the information center. It is here that decisions are made, action is initiated.

Here is the operations board for the particular defense region. Like the filter board, but larger, it includes all the filter areas of the region. Here, too, plotters place their symbols; but now they are duplicates of the evaluated information received moment by moment from tellers at each filter board in the region.

In the same room are the seaward board, on which all flights approaching from the sea are plotted; and the status board, on which are shown the availability, position, and condition of pursuit squadrons in the region.

An Army Filter Board

Plotters receiving reports of aircraft from civilian observation posts place markers on the map to represent the information given. As markers from successive reports form a line, the facts they reveal are evaluated or "filtered." On the balcony are tellers, who pass the filtered information by telephone to other plotters at an operations board. Women in all these posts are civilian volunteers



A CORNER OF AN OPERATIONS BOARD

Evaluated information from filter centers of a defense region is reproduced on such a map at an Army Information Center, where the Controller, on a balcony overlooking the room, is enabled to take appropriate action

Organization at the Army Information Center

ON a balcony overlooking these three boards sit the men who decide, and the men who help them. Contact among them, even between those who sit side by side, is by telephone.

First comes identification of the flight, from location and direction—if it can be identified. On the balcony, with this responsibility, are representatives—liaison officers—of the Army, the Navy, and the Civil Aeronautics Administration.

On the balcony is the Controller. He is, or acts for, the Commanding Officer of the region. It is he who orders into the air, from the most logical field in the region, pursuit of sufficient strength to effect interception of an enemy flight—of which more in a moment.

Acting as liaison officers also, and likewise on the balcony, are other important individuals:

The Anti-Aircraft Officer notifies the anti-aircraft artillery, putting these forces on the alert.

Radio Officers control various channels, including those with planes in flight.

The CAA representative can order all civilian planes grounded.

The Federal Communications Commission representative can silence broadcasting stations when and where necessary.

The Civil Air Raid Warning Of-

Instant telephone communication among the officers at an Army Information Center and to points outside is available through equipment such as is shown here

ficer notifies designated civilian district warning centers of the approach of enemy planes, transmits the "all clear," and issues the Interceptor Commander's orders for black-outs. With the giving of such warnings, the responsibility of the Air Force for local civilian defense ceases, since the kind and extent of passive defense measures in any community are matters to be handled by local civilian authorities.

ONCE the Controller orders pursuit planes from ground alert into the air, he immediately turns over to an Intercept Officer the navigation for and direction of those planes in flight. This officer, in a nearby room with assistants, calculates the most effective point of interception. He knows the speed, rate of climb, and other characteristics of the pursuit planes, and is in possession of information about weather conditions throughout the region. He is informed of the situation as it develops on the filter map with respect to the particular mission he is directing. Constantly in touch by radio with the pursuit flight, perhaps through successive ground stations, the Intercept Officer guides the planes to the point of contact with the enemy. When the Flight Commander tells him, in a single word, that contact with the enemy has been made, the Intercept Officer relinquishes control. In combat, the Flight Commander is on his own—although he can resume radio communication with the information center at any moment.

Just as the operations board at a regional information center duplicates and combines the evaluated information from several filter boards, so does a command post picture for the Commanding General of an Interceptor Command the situation in an entire Air Force area. Here he can observe and oversee all the activities of his command. He is, therefore, in position to dispose of his forces to meet any situation which may arise.

This account of the operation of the interception system, incomplete though it is, should confirm the remark made on a preceding page about team-work. Bearing out the accompanying statement about speed is the fact that it has taken you, the reader, longer to progress this far than would be required for the dispatch of pursuit planes on a mission following the receipt at a filter board of the first "flash" messages from the observation posts which start the process here described.

THIS has been, necessarily, a generalized picture. Nothing has been said here, for obvious reasons, about precautions in effect nor the speed with which operations can be resumed if any vital element in the system should be damaged. It should perhaps be pointed out, too, lest this report seem unrealistic, that no method of interception can rout or bring down, every time, every plane of an enemy formation. Some may escape attack and complete a mission; particularly, as the experience of England still proves, in night assaults.

To the people of this country it should be heartening reassurance, none the less, to know that around them is spread the protection of the aircraft warning network. Watching over them, on behalf of the Interceptor Commands, are those thousands upon thousands of volunteers who, motivated wholly by patriotism, are contributing their long hours at observation posts and filter boards and information centers.

In charge of the whole system are Army Air, Artillery, and Signal Corps officers who have devised and adapted and tested and improved and now operate it: cool, keen, capable men, aware of the ever-present danger of attack by air, sensible of their grave responsibility to protect the nation and its citizens. Practical and efficient they are, too; and the Bell System's contribution to this particular phase of military defense has been made the more smoothly and effectively because they have been always receptive to suggestions which may improve the technical operation of the system over which they have charge.

The Telephone's Part

ALTHOUGH little has been said in detail about the use of the telephone in the system described, it must be evident that every operation, from the reports of airplanes seen by civilian observers to the ordering of pursuit into the air, is keyed to and carried out by telephone. And even the pursuit flight is controlled by Army radio telephone sets connected by telephone circuits to information centers.

Fundamental to all is the use of existing commercial telephone lines, both of the Bell System and of independent telephone companies, made possible because the United States is served, as is no other country, by a network of telephone lines not only interconnecting cities and towns and hamlets but reaching out into almost every countryside. "Flash" calls from observation posts, using regular commercial telephone lines, get absolute right of way, of course. Where certain telephone and teletypewriter circuits may be required for the use of the Air Forces exclusively, these are provided in most cases from available lines. Even the intricate and vitally

MORE TELEPHONE EQUIPMENT
Since an Interceptor Command's operations are executed in terms of seconds, coördination of activities by telephone is of primary importance

Teletypewriter Installation for an Interceptor Command

Duplicating telephone circuits to a considerable extent, teletypewriters are used for communication with other points on routine matters or when messages of record are desired—as well as providing alternate routes in case of need

important intercommunicating systems by which coördination is attained at filter and information centers is put together out of standard parts, with a minimum of special equipment. The use of standard equipment—although specially arranged—expedites installation, and minimizes maintenance problems which might result from the use of specially designed facilities.

The aircraft warning system, as it exists today, might almost be said to be a joint achievement of the Army Air Force Interceptor Commands and the Bell System. The leadership is the Army's, obviously. Working with the Interceptor Commands, executing and also contributing during trials, tests, and maneuvers, have been the Bell Telephone Laboratories, which have designed and adapted circuits and equipment for special purposes; the Western Electric Company, which makes what the Laboratories design; the System's operating telephone companies, and independent telephone companies as well, which train their operating personnel and make necessary arrangements of the physical facilities; the Long Lines Department, which provides and assigns the intercity circuits and also must train those concerned with their use for such purposes; and the staff of the A. T. and T. Company, by whom the System's obligation in its broad aspect is correlated.

AN AIR RAID WARNING SWITCHBOARD

Through switchboard positions such as that shown in the foreground, the C. A. R. W. officer at each Army Information Center notifies designated civilian district warning centers of the approach of enemy planes. Note that there is a group of four jacks for each warning center: three to report differing degrees of danger, and the fourth to transmit the "all clear"

"The Determining Factor"

To summarize and conclude this discussion of the aircraft warning system, it is perhaps appropriate to quote from a broadcast made from an Interceptor Command information center by a military commentator not long ago:

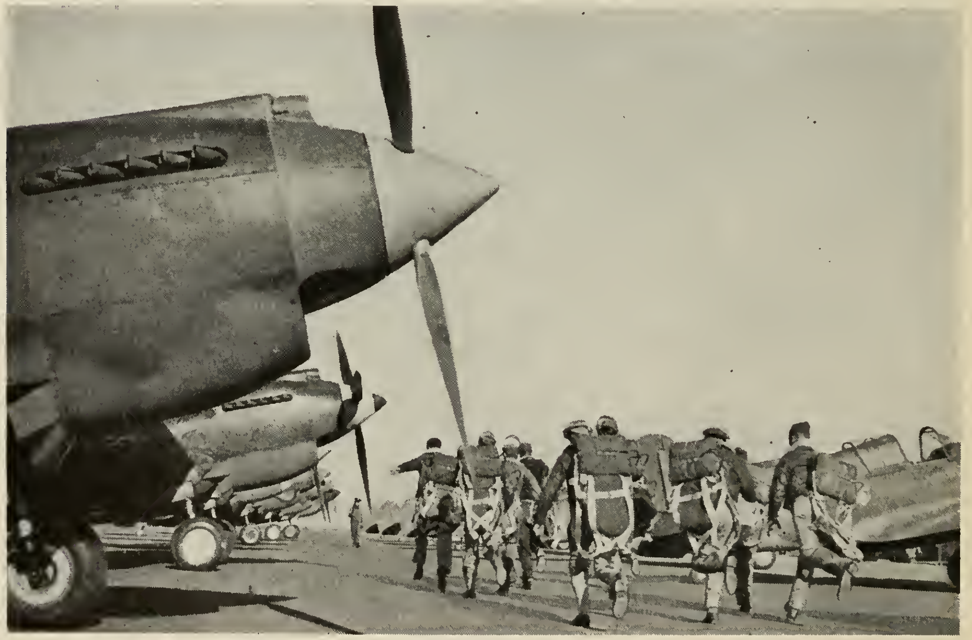
"This is essentially the same warning and interception system that the British have used in interdicting large sections of their island to enemy bombers. The systems were developed independently, and we are adapting British methods to our own use, while we pass on to them whatever we have discovered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

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

"That's not the case with us—we can have more observers because we have the finest telephone service and equipment in the world, all concentrated under one company *; a company that has been so enthusiastically

* This reference is obviously to the function of the A. T. and T. Company in coördinating, at the Army's request, the activities of the Bell System companies and the country's several thousand independent telephone companies to provide service for the aircraft warning network.—ED.

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



ON THEIR WAY

These pilots of interceptor-pursuit planes have been ordered into the air on a mission

"FREQUENTLY REPRINTED DIRECTORIES" FOR THE INFORMATION SERVICE

Special Printings of the Customer Telephone Book, Supplemented by Other Records, Are a Recent Development Permitting a Faster and More Accurate Service on Calls to "Information"

By JEROME D. TOWE

THE progress made by the Bell System in providing customers with an increasingly satisfactory and pleasing service on calls to "Information" was reviewed in a recent issue of this MAGAZINE.* In emphasizing the importance of complete and easily usable records for the use of Information operators in handling calls, reference was made to a relatively new development known as the "frequently reprinted directory," which has contributed substantially to the improvement of Information service in large and medium-sized cities. These Information directories are brought up to date and completely reprinted at frequent intervals, usually every two weeks, and provide operators with a high proportion of all current listings in one convenient volume. New and changed listings for the brief period between reprints are covered in a supplemental printed list known as the "daily addendum."

While alphabetical Information directories are in most cases produced as a by-product of the regular customer directory, the frequency of reprint and the production speed required present an entirely different compilation and printing problem.

In the case of a typical large city, the customer directory is issued at intervals of from six to nine months, and requires over a month for printing and delivery. The alphabetical Information directory for that same city, on the other hand, is completely reprinted every two weeks, and the time between the close of copy and delivery to Information centers must not exceed two or three days! Somewhat similar speed requirements apply to the production of street address directories (in which the listings are arranged by street number under the proper street name) in cities where such records are provided on a frequently reprinted basis to supplement the alphabetical records.

To illustrate the service advantages gained with frequently reprinted directories, it might be well to begin by describing other types of Information records.

* "Providing the Information Service," August, 1941.

Information Records

IN many cities, particularly the larger ones, the alphabetical records consisted of three separate reference sources: 1), the regular customer directory, normally reprinted at intervals of six months or longer; 2), a cumulative main addendum for new and changed listings, brought up to date and reprinted at intervals of from two to eight weeks; and 3), a cumulative addendum reprinted daily and covering the period between reprints of the main addendum.

In a few medium-sized cities, all new and changed listings occurring between directory issues were transcribed to visible index strips and placed in rotary file frames which were used in place of the two printed addenda mentioned above.

In certain other cities, the complete customer directory was transcribed into visible index listings and placed in rotary file frames. This provided one complete alphabetical record which could be kept up to date daily, although the record was divided for capacity reasons into three, four or five rotary files.

Somewhat similar arrangements applied to street address records where they were used, although addenda for book records of this type were not provided more frequently than every two weeks.

In cities using alphabetical records consisting of the customer directory plus printed or rotary file addenda, it was necessary, in order to avoid giving out incorrect numbers, for the operator to consult the addenda first to check the latest information, since a substantial proportion of telephone numbers are changed during a directory period. While this check obviously was necessary, it was found that more than half of the calls to Information concerned listings appearing correctly in the customer directory. This resulted in a high proportion of calls requiring reference to two or three records before the desired number was found. Under this arrangement, the operator work time per call was relatively high; in other words, service to the customer was delayed.

While complete rotary files provided only one record to search, there were several disadvantages associated with these records in the larger places. The amount of space required by the volume of listing information precluded their use in many cities. Daily maintenance of listing changes consumed much time. As the volume of Information calls increased, thereby necessitating more operators, additional sets of records had to be provided and maintained.

UNDER the frequently reprinted directory arrangement, new directories for the various cities are usually printed every two weeks—although the interval may vary somewhat, depending on local conditions. While a printed cumulative daily addendum is provided under this plan, the addendum period is so shortened that it is practicable for operators to consult the main Information directory first on almost all calls, with reference to the second record—the addendum—on only a few calls.

It is interesting to note that, in cities formerly using book records, the additional cost of the frequently reprinted directories usually has been

A LISTING SLUG

On the upper edge may be seen the type characters, which are raised and in reverse

more than offset by savings in operating cost. This is attributable to the shorter work time per call, which results from the higher proportion of calls requiring only one record reference. The increased speed of handling calls has made it possible in some cities to defer for some time the provision of additional Information positions and records. Also, the compactness of the new records has facilitated the design of improved desk positions more conveniently arranged and requiring less floor space.

In addition to the faster Information service made possible by the new records, better service has resulted from the increased accuracy of the new records.

The favorable experience from the service standpoint with frequently reprinted directories as information records, and the reasonable over-all cost, have resulted in the extension of the plan to practically all of the larger and a number of the medium-sized cities in the Bell System. Information records for these cities naturally present considerably more of a problem than in the smaller places because of the amount of listing information required, the larger number of operators to be provided with records, and the volume of listing changes.

Printing Problems

BEFORE describing the various steps in the development of present-day production methods for frequently reprinted directories, it might be helpful to outline briefly the printing methods generally used for the large-city directories distributed to customers.

Customers' listings are set on typesetting machines which have keyboards somewhat similar to a type-writer keyboard. As the keys corresponding to the type characters in the listing are depressed, individual type molds, called matrices, form a mold for the entire listing, into which hot metal pours. The product of this operation is a bar of metal with raised type characters on its printing edge, called a listing slug. Listing slugs are more easily handled than single type, and errors resulting from the dropping out of single characters are entirely prevented.

The type for each directory, in the form of listing slugs, is kept standing from issue to issue, revisions being made by inserting new slugs in proper position for new and changed listings and removing the slugs for discontinued listings. Before printing, the slugs are assembled in pages as they are to appear in the new directory. The directories are printed on high-speed rotary presses similar to those used in printing large-edition newspapers. As a necessary part of printing operations of this kind involving large press-runs, plate reproductions of the type pages are made which are curved to fit on the cylinders of the press, so that the printing is done from the plates rather than the type.

Some idea of the size of the printing job presented in producing frequently reprinted directories is indicated by the fact that the largest directory handled on this basis contains almost 800,000 listings, comprising about 1300 pages. In most cases the printing schedules for these directories provide for complete reprinting within two or three days, generally over a week-end. While the number of copies required for Information purposes is, of course, relatively small compared with the number of customer directories printed, each reprint requires type changes in practically all pages, making necessary a complete printing operation for the entire directory.

Two Sizes of Books

In the early study given to the page and column arrangements of frequently reprinted directories, it was recognized that the page size of the regular directory was not a controlling factor in determining the most suitable page size for the Information record. Accordingly, a five-column page make-up was adopted where the customer directory was on the four-column arrangement, as in most of the large cities, and a four-column make-up was used where the customer directory was on a three-column basis. This resulted in a larger page size for the Information directory, but reduced the number of pages considerably, with resultant savings in printing expense and increased printing speed. From the standpoint of ease of use as Information records, the larger page size is considered more desirable, as the resulting smaller number of pages facilitates reference.

In the preliminary consideration given to methods of printing Information directories, it was obvious that the production speed required made it essential that these directories be printed directly from type, eliminating the intermediate step of plate making. Consideration was given to the possibility of printing the alphabetical Information directory from the same set of type used for the customer directory. Tests indicated, however, that the frequency of handling and

TYPE-SETTING MACHINES

The intricate mechanisms in this group, which set customers' individual listings, are equipped to cast hard-metal listing slugs

normal wear in printing would impair the clarity of the type when used for making plates for printing the customer directory. Accordingly, the plan adopted for the first alphabetical Information directories provided for the use of an additional set of listing slugs, which was maintained independently of the type used for the regular customer directory. This arrangement, while considered satisfactory at the time, required considerable duplication of operations on the part of the telephone company in maintaining printer's listing copy, and on the part of the printer in setting up and handling two complete sets of listing slugs.

Development of Hard Metal Type

IN the original consideration of the problem, it had been recognized that the use of one set of listing slugs for both the Information directory and the regular directory would be an economy and would speed up the production of the regular directory, since the type would be kept up to date for Information record purposes. The problem here, however, was that regular type metal is relatively soft and, as previously mentioned, would be subject to considerable wear if used for printing Information records. Ordinary type metal used for listing slugs is about 85 per cent lead, 11 per cent antimony, and 4 per cent tin,

LOCKING UP

These eight pages of listing slugs are being made up in four-column pages for the production of an Information directory for use in a city where the customer book is three columns wide.

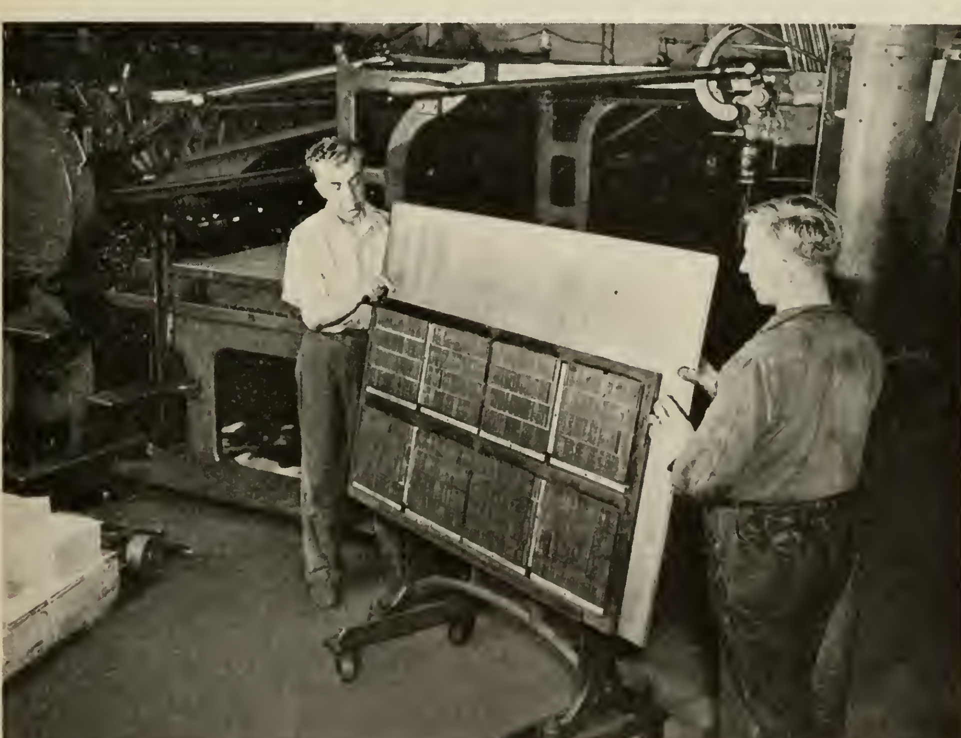
and tends to scratch and show other imperfections when handled frequently.

The idea was advanced that the use of a harder metal in the casting of listing slugs might permit using one set of type for all alphabetical records without impairing the clarity of the type. Experiments were made with a number of metals available commercially, but it was several years before a suitable metal alloy of the required hardness and other essential characteristics was developed. In the metal alloy finally adopted, the lead content was materially reduced, the amount of tin and antimony increased, and very small quantities of copper and cadmium added.

THE use of one set of type for printing both the regular customer directory and the alphabetical Information directory made it desirable that both directories be handled by the same printer, in order to avoid divided responsibility for the printing job. Also, in order to obtain the full benefit of the plan, it was highly desirable that the same printer handle the daily addendum, which would be printed from the same type as the other alphabetical records. Distance between the directory office of the telephone company and the regular directory printer made it impracticable for some companies to forward copy for the daily addendum by messenger. Accordingly, in order to insure the printing savings and other advantages of using one set of type for all alphabetical records, arrangements were made for transmitting copy to the printer by teletypewriter.

In addition to being faster than messenger service, use of the teletypewriter made it feasible to forward copy several times a day, with resulting improvement in the flow of work to the printer. This latter advantage is important, particularly at periods of peak service-order activity, since the printing of the daily addendum for cities located several hundred miles away is a carefully timed night-shift operation with a definite dead-line. To assure delivery of the addendum before eight o'clock the following morning, arrangements are made for special mail or express handling on a night train arriving at the distant city at an early hour and for regularly scheduled pick-up and delivery to the Information center.

One set of hard metal type used for the daily addendum, the alphabetical Information directory, and the regular customer directory, is now recognized as the most efficient plan where the Information records and the regular directory can be handled by the same printer. Under this arrangement, the listing slugs set up originally for the daily addendum are transferred to the standing type for the Information directory when a new issue of the latter record is to be printed. The Information directory in most cases is printed over a week-end, since the accumulated type for



READY FOR THE PRESS

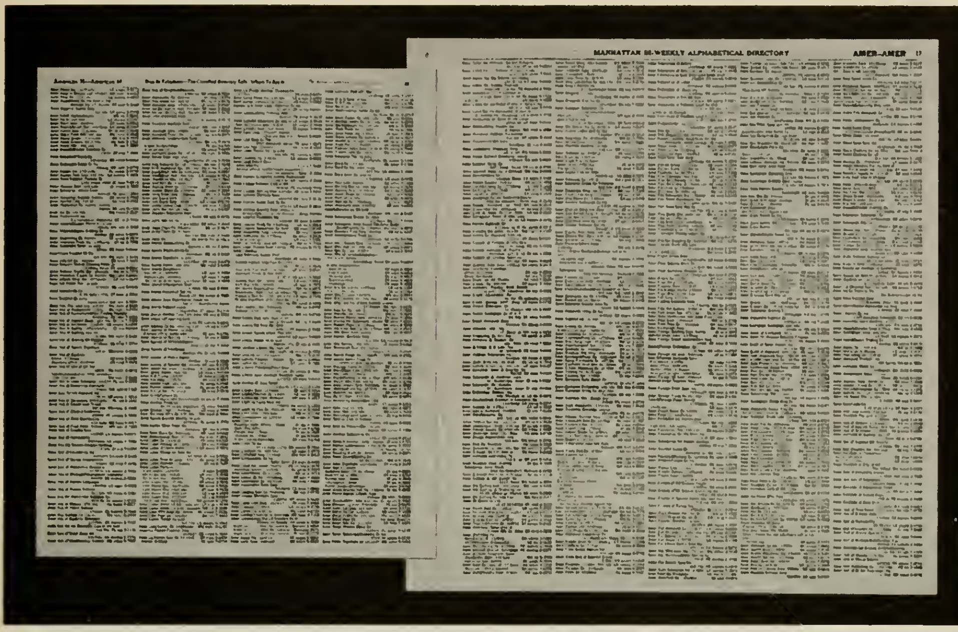
The rolling table tilts to a horizontal position at the exact height of the press bed, minimizing the lifting of the type form the daily addendum ordinarily can be used during that period without interfering with the production of the daily addendum. In printing the regular customer directory, the standing type for the Information directory is reformed into standard-size pages preliminary to making the plates from which the directory is printed. After the regular directory has been printed, the type is again arranged in Information directory page style and is ready for the next issue of that directory.

Mechanical Improvements

There is, of course, considerably more handling of the standing type in the printing of Information directories than in the case of regular directories. In connection with each reprint the type must be removed from storage racks, listing slugs added and removed, the type pages locked up and placed on the press, and the type finally moved back to the storage racks. Type is heavy—four pages weighing some 150 pounds—so that it is important to keep the amount of handling and lifting to a minimum. A number of interesting developments were introduced which considerably reduce the handling time. While the problems in the various printing plants naturally required individual solution because of differences in printing methods, plant lay-out, and storage facilities, operations generally were speeded up and efficiency improved by the use of specially designed type storage racks, type trays, metal frames for holding the type in page form, transfer tables mounted on rollers, and similar improvements.

The introduction of hard metal type has advantages for regular directory work as well as for the Information service. Since only one set of type is used, the telephone company maintains only one set of printer's listing copy. The company is able to make current checks on the accuracy of listings inserted in the Information records, as a result of proof-reading in the directory office and use of the records by Information operators, and to make any necessary corrections before the listings appear in the regular customer directory. While the number of such errors discovered is relatively small, due to the high standards of compilation and printing accuracy, the result of these checks has been to reduce the already low level of directory errors by as much as 25 per cent in some cases. Another advantage has been in a reduction in time, between the close of copy of the regular directory and delivery to customers, of a week or more for some directories—because the type is up to date at directory closing except for last-minute changes. With this reduction in directory production time, a customer receives a more up-to-date directory, and this tends to reduce the load at "Information" earlier than would otherwise be the case.

Although the frequently reprinted directory plan originally was restricted to the larger cities, developments in production methods have resulted in bringing the cost of the plan for medium sized cities down to a point where it has been adopted for a number of such cities. The principal difficulty here has been the relatively



CONTRASTING PAGES

The page at the left is from a customer directory, while at the right is one from the same city's alphabetical frequently-reprinted Information directory which illustrates the large amount of listing information shown on a single page of the latter

high cost of providing printed daily addenda for these cities and the fact that in many cases the distance to the regular directory printer makes it impractical to provide overnight printing and delivery of the addendum. Equipment has been developed recently, however, which makes it feasible for the telephone company to produce the daily addendum locally on multigraph equipment at a cost sufficiently low in many cases to warrant the introduction of frequently reprinted records.

THE use of frequently reprinted directories in providing the Information service is a development about which the telephone user will probably never hear. As this article has made evident, it is only one aspect—and a somewhat technical one, at that—of giving him a quick and courteous and accurate answer to the inquiry he makes of the Information operator. But to the user, that—and every—inquiry is important. And since upon the Bell System rests the acknowledged responsibility of furnishing its customers with the best telephone service possible, whatever contributes to a more satisfactory Information service makes a contribution also to the achievement of that ideal.

ACROSS THE ROOF OF THE CONTINENT

A New Line Through the Rocky Mountains, Built to Unusually Exacting Specifications, Replaces What Was for 41 Years the Highest Regular Telephone Toll Line in the World

By STUART SHAW

THE highest regular telephone toll line in the world no longer crosses Argentine Pass, in the Rocky Mountains of Colorado, where for more than 40 years it has withstood the snows and winds a-top the Continental Divide. That line has recently been dismantled, and the altitudinous distinction apparently belongs now to a line which crosses the Andes of South America. But the old line crossing the Rockies has been superseded by a new one built last year over Loveland Pass at a somewhat lesser height.

The story of the two lines, the old and the new, is worth telling, for both are unusual construction projects; and together they write one more chapter in the tale of providing telephone service for people wherever they may be—in busy cities, on level prairies, or in the canyons and on the rocky slopes of great mountains.

The routes of early-day long distance telephone lines across the Rocky Mountains often were dictated by the location of mining camps, for it was there that the need for service lay. It was for this reason that in 1899–1900 a regular long distance line was constructed over Argentine Pass, crossing the Continental Divide in central Colorado at an altitude of 13,300 feet above sea level. This is very high—even in a state that includes within its borders 49 of the total of 64 peaks in the United States 14,000 feet or more in height.

There were many lower passes than the Argentine. Why should a telephone line have been built over this inhospitable crest, where storm and wind conditions rivaled those of the Arctic?

The answer lies in the fact that some of the richest silver mining country in the world lay along the lower reaches of both sides of the pass. Mines and mills, employing a large number of men, clung to the hillsides, and the water courses were dotted with busy camps now almost forgotten. Those interests could be served on the same pole line that carried other circuits.

And so it was that the Argentine Pass line of The Mountain States Telephone and Telegraph Company came into being. At the time it was

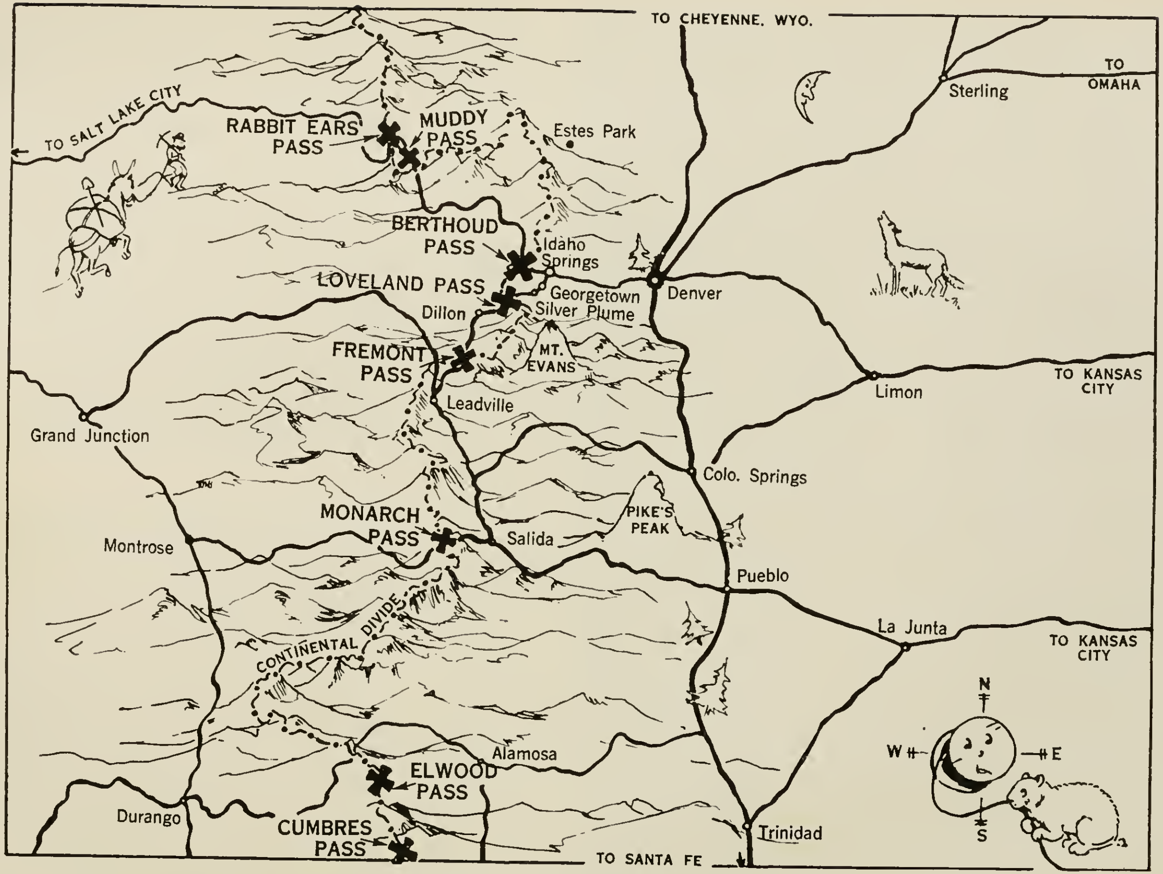
NO LONGER THE HIGHEST

These were the top fixtures of the telephone line over Argentine Pass, elevation 13,300 feet—the highest regular toll line in the world. With the construction of the line over Loveland Pass, at a lower elevation, this line was superseded, and was dismantled last year

removed from service, in the summer of 1941, it was, as far as available records show, the highest regular toll line in the world. There were single telephones at higher altitudes—as, for instance, the telephone on the summit of Pike's Peak at more than 14,000 feet—but no regular toll line connecting telephone exchanges.

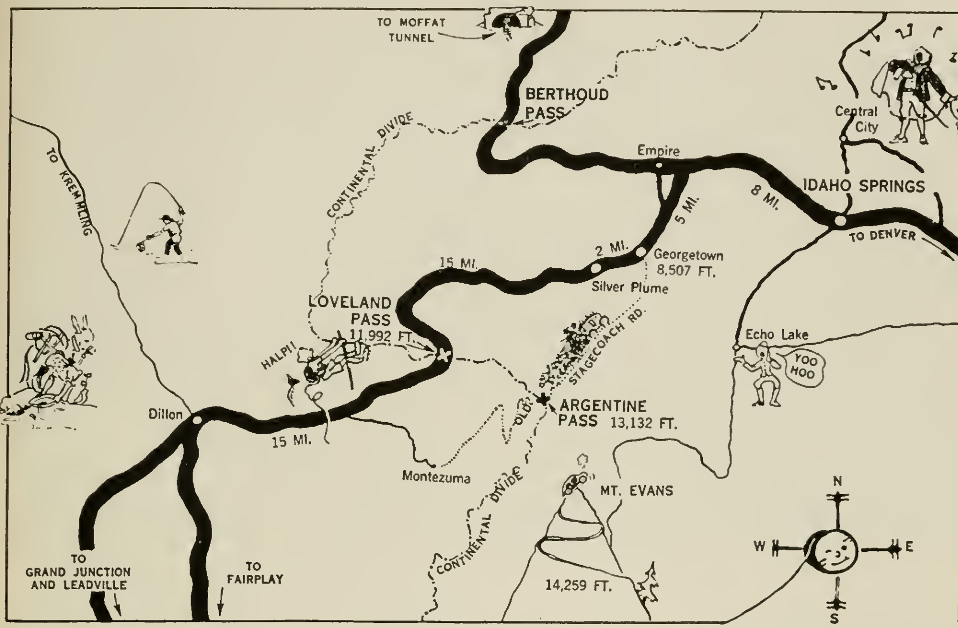
Construction of this line, connecting Denver, Central City, Idaho Springs, and Georgetown with the booming Western Slope camp of Leadville was a staggering job for both man and beast. When the high altitudes were reached, a base camp was established at timberline, with a large crew working toward the top. All materials had to be maneuvered to the summit by men and horses. Simply getting to and from work each day often meant an arduous climb of several thousand feet in the thin and brittle air of this altitude.

It had been planned to lay submarine cable in a shallow trench over the top section as a protection to the service against the vicious storms that swirled over the crest. But the snows came early in 1899, and the cable had not arrived, so a crew under Murray MacNeill, present plant extensions engineer of the Mountain States Telephone and Telegraph Company, laid insulated wire over the snow for use during that first winter. The wire



EIGHT CROSSINGS OF THE CONTINENTAL DIVIDE

This sketch-map of the State of Colorado shows the passes over which telephone lines cross the Rockies. Only important roads and towns—and local color—are included



WHERE THE NEW LINE CROSSES

This drawing includes only the area in the general vicinity of Loveland Pass and Argentine Pass. Elevations shown are for the roads, which are somewhat lower than the telephone lines

was broken on a number of occasions by snowslides and had to be repaired.

The submarine cable was laid the following summer. It served well, except that it was subject to damage from slide rock, and the mountain rats (called conies) had a taste for the jute covering of the cable. Frequent repairs were necessary. The line was extended to Grand Junction soon after 1900, and became an important route serving Western Slope points.

MAINTAINING this line always has been difficult, however, and even hazardous. Argentine Pass can be reached only by a historic old stage road that connected the mining camps of Georgetown and Leadville in the 70's. It was too steep for anything but horse or foot travel, even during the summer months. And throughout the long winter a trip on snowshoes or skis was the only answer to a case of trouble on this route.

The line was rebuilt in 1917, with open wire construction of the heaviest type yet seen in the section over the top. This proved satisfactory from a strength standpoint, and the line was in service continuously until the summer of 1941. From a transmission standpoint, however, this line had become increasingly unsatisfactory.

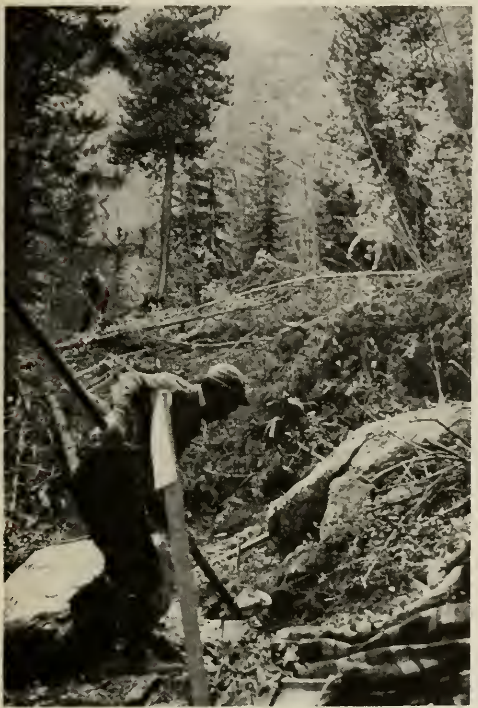
The conductors over the top section were steel messenger strand, to provide the needed strength. In recent years a high-tension power line had closely paralleled the telephone line over a large part of the route—another objectionable factor. Further-

IT'S A LONG WAY UP

A load of telephone poles at the summit of Loveland Pass. The new line is at the left—and higher

AERIAL TRAMWAY

Poles are being carried up a rocky mountainside above Silver Plume by means of winch lines operating from the telephone trucks in the right background. The tracks seen in the picture are for ore cars of the mine which is the location of this operation



HOLE FOR A POLE

Digging pole holes was a tough job; most of them had to be dynamited. Clearing right-of-way is progressing in the background

more, most of the poles had been in service nearly 25 years and would soon have to be very largely replaced. As a matter of immediate necessity, some of the steel strand across the top had been replaced with stranded copper about two years ago, but the greater part of the steel remained.

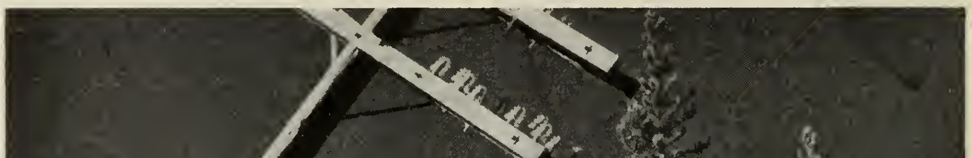
ALTHOUGH there still is a certain amount of silver production in the Argentine area, today many of the properties are but ghostly reminders of a past that was glorious—at least while it lasted. Obviously, the conditions under which the Argentine Pass line was built have changed considerably. What is more, the horseless carriage has come to stay—and with it a new conception of roads and transportation.

When the state of Colorado determined to build a broad, hard-surfaced highway over Loveland Pass, between Georgetown and Leadville, it became evident that this would be a far more satisfactory route for the Denver-Grand Junction toll line. Loveland Pass is about six miles north of Argentine Pass, with a gigantic mass of serrated peaks lying between, a number over 14,000 feet. It is a somewhat lower pass—12,000 feet, as compared to more than 13,000 for Argentine. The new highway would be a principal route between Denver and Western Slope points, and would

SNAKING A POLE TO ITS LOCATION

So steep and rough was the going here that horses found difficulty in staying on their feet

ATTACHING CROSS-ARMS
A drive screw is hammered home in a setting of scenic splendor



IN TIMBER WEST OF LOVELAND PASS
Snubbing rope and pole gin are typical of the precautions which resulted in a perfect safety record for the entire project

Grandstand View
Construction of an H-fixture on the crest of Loveland Pass

Construction near the Summit

The crew is preparing to string the stranded copper conductors. Note the heavy construction and guying shown on the H-fixture in the center of this picture be kept open all winter with powerful snowplows. Maintenance of the telephone line could be effected with comparative ease, for it need never be more than a few hundred yards from the road. Construction, too, would be simplified.

The decision was reached early in 1940 to build a 19-mile reroute of the line over Loveland Pass, and the highest toll line in the world was to be no more. Our information indicates that the distinction now goes to South America where a line crosses the Andes at 12,600 feet. But the Loveland Pass line remains the highest in North America.

Laying Out the Line

STUDIES of snow conditions on Loveland and other passes had been made over a period of years. The engineers sharpened their pencils to design facilities in the light of more than fifty years of experience in mountain construction. Much detailed engineering work preceded actual construction of this new section of line. Special facilities were required, to produce needed strength characteristics. A half mile section of the line across the top of the pass was designed to withstand a 70- to 75-mile-an-hour wind coupled with ice coating on the wires averaging four inches in diameter!

Two survey parties started out as early in 1940 as snow conditions would permit, working up from each side toward the top of the pass, laying out the line and specifying pole locations, sizes and so forth. The new line was to leave the old at Georgetown and rejoin it on the other side of the pass, near Dillon.

It is a fascinating country, both scenically and historically. At numerous points the route of the new line crosses the clearly discernible track of an old stage road, one that supplanted the Argentine Pass route in 1879 and set a new high in transportation at that time. Passengers in those days made the trip in a Concord stagecoach, covering the distance between Georgetown and Leadville from dawn to dark! Today it takes less than two hours.

As soon as the project was approved, orders for material were placed with the Western Electric Company. Much of this material was of a decidedly special nature.

In the meantime, ground crews started clearing the right of way and digging the pole holes. This was laborious hand work. To understand why, one need only visualize a condition, not of rocky ground, but of rocks with a little dirt between them. Even if it had been possible to get motor driven digging equipment to the right of way—which it generally was not—it could not have been used because of the character of the ground. Few holes were dug without the use of dynamite.

A RIGHT-OF-WAY had to be obtained and clearance provided for ten feet on each side of the center of the line. Except for the top section, practically the entire 19 miles had to be cleared, for the route lay through wooded country, a tangle of aspen and spruce, with a few sections of heavy timber. Coöperating with the Forest Service, much good timber was saved by careful trimming. The brush was piled for burning as soon as a sufficient

A FINISHED SECTION OF THE LINE
Note that, contrary to usual practice, the pole line is not straight—thereby avoiding low ground where the snow may drift 20 to 30 feet deep in winter

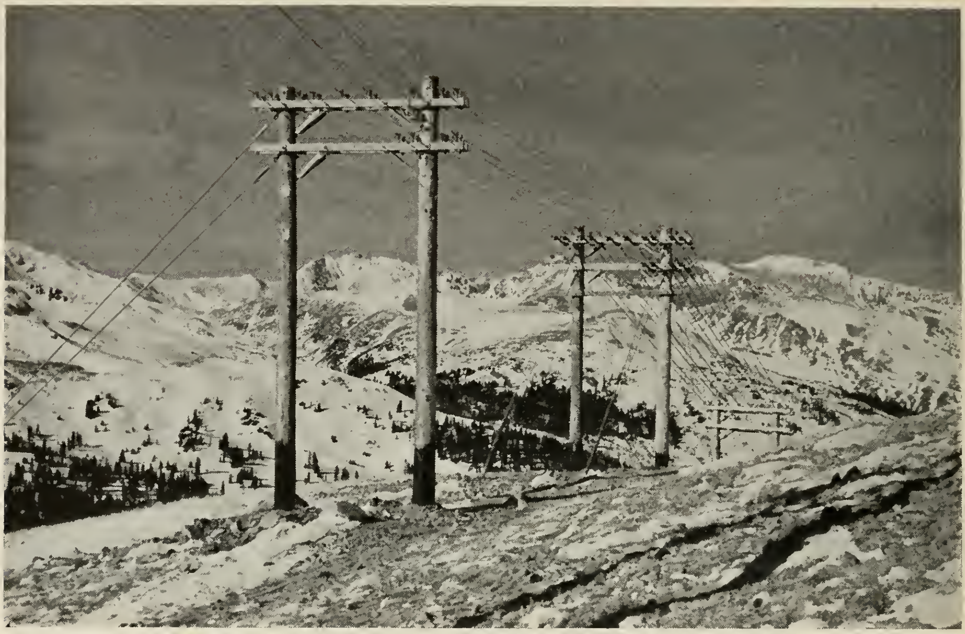
snowfall laid a protective blanket of moisture over the surrounding forest.

In general, full length treated lodgepole pine poles, native to the mountain territory, were used in building the line. The railroad was utilized from Denver as far as its terminus at Idaho Springs, but this was still 25 miles from the top of the pass and more than 4,000 feet lower in altitude. The poles and other material were hauled by truck from this point to various locations along the road near the right of way. From the road, all the material had to be either carried by the men or snaked with horses to the point where it was to be used in the line.

The poles varied between 25 and 40 feet in length, depending on the requirements of a particular location. In unloading, care had to be exercised to drop off poles of the proper length in the right locations.

There was nothing unusual about the framing and setting of the poles in the lower sections except, perhaps, that in numerous places the right of way was so steep that a crew moving from one pole location to another might climb or descend a hundred feet.

ON the Eastern Slope, just above the old mining camp of Silver Plume, the line lay across the face of rocky cliffs where even horses could not drag the poles into position. At several successive locations along these cliffs a pulley block was attached either to a large tree or to an outcropping of solid rock, about 400 feet above the road, and the winch line from the power-driven winch on the



AT THE SUMMIT

This is the line as it crosses the crest of Loveland Pass—altitude slightly more than 12,000 feet. Well illustrated is the unusually sturdy construction which is necessary to withstand the snows and gales of mountain winters

construction truck was passed through it. The resulting aerial tram was capable of transporting safely a load of some twelve or fifteen hundred pounds in the form of poles or crossarms.

Unusual Construction Features

STRENGTH is the outstanding characteristic of the two-pole H-fixture type of construction used exclusively in the half-mile section across the top of the Pass.

The poles used in the H-fixtures have approximately twice the strength of poles ordinarily used on such a line at lower altitudes. The span length is approximately 80 feet, instead of the usual 130 to 160 feet. The line is sectionalized in 300- to 400-foot sections by having the line wires dead-ended in both directions on separate crossarms, a short jumper wire being used to connect the dead-ended points of each individual line wire. This is done so that a possible failure of one section would not necessarily bring down adjoining sections.

The H-fixture pole construction at each end of the sectionalized pieces of the line is guyed at right angles to the line and also in the direction of the line with 10,000 and 16,000 pound steel strand. Intermediate side anchors are provided throughout the various sections.

Special insulators, crossarm braces, and transposition brackets are provided. It is estimated that the pole structure has about eight times normal strength. The line wires in this top section are composed of No. 1 stranded hard drawn copper wire, with a breaking strength of 3,800 pounds. This represents about five times the strength of the ordinary 128 hard drawn copper wire.

THUS a new crossing of the Continental Divide took its place in the system of the Mountain States Telephone and Telegraph Company. It is one of eight such crossings in Colorado alone. The seven Rocky Mountain states served by the Company comprise a far flung and rugged territory that is 24 per cent of the area of the United States and includes but 3 per cent of the population. A main range of mountains divides it all the way from the Canadian border to Mexico and presents problems of telephone construction and maintenance seen nowhere else on a comparable scale in the Bell System.

BILLS FOR 13,000,000 CUSTOMERS

Charging for a Hundred Million Items Each Month Is an Extremely Complex Operation Requiring Modern Methods and Machines to Achieve Accuracy, Promptness, and Clarity

By F. RAYMOND BREWSTER

EVERYONE who operates a business on a credit basis knows the importance of accuracy and promptness in the rendering of periodic statements to his customers. Whether it be a neighborhood store or a large business, there is extra responsibility at "billing time." Every business man who strives to give good service is naturally anxious to avoid those irritating and time-consuming incidents known as errors. The Bell System, with more than 13,000,000 customers, whose services require the billing of more than 100,000,000 items each month, obviously has a problem of extraordinary complexity. These items consist mainly of charges for the installation of or change in service, and for local service and out-of-town calls. At every step along the line, from the several sources of origin of these millions of transactions to their reflection on the bills, there are numerous opportunities for mistakes.

That the System has arrived at an average of only 3.8 errors affecting the amount of the charge or credit for every 1,000 bills rendered indicates that it has approached the problem with care and thoroughness, since this average includes errors irrespective of where they originate: whether made in writing a toll charge ticket; in writing service orders and reporting the work done on the orders; in recording, computing, and accounting for service charges; in reporting and applying payments; or to any other of the many phases of operation and accounting in which errors may affect the amount of the bill.

It is not the purpose of this story to deal primarily with errors, but since the accuracy of the bills and the promptness with which they are rendered are the two most important bases for measuring the character of the job performed by all departments, in so far as their activities are reflected on the bills, it is helpful to know at the outset what sort of result is achieved.

Customers are mainly interested in receiving accurate bills. Probably not so many are particularly interested in receiving bills promptly. There is, none the less, a mutual advantage to the customer and to the telephone company in prompt billing. To the

IN AN OPERATING COMPANY'S REVENUE ACCOUNTING DEPARTMENT
Various clerical operations in connection with the preparation of tickets for billing customers' toll service are being carried on by the group of girls shown here

customer, the prompt receipt of the bill enables him more readily to check the items billed, because they are current, while regularity in the receipt of the bill leads him to expect it on a given date and assists him in planning to meet it. To the company, the principal advantage is that regularity in the delivery of bills to customers results in regularity in the pattern of payments, so that the receipts and disbursements of cash can be coordinated to fit the pattern, thereby permitting an efficient management of funds.

SOME further idea of the magnitude of the task of the Bell System in preparing telephone bills may be gained by simply stating a few facts. The bills now cover the monthly fixed charges for 19,000,000 telephones. During the year 1941 there was an increase in the System of about 1,360,000 telephones; but to produce this net increase, nearly 5,500,000 telephones were connected and more than 4,100,000 were disconnected. This movement of telephones in and out requires a vast amount of clerical work.

In the Accounting Department, each connection or disconnection requires the establishment of a new customer's account or the closing out of an account or a change in the address or in the monthly fixed charge for an existing account—all of which usually requires the computation of a fractional monthly charge during the month in which the telephone was connected or disconnected.

Each of the 13,000,000 bills issued carries the regular recurring monthly charge for service. This is the amount which the customer generally has in mind as the charge for his service and, on the average, about half of the Bell System's customers have no other charges. However, about half the bills include charges for toll messages and for telegrams telephoned to telegraph offices for sending. The total number of such items is now averaging about 70,000,000 monthly. Other types of charges appearing on telephone bills include those for local messages in excess of a stipulated number per month when the service is on a measured basis; those for advertising in telephone directories; and adjustments due to changes in service or equipment involving revisions in rate, or to moves into areas having a different billing date.

New Taxes Present Problems

THE Revenue Act of 1941, signed by the President on September 20, 1941, introduced a number of new problems in billing and accounting for the Federal taxes on telephone service. Prior to the enactment of this law, a Federal tax was imposed only on telephone messages of 50 cents or more and only at three rates (10 cents, 15 cents, or 20 cents), which could easily be memorized by the clerks affected; on telegrams at 5 per cent, cable and radio dispatches at 10 cents each; and on leased wires, including teletypewriter exchange service, at 5 per cent. Under the new law, the tax is imposed at the rate of five cents for each 50 cents of charge or fraction for telephone messages of 25 cents and over and at 6 per cent for messages of less than 25 cents, as well as 6 per cent on local service charges; also on teletypewriter exchange service, telegrams and leased wires at 10 per cent.

The introduction of a tax schedule at different percentage rates for different services, and also at a sliding scale which produces tax charges of amounts much more diverse than the three charges previously in effect, caused some difficult problems in setting up billing procedures. It also resulted in an increase in the billing and accounting work due to the substantial increase in the number of entries of tax charges on toll tickets and bills. In addition to the Federal tax, city and state taxes must also be billed where applicable. The billing of these varied tax charges not only involves a considerable amount of work, but seriously increases the possibility of error.

The billing and accounting problems raised by the provisions for taxing telephone service under the Revenue Bill of 1941 will serve to illustrate the accounting methods service rendered to the Associated Companies of the Bell System by the centralized staff of the American Telephone and Telegraph Company. This problem, like many other activities, required close coördination of the Methods Staff of the A. T. & T. Comptroller's Department with others, in this case especially the staff of the Commercial Engineer and the General Tax Attorney. It was necessary to keep closely informed on the progress of the legislation through Congress in order to keep the methods problem abreast of the law and to develop uniform interpretations for the guidance of the field. In this case, a centralized staff made it unnecessary for each Associated Company separately to perform these services for itself. It also relieved the Internal Revenue Bureau at Washington of a multiplicity of in-

SORTING TOLL TICKETS BY TELEPHONE NUMBER

The 100-pocket racks are numbered from 0 to 99. By sorting by the last two digits of the telephone number, and then reversing the pile and sorting by the first two digits, toll tickets can be quickly arranged in the numerical order of the telephones in a given central office

quiries on questions common to all the companies.

The probability that there would be new tax problems to meet became apparent in the Spring of 1941, when the United States Treasury Department tax proposals were first mentioned and a subcommittee of the Ways and Means Committee of the House of Representatives began to consider tax legislation. It soon became evident that some form of tax on telephone service other than the one then applicable probably would be written into the new law. Each of the several proposals made was considered, and tentative plans were sketched for meeting the problems peculiar to each proposal.

Much of the billing and accounting work requires the use of office machines, some of which are of special construction. In view of the growing delays in the delivery of such equipment, the first definite action was to suggest to the Associated Companies that they place orders at once for any necessary additional mechanical equipment, and also that they consider engaging additional clerical employees who could be partially trained by the time the added tax work became a reality. They were also advised regarding certain changes that might be necessary in some of the machines in order to meet the billing requirements under the new tax bill. The Western Electric Company was also consulted regarding provision for an adequate supply of paper which would be required for a large quantity of new toll service statements.

In July, 1941, the general basis of the new taxes was sufficiently clear to enable the staff to give the Associated Companies some preliminary information, although the specific rates of tax and the probable effective date were not known. By the end of August, the terms of the new tax bill had been reasonably settled, although not with sufficient certainty to permit of starting the chain of operations that would be required in connection with revising the billing records.

AFTER the revenue bill had passed the House and the Senate and the several amendments had been agreed to by the conference committee and lacked only the President's signature to become a law, it was considered safe to go ahead. The entire procedure had been closely followed by the Methods Staff, and constant contact had been maintained with the field, so that when the signal to proceed with the preliminary work of revising the billing records for 13,000,000 customers was given, the job got under way with little delay. The alteration of billing machines, designing and procurement of new electrotypes for the machines which print and address the bill forms, and the work of printing an initial supply of some 20,000,000 new toll service statements and other new forms was started at full speed when the bill was finally passed.

The President signed the bill on September 20; but on September 19 seventeen pages of text and twenty-two exhibits, prepared in coöperation

PREPARATION OF TOLL STATEMENTS

After individual toll tickets have been arranged in telephone-number order, the items, charges, and taxes are listed on the toll statements which accompany subscribers' bills. About seventy million such items are listed each month at the billing centers of Bell System operating companies with the Commercial Engineer's staff, were mailed to the Associated Companies, outlining the new procedures to be followed in the preparation of customers' bills.

Rotation Billing

THE actual preparation and issuance of telephone bills is carried on by the Associated Companies of the Bell System, since it is they, of course, which provide the services for which the bills are rendered. Each company has one or more billing centers where the bills are prepared. These billing centers are known as revenue accounting offices, and are part of the Accounting Departments of the several companies.

The basic material from which the bills are prepared, such as service orders, toll tickets, etc., is received in the revenue accounting office daily from all the exchanges for which it handles the billing. It has been found most economical to centralize the preparation of bills for an entire company or state or for a large group of exchanges. This centralization provides the most efficient organization of the billing work and permits the economical use of high-capacity office machines.

Bills are issued on a "rotation billing" basis. Under this plan, the accounts of a revenue accounting office are divided into groups (usually six or ten) by exchanges or central offices, and a fixed calendar date is assigned to each group. Bills are released upon completion, with an objective of not more than six business days after date. In the first part of 1941, this objective was 95 per cent achieved. The specific release dates of bills payable at each business office are forecast at least one month in advance, so that provision can be made for the personnel requirement for the business office peak periods. Rotation billing, by distributing the total work throughout the month, makes possible the listing of all the toll service and telegram charges for the entire monthly period for each customer in a single handling, and also permits the use of toll service statements printed and perforated on a continuous roll of paper.

FOR PREPARING TOLL STATEMENTS
Such typewriters, equipped for their particular function, have capital letters only, automatic paper-handling device, counter for totaling the number of items listed, and electric carriage return

THE adoption of rotation billing makes possible the economical application of billing machines to the preparation of customers' bills, and a total of 450 such machines is now being used by all Associated Companies. These billing machines embody features not previously available in such machines, and as a result of the work of the Methods Division in coöperation with the manufacturer, they have become standard features

A Billing Machine

In the rack may be seen the data from which customers' bills are prepared. Above them is the numerical keyboard, while the oblong keys at the right are the line finders which automatically move the bill form to the printed line corresponding with the charge about to be listed

of this type of machine and made available to all who have use for them.

One of the important improvements embodied in such machines for the first time is the automatic line finder. In the type of billing machine previously used, the operator was required manually to turn the platen of the machine to the proper line for the entry of any charge other than that appearing on the first line of the bill. This not only required time, but what is more important, it was subject to inaccuracies which could be detected only by means of a visual line-by-line comparison of the completed bills with the posting media.

In the operation of the machine, the bill form is inserted and aligned against a stop on the feed table below the keyboard. The amounts of the monthly service charge and the related Federal tax, as shown by the card record of the customer's service, are set up by depressing the proper keys. The depression of the control key for the first writing line automatically injects the bill form into the machine, imprints the amount of the tax and the monthly service charge, including the tax, on the first line of the bill form and its three stubs simultaneously, stores the amount in an accumulating register for that line, and also adds the amount in a register known as a "crossfooter" which accumulates the total amounts entered on a given bill.

The other charges to be shown on the same bill may be entered in any sequence and will be printed on the proper line of the bill and stubs by the depression of the control key associated with that line. There are usually six lines on the bill forms, and the machines have control keys for each line. Since the bill form cannot be seen by the operator during the process of its preparation, a "window" is provided in the machine case at the right-hand side below the keys, through which the operator may see the amount and the classification of the last item entered on the bill. Credit amounts are imprinted on the bills in red and are automatically subtracted from the bill total.

When the last item to be shown on

A BILLING MACHINE IN USE

The operator is inserting a bill form in the throat of the machine, where it automatically moves up to receive charges for the various services in proper order. When the "total" key is punched, that final figure is printed and the completed bill is ejected into a rack located below the operator's left hand. Bills for the Bell System's thirteen million customers include more than a hundred million items each month

the bill form has been entered, a "Total Bill" key is depressed which automatically prints the total on the bill and stubs, stores it in an accumulating register, clears the "crossfooter" ready for the next bill, and ejects and stacks the bill in a tray below the feeding table. The operation of the machines may appear to be complicated in description, but because of their automatic features, they are simple to operate and produce bills which are neat and accurate and for which the charges are proved against "control" totals before the bills are released to customers.

Double-Checking for Accuracy

THE proof of the accuracy of work is stressed at every step throughout the process of preparing bills, and if it is not secured as a by-product of some operation, it is given special attention to the extent warranted by the results being secured. The clerical and mechanical processes are planned so that, as much as possible, accuracy is effected automatically or mechanically, dependence on visual comparisons being avoided when possible.

A typical illustration of a "by-product" proof is the verification available through the comparison of predetermined "control" billing totals with those automatically accumulated in the machines as the preparation of the bills progresses. Bills are divided into groups of about 400, which constitute a "book" of a size convenient for regulating the flow of the work and for balancing. It is this balancing feature which has contributed largely to the greater degree of accuracy through the mechanical verification which it provides.

WHEN a "book" of bills has been completed, the accuracy of the billing is proved before the bills are released for mailing. The charges shown on posting media for the bills in the "book" are totaled prior to the machine billing operation, separate totals being secured for the monthly service charge, the additional local messages or message units, the toll service, the adjustments necessary because of changes in service, the directory advertising, and the balance due on previous bills, each of these having a separate line on the bill form and a separate accumulating register in the machine.

These so-called "control" totals are entered on a form for the related billing book, and at the end of the run of the "book" the form is inserted in the machine and the register totals are imprinted on the form alongside the respective control totals. On the average, the control totals and the register totals are found to be in agreement for more than 90 per cent of the "books." If differences are disclosed, they are located and any necessary corrections made on the bills and in the totals. In effecting an agreement between these totals, the proof has been established that not only are the bills in balance in the aggregate, but also that the charges have been properly classified and entered on the proper lines of the bill and in the right amounts. These "book" totals are subsequently summarized and become the basis for entries of accounts receivable and revenues on the general books of the company.

Machines are also used for printing and addressing bill forms at a single operation from a continuous roll of blank paper. These finished bill forms include not only the composition of the form with its three stubs but also four address imprints and a perforation. They are produced at the rate of 2000 an hour. One of the stubs remains attached to the bill mailed to the customer, and he sends or brings it to the business office when paying the bill. The second stub is forwarded to the business office for use in collection work, while the third stub remains in the Accounting Department and becomes the record of the company's current account with the customer.

Other types of special machines are used for a variety of purposes.

THROUGH constant study of both methods and machines, the work of preparing telephone bills is keeping pace with the many other improvements being made in the handling of our business, and one of the important factors considered in reaching conclusions is that of developing both methods and machine applications that will tend to a greater degree of accuracy and promptness in our billing service.

While accuracy and promptness are primary requisites, two further qualities are of importance to the success of the job as a whole: neatness and legibility of the bill forms, and ease of understanding of the various items—charges, credits, and adjustments—which comprise the total of the bill. The Methods staff of the A. T. & T. Comptroller's Department and the Commercial Engineer of the O. & E. Department have recently recommended to the Associated Companies revision of the bill forms to improve the typography, and the clarity and completeness of explanations, with corresponding improvement of the explanation of adjustments due to changes in service.

System-Wide Measurements

IT has always been the aim of the operating companies to furnish customers with a high grade of billing service, and various analyses have been made from time to time for the purpose of procuring quantitative information relative to the quality of such service; but these analyses have generally been confined to departmental studies, and have therefore reflected the limited viewpoint of departmental performance. Recognizing the importance of measuring the company over-all character of billing service in such a manner that corrective action could be applied where most needed, preliminary consideration was given by the American Company in 1936 to the development of a plan for System measurements.

This activity was carried forward jointly by the Methods Division of the Comptroller's Department and the Commercial Engineer's section of the Operation and Engineering Department of the A. T. and T. Company, with the result that a tentative plan with related reports was recommended and adopted throughout the System in March, 1937. As a result of experience in operating the plan, various modifications and changes were made until July, 1939, when the plan in its present form became effective. Under the plan, monthly reports prepared by the Associated Companies serve as a basis for System summaries compiled and issued by the American Company. Adoption of this measurement plan has helped the Associated Companies to accomplish material improvement in substantially all phases of billing service.

NOBODY likes to get bills: the pocketbook nerve is one of the average citizen's most sensitive spots. But since the rendering of telephone service requires money, and that in turn necessitates billing the users of the service, it is the accepted responsibility of the Accounting Departments throughout the System to present bills to customers which are correct, regular and up to date, business-like in appearance, and easy to understand. The constant effort to accomplish those aims has been the theme of this article. Moreover, in order that bills shall be as low as is consistent with the kind of telephone service which Americans are accustomed to and demand, the billing job, like all others, is done as efficiently and as economically as modern machines and modern methods make possible. To the achievement of "the most service, and the best . . ." which is the Bell System's avowed ideal, the billing function makes a definite contribution.

THE MOBILIZATION OF SCIENCE IN NATIONAL DEFENSE

*How the NDRC Guides the War Activities of Civilian Scientists Is Told by the Chairman of Its Transportation and Communication Division, Who Is also Chairman of Bell Laboratories **

By FRANK B. JEWETT

PROBABLY the most difficult hurdle every industry has had to get over, in the effective introduction of scientific research as a powerful tool in its operation, has been to realize that the most profitable research is that which is carried on with the least restraint imposed by current practice. Practice can be adapted to radically new ideas, but radical ideas rarely, if ever, evolve from mere improvements in current practice.

Research in military matters is no exception. War being a very ancient art, military men are, on the whole, extremely conservative as to new tools. Like doctors, long experience has made them cautious and with possibly a more than ordinary tendency to impose on a research project requirements of current practice which, in fact, hamper rather than help. Against this tendency is the fact that they are quick to adopt the radically new once its utility is demonstrated. War, more than any other of man's activities, puts a high premium on being in the lead.

As soon as war in Europe on a vast scale was seen to be imminent, the nations there commenced frantically to mobilize and organize their scientific and technical men and resources, and to establish effective liaison between them and the combat services. For more than a year after this movement was in full swing across the Atlantic, our aloofness from the struggle and our ardent desire to keep from being sucked into the tragic maelstrom operated to prevent any effective steps in the direction of mobilizing our vast scientific resources for total war.

The military services endeavored to strengthen their scientific branches and here and there enlisted the aid of civilian science. They were hampered by inadequate funds, by the pattern of years of a starved organization imposed by an anti-war philosophy, and by the fact that civilian sciences, both fundamental and applied, were built up on a basis of operation in a slow-moving peace economy. The latter had no machinery for marshaling its forces for war and, in

* Excerpts from an address before the winter meeting of the Institute of Radio Engineers, New York, January 12, 1942.

the main, it knew little of war's requirements and frequently preferred to follow the courses it understood and liked.

But about two years ago, it became apparent to a few individuals that the *laissez-faire* approach to the mobilization of science ought to be abandoned in favor of a more direct and forceful organizational approach. At that time there existed certain technical groups and associations which, on the one hand, called for strengthening, and on the other were of suggestive value in the search for a suitable organizational set-up. I have already remarked upon the scattered technical groups and laboratories within the Army and Navy which over the years had been doing commendable work, but had been given insufficient funds and encouragement. It was, of course, obvious that as the tension of the emergency increased, the responsibilities placed upon these technical groups would mount, with a resultant need to augment their personnel; but it was equally apparent that they could not be expected to carry the full load of scientific development and adaptation.

Civilian Scientists' Participation Prior to This War

CIVILIAN participation in one way or another in the solution of military problems has come to be taken for granted. It was first given official recognition in the United States when the National Academy of Sciences was incorporated, in 1863, by an Act of Congress. The charter of the Academy requires that whenever called upon by any department of the Government, it shall investigate, examine, experiment, and report upon any subject of science or art; the actual expenses of such investigations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government.

The Academy is, therefore, recognized as a continuing official adviser to the Federal Government, and it must attempt to answer such questions of a scientific or technical nature as are officially submitted to it by members of Government Departments. A permanent channel of communication was thus created; but power to initiate traffic over it resides with the Government, and no auxiliary machinery was created whereby the Academy or any other civilian agency might take the initiative in bringing before the Government matters of scientific importance.

LESS than a year prior to the entry of the United States into the first World War, a significant step was taken designed to facilitate the use of the channel of communication between Government and the National Academy. In 1916, the National Research Council was created by President Wilson, and a little later was to play a part in focussing civilian effort on the military problems then arising. The National Research Council was, and is today, a subsidiary of the National Academy of Sciences and, like the Academy, is largely an advisory body only and awaits the assignment of problems by one or another branch of the Government before it can go seriously to work. Moreover, the Council, like the Academy, is not in possession of free money, a corporate laboratory and other research facilities, and is, therefore, not well constituted to conduct research work on any extensive scale.

We turn our attention, therefore, to another agency contemporaneous with the National Research Council, which was created for the express purpose of establishing coöperative effort between military and civilian groups, and which was provided by Congress with funds necessary to create research facilities and to operate them when once created. This agency is the National Advisory Committee for Aeronautics, commonly known as the NACA.

The law which created the Committee provides that it shall "supervise and direct scientific study of the problems of flight, with a view to their practical solution," and also "direct and conduct research and experiment in aeronautics." The Committee is composed of fifteen members, including two representatives each of the War and Navy Departments. Throughout its more than twenty-five years of existence, the NACA has given ample testimony of the fruitfulness of coöperation between military and civilian groups, and, moreover, has provided a prototype as to an organizational arrangement for effecting such coöperative effort successfully.

When, some two years ago, the group to whom I have already referred became convinced that broader participation by civilian scientists in the whole military program was likely to be essential, they regarded the NACA as typifying the sort of organization they would like to see created. A plan was therefore drawn up envisaging a Committee composed in part of civilian scientists and in part of Army and Navy representatives. On the one hand, the Committee was charged with a broad study of the materials of warfare and, on the other, it would recommend and, if possible, initiate such research as was believed to be in the national interest.

Steps Leading to the NDRC

The NACA was created in 1915 by an Act of Congress. The somewhat duplicative plan just referred to was submitted to President Roosevelt about a year and a half ago for such action as he saw fit to take. The proposal appealed to him, and he decided to create the Committee by Executive Order.

This Order established the Committee as a division under the Office for Emergency Management, and conferred upon them power to take the initiative in many scientific matters which they believed to have military significance. It also directed the Committee to develop broad and coördinated plans for the conduct of scientific research in the defense program, in collaboration with the War and Navy Departments; to review existing scientific research programs formulated by these Departments, as well as other agencies of the Government; and advise them with respect to the relationship of their proposed activities to the total research program. Moreover—and this is especially important—the Order directed them to initiate and support scientific research on the mechanisms and devices of warfare, with the object of improving present ones and creating new ones.

The Order contemplated that the Committee would not operate in the field already assigned to NACA nor in the advisory field of the National Academy of Sciences and National Research Council.

PARENTHETICALLY, it might be noted that in this latter field the Academy and Council are currently engaged on advisory work for Government for which the out-of-pocket expenses alone are at the rate of much more than $1,000,000 a year. A recent count shows that the present personnel of Academy and Research Council advisory committees runs to about 225. These figures will give an idea of the vital part which these fact-finding groups are playing in the present emergency. But to be a little more specific, I might mention that one important committee of the National Academy is advising the Office of Production Management on the availability of strategic materials.

In order to formulate adequate rules for the utilization of materials of whatever sort, accurate knowledge as to their availability, as to new processes suggested for producing them, as to possible substitutes, and a thousand and one other basic questions must be answered. This can only be done by highly trained scientists and engineers. Only after they have answered can the urgent problems of proper utilization be handled. The Academy has assembled a group of the most distinguished men in the United States to give OPM this basic information.

Thus, in June, 1940, the National Defense Research Committee, more familiarly known as the NDRC, was born. It was constituted of eight members, two of these being high ranking men from the Army and Navy respectively, five more being civilians well known for their experience in organizing and directing both fundamental and applied scientific research, and, as an eighth member, the Commissioner of Patents.

The Field of the NDRC

THE Executive Order creating the NDRC omitted any reference to the biological sciences, and, in particular, to the medical sciences. However, during its first year of operation, experience accumulated to the effect that a broader program of attack would not only be useful but was, in reality, urgently demanded. This realization prompted a second approach to President Roosevelt, with the result that in June of last year he created two new functional groups.

One of these was the Committee on Medical Research, to explore its indicated territory in the same manner that the NDRC had been exploring the physical sciences. Then, over and above both the NDRC and the Committee on Medical Research, there was placed the Office of Scientific Research and Development, usually referred to as OSRD. This latter Office was placed in charge of Dr. Vannevar Bush, who until then had been Chairman of the NDRC. President Conant of Harvard was then made Chairman of the NDRC, and Dr. Newton Richards of the Medical School of the University of Pennsylvania was made Chairman of the CMR.

In order to insure complete coördination of civilian and military research and development, Dr. Bush, as Director of OSRD, was provided with an advisory council consisting of the Chairmen of NDRC, CMR, and NACA; the Coördinator of Naval Research and the Special Assistant to the Secretary of War performing a somewhat similar function in that service.

The Executive Orders creating these various committees naturally had to leave indeterminate the question of financial support. They are all subsidiary to the Office for Emergency Management and, like this Office, must look to Congress for the necessary operating appropriation. Thus far the appropriations, while not munificent, have been adequate. During its first year of existence the NDRC authorized research projects which totaled about ten million dollars. At the beginning of its second year, it was granted another ten millions and this was recently augmented by several millions more. To be more specific, the OSRD, during its first year of existence, will guide the expenditure of about twenty millions throughout the whole scientific field.

* * *

NDRC Departments

THE work of the NDRC is divided into four major departments: Division A, of which Professor R. C. Tolman of California Institute of Technology is Chairman, deals with armor, bombs and ordnance, in general; Professor Roger Adams of the University of Illinois heads Division B on chemistry; Division C deals with transportation and communication, and submarine warfare, and I am its Chairman (this Division operates the subsurface warfare laboratories); finally, Division D, which deals with instruments and numerous miscellaneous projects difficult to catalog, is headed by President Compton of Massachusetts Institute of Technology. . . .

To expedite discussions, surveys, and the general handling of the work, a further breakdown has been found desirable, the result being that each Division comprises several so-called Sections. Division B on chemistry, under Professor Adams, is divided into thirty-one Sections—which stands to date as a sort of record.

THE work of a Section is entrusted to a Section Chairman, who in turn calls to his aid certain individuals who become permanent members of his Sectional Committee and who are known technically as Members. Then there are others who may be asked to render advice and assistance from time to time, and hence are called Consultants. Members and Consultants are officially appointed by the Chairman of the NDRC and are designated only after official clearance by the Army and Navy Intelligence and the FBI. Full consideration is therefore given to the basic requirements of the military services as regards the confidential handling of their problems. . . .

Neither the five civilian members of the NDRC itself nor any of the Section Chairmen, Members, or Consultants are paid from public funds. Without exception, they are loaned to the

Government by their employing organizations and frequently the loan is complete, the work being so voluminous and detailed as to require a man's full time. Thus, when I tell you that about 500 of the leading scientists of the country are encompassed in the present NDRC organization, you will see that the Federal Government and even the forgotten taxpayer are getting a lot of valuable consulting talent free of charge.

* * *

The Magnitude of Effort

THE number of NDRC projects now approved and, for the most part, contracted out to universities and industrial research laboratories stands around 600, while the number of contracting institutions is over 100; and . . . the total value of the projects thus far determined upon is upwards of twenty million dollars. . . .

The question is frequently asked as to how many technical people have been drawn into the civilian defense effort which the NDRC directs. Obviously this is quite difficult to estimate, let alone to enumerate in detail. I have already mentioned that there are about 500 scientists in the NDRC organization serving as Members, Consultants, etc. It seems likely that somewhere between two and three thousand scientists are at work on defense projects as employees of contractors, with about an equal number of less highly skilled individuals assisting them as laboratory assistants, technicians, etc.

Then, if the situation which I know to exist at the Bell Telephone Laboratories is to be taken as a criterion, we must add to this scientific group another very considerable array of technical people who call themselves engineers, as opposed to physicists and chemists—an array which, if enumerated, would no doubt total four to five thousand.

Recent figures from the Bell Telephone Laboratories might be of interest as perhaps typifying the situation found in a number of industrial laboratories which are fulfilling defense contracts, some for the NDRC and some directly for the Army and Navy. A rough count shows that about 600 of our technical staff are now engaged directly on a full-time basis on defense projects. When I say that they are "engaged directly" on defense projects, I am excluding those who by circumstances arising out of the defense program have been forced to devote themselves to such problems as the finding of substitute materials and the engineering of emergency telephone projects.

* * *

I SUPPOSE it depends upon one's point of view as to whether the effort I have just outlined appears large or small. On the one hand, it seems fairly certain that it is only a beginning, and must expand further. On the other hand, it is already certainly large when contrasted with any civilian effort which was able to assert itself during the last war. And looking back to the situation which existed a quarter of a century ago, it is difficult to understand why the then available civilian agencies were not unleashed to an extent commensurate with their obvious capabilities.

True, the National Research Council was created to assist with the solution of defense problems, but it was, as I have pointed out, in the position of a doctor waiting for clients; it could not adopt the attitude of an aggressive salesman and initiate attacks on what it regarded to be important military problems. Hence we can declare that, as regards organization, notable progress has been made.

As to future expansion of our civilian defense effort, it is becoming increasingly essential to bear in mind the potential shortage of trained personnel. Without insinuating anything as to guilt, the chemists declare that this is a physicist's war. With about equal justice, one might say that it is a mathematician's war. The visible supply of both physicists and mathematicians has dwindled to near the vanishing point, consistent with the maintenance of anything like adequate teaching staffs in our universities. If this civilian defense effort is to expand, and such indeed now seems imperative, the limiting factor may therefore be a shortage of highly trained individuals. . . .

* * *

Shortening the Time Gap

ANOTHER present problem, and it is the last with which I shall trouble you, is one which by its existence supplies evidence that real progress has already been made in some of the research programs thus far initiated. It has to do with shortening the time gap between proven laboratory research results and the stage where mass production can be undertaken. Some of the laboratory results already achieved hold such promise that every day which intervenes before their widespread utilization becomes a serious matter. Obviously, the problems to be met here cover a wide range of equipment and materials—as wide as that marked out by the scientific results themselves—and since they involve large-scale manufacture, the whole plan must be carefully worked out with other official agencies, particularly the Office of Production Management and the armed services.

I am sure, however, that we are prepared to meet and solve these problems; and rather than be concerned with the difficulty of making progress along this avenue, I think all who are guiding the work of the NDRC would exclaim to the ranks of scientists and technicians, "Bring on your results, the more the better, and we will guarantee them a speedy passage to the firing line!"

IN the foregoing, I have attempted merely to sketch the set-up of organized civilian research and development created for the war emergency. Obviously, it is only a part of the total effort which is being mobilized. It would be unfair to thousands of scientists and engineers to imply that the main results were dependent on the work of these agencies.

The scientific departments of the armed services are being greatly enlarged; industrial laboratories are turning more and more of their efforts to direct and indirect war work; and engineers everywhere are active. Fundamental and applied science are on the march.

FOR THE RECORD

M. R. SULLIVAN AND C. O. BICKELHAUPT ELECTED A. T. & T. VICE PRESIDENTS

Two recently elected Vice Presidents of the American Telephone and Telegraph Company are Mark R. Sullivan, who since 1939 has been Vice President of the Pacific Telephone and Telegraph Company in charge of operations, and Carroll O. Bickelhaupt, who has been since 1930 an Assistant Vice President of the A. T. and T. Company.

Mr. Sullivan, whose election was effective last December 1, is now in charge of the Department of Operation and Engineering during the absence on leave of Vice President W. H. Harrison in Washington as head of the Production Division of the War Production Board. A native of Oakland, Cal., Mr. Sullivan started his telephone career in 1912, at the age of 19, as a clerk in the office of the division traffic engineer in San Francisco. Progressing through the Pacific Company's traffic organization, he held, among others, the posts of division traffic supervisor, general toll supervisor, and general traffic supervisor. In 1928 he became general traffic manager for the Northern California and Nevada area, and in 1934 vice president and general manager for that area. Four years later his duties as vice president were made company-wide as chief of staff of the operating vice president's organization. In 1939 he was elected vice president in charge of operations—the position he held at the time of his election to the A. T. and T. Company.

Mr. Bickelhaupt was elected, on December 17, Vice President of the A. T. and T. Company with special duties on National Defense matters. He commanded a Signal Corps battalion in the first World War, has been continuously active since that time in the Signal Corps Reserve, and is at present on leave of absence for military service as Colonel, Signal Corps, on duty in the Office of the Chief Signal Officer of the Army, War Department. Born in Roscoe, South Dakota, he began telephone work during school vacations with the Dakota Central Telephone Company at Aberdeen, S. D. After graduation from the University of Wisconsin in 1911, he joined the A. T. and T. Company in New York as a junior engineer in the commercial engineering division. In 1922, having served, among other offices, as toll rate engineer and toll traffic engineer, he became commercial engineer. He was elected, in 1925, Vice President of the Southern Bell Telephone and Telegraph Company in charge of operations, continuing in this position for five years. In 1930 he was made an Assistant Vice President of the A. T. and T. Company.

ISAIAH BOWMAN ELECTED AN A. T. & T. DIRECTOR

On January 21, Isaiah Bowman was elected a Director of the American Telephone and Telegraph Company, to fill the vacancy created by the resignation of

Barklie Henry, a Director since 1939, who has been called to active duty by the Navy. Dr. Bowman is President of Johns Hopkins University.

NET TELEPHONE GAIN IN 1941 WAS 1,360,000

In 1941 there was a net gain of about 1,360,000 telephones in service in the principal telephone subsidiaries of the American Telephone and Telegraph Company included in the Bell System. This was the largest increase for one year in the history of the Bell System. The largest previous annual gain was 950,000 in 1940. At the end of December, 1941, there were about 18,840,000 telephones in the Bell System.

The gain during the month of December, 1941, was about 130,100. This was the largest December gain in the history of the Bell System. The gain for the previous month was 102,100, and for December, 1940, it was 111,300.

The total number of telephones in the United States which can be interconnected, including those of the Bell System and several thousand independent telephone companies, was about 23,430,000 at the end of 1941.

CONTRIBUTORS TO THIS ISSUE

Entering Yale in 1914, Judson S. Bradley left college in 1917 to enlist in the U. S. Army Ambulance Service. Returning from overseas in 1919, he reentered college, and received his B.A. degree in 1920. For the next four years he was assistant editor and managing editor of the *Yale Alumni Weekly*. In 1925 he joined the Publicity Department of the Southern New England Telephone Company, in New Haven, as copy writer, and was subsequently advertising manager until 1928. In that year he was transferred to the Commercial Division of the American Telephone and Telegraph Company, and in 1930 became a member of the staff of the General Information Department. He has contributed a number of articles to the Bell Telephone Quarterly and its successor, this Magazine, of which the most recent was "The Bell System and National Defense," in the issue for February, 1941.

[Photographs from commercial agencies used in his article: Acme, pp. 6, 10, 11; Press Association, p. 8; Wide World, p. 16.]

Joining the New York Telephone Company in 1922, Jerome D. Towe filled a number of assignments in business office work in New York City and Paterson, N. J., in the the next several years. In 1925 he became a business office manager at Paterson and, with the organization of the New Jersey Area of the New York Company, was appointed successively directory compilation supervisor and directory production manager for that area and later for the New Jersey Bell Telephone Company. In 1929 he was transferred to the Department of Operation and Engineering of the American Telephone and Telegraph Company, where, in the Commercial Division, his present assignment is in the group engaged on directory service and production matters.

After receiving a B.A. degree in English Literature from the University of Colorado in 1925 and pursuing special courses in writing and English at Columbia University, Stuart Shaw was for two and a half years a newspaper reporter in Denver before he joined the publicity department of the Mountain States Telephone and Telegraph Company as a writer in 1928. Since 1930 he has been editor of the company's employee magazine, *The Monitor*.

Mr. Shaw's article gives evidence of the versatility of the *Monitor's* staff; for the two maps are by Miss Beulah Black, staff artist, and the accompanying photographs are by Lawrence Effinger, editorial assistant. While the latter was making those "stills," Mr. Shaw, whose hobby is photography, was busy taking motion pictures of the same and other construction scenes. In connection with identifying the pictures which are reproduced with his article, Mr. Shaw wrote:

"As a matter of passing interest, that picture on the top of Argentine Pass represents a lot of leg work. The road is now not much more than a horse trail, though previous to 1879 it was the stage road between Georgetown and Leadville, famous mining camps of the early west. Mr. Effinger and I started up there . . . in a light pick-up truck equipped with double reduction gear. We put on tire chains to provide traction on the steep grade, but soon began running into mud and snow. After digging the car out several times, we decided it would be easier to walk up. So, loaded with movie and still equipment, we started out from about 11,000 feet to make our way to the top at something over 13,000 feet. If you don't think that a climb like that will make a couple of office workers pant and blow, you are mistaken. Well, skipping over a lot of anguish of soul and body, we finally got there and it really was worth the effort. We were lucky to have struck one of the few clear, quiet days to be found at that altitude. The country stretched out in all directions in a manner that I am going to sidestep by calling indescribable. There is peace, and an ageless quality to those hills. . . . There is no sound but the sound the Indians knew before the white man came."

The Bell System career of F. Raymond Brewster started in the Accounting Department of the New York Telephone Company in 1899, but was terminated temporarily when he entered the public accounting field in 1904. Returning to the Bell System in 1906, he progressed through field and methods staff positions in connection with the customers' accounting work in the New York Telephone Company, and in 1919 joined the staff of the Comptroller of the American Telephone and Telegraph Company in charge of customers' accounting methods. During this period the practices of the Bell System underwent fundamental changes, including the substitution of small stubs in place of heavy ledgers for keeping customers' accounts, and also the adoption of "rotation" billing and the use of machines in place of longhand entries—both of which are mentioned in his article. In 1936 he was appointed General Supervisor of Methods in the Comptroller's Department, the position he now holds.

It was in 1904 that Frank B. Jewett left the teaching staff of Massachusetts Institute of Technology to join the engineering department of the A. T. and T. Company. He had been graduated from Throop Polytechnic Institute (now California Institute of Technology) with the B.A. degree in 1898, and had received his Ph.D. degree from the University of Chicago in 1902. From 1908 to 1912 he was transmission and protection engineer of the A. T. & T. Co. In the latter year he was transferred to the Western Electric Company as Assistant Chief Engineer, and became Chief Engineer of the company in 1916 and Vice President in 1922. In 1925 he was elected Vice President of the A. T. & T. Co., and in the same year was also made President of the Bell Telephone Laboratories. The latter office he resigned in 1940, becoming Chairman of the Board. He was awarded the Distinguished Service Medal for his work in the first World War, has received a number of honorary degrees, medals, and awards, and is active in numerous educational and scientific organizations. He has served since April, 1939, as President of the National Academy of Sciences, and as head of the division of transportation and communication in the National Defense Research Council since June of 1940.

BELL TELEPHONE MAGAZINE

VOL. XXI JUNE, 1942 NO. 2

THE RÔLE OF THE TELEPHONE IN THE CIVILIAN DEFENSE ORGANIZATION

SOME THOUGHTS ON ORGANIZATION AND EXECUTIVE WORK

PLOWING CABLES INTO THE GROUND

THE FUTURE OF TRANSOCEANIC TELEPHONY

"WHAT NUMBER ARE YOU CALLING, PLEASE?"

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE MAGAZINE

Continuing the Bell Telephone Quarterly

A Medium of Suggestion and a Record of Progress

"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."

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BLACKOUT PASSPORT

THE RÔLE OF THE TELEPHONE IN THE CIVILIAN DEFENSE ORGANIZATION

The Bell System Not Only Provides Communication Facilities But Has Trained Representatives Qualified to Act as Communication Advisers to Defense Organizations Throughout the Country

By F. SELWYN GAY

Air-raid sirens wail. Municipal and civilian protection groups man their respective posts of duty. Radio stations are silenced. Streets are cleared of traffic. Blackout is effected. The public takes cover. Thus an American city prepares itself for a potential attack from the air. And with incredible speed—perhaps but a matter of a few minutes.

Assume, then, that some enemy aircraft are able to break through our air and ground defenses. Bomb bursts cause damage and casualties. Alert air-raid wardens, on watch, report each incident promptly to defense headquarters. Emergency crews are dispatched to deal with individual incidents. Fires are extinguished, medical attention is rendered, blocked streets are cleared, damaged vital services (power, gas, water, telephone) are repaired. Before the last bomb burst, rescue and repair work is well under way. Lives are saved. Prompt, effective action has minimized the effects of the attack. The city has capitalized on its careful planning and thorough organizing for protection. And each citizen who participated feels amply rewarded for the many hours willingly spent in training and practice.

No, this has not happened here—yet. But it can! If it does, the communities of our country are preparing to carry out the effective protective actions outlined in the two preceding paragraphs.

As part of the task of organizing for civilian defense, both the telephone service and telephone people are doing a vital job—just as they are in other war activities. The importance of the telephone is recognized in an official Office of Civilian Defense publication, "The Control System of the Citizens' Defense Corps," which states: "To properly operate a civilian defense organization, a positive, accurate, and dependable communications system is a vital requirement. Because of its high degree of availability, flexibility, and dependability, the land line telephone is being relied upon as the basic means of communication."

A PORTABLE DEMONSTRATION OF CIVILIAN DEFENSE COMMUNICATIONS

Developed by Bell System companies for the education of their employees, such working exhibits and other presentations have been found useful also for the training of civilian defense groups

The Birth of Civilian Defense and Its "Signal Corps"

THE need of our country for effective civilian defense was recognized during the early days of our defense program. The national Office of Civilian Defense—the O.C.D.—was established early in 1941, followed shortly by nine regional offices coterminous with Army Corps areas. Along our coasts and borders, state, county, and municipal civilian defense councils were formed. Under national and state leadership and with the assistance of the military services, each critical region was carefully studied. War-time protection requirements were crystallized. The work of recruiting, training, and equipping volunteer civilian defense corps got under way.

There has been telephone company participation from the very start, since good communications are essential to civilian defense—as is the case in any emergency work. Telephone people have taken the initiative in offering to assist civilian defense officials with their communications problems.

While the O.C.D. was being organized, for example, such help was offered to and accepted by its director. A liaison officer to represent the Bell System was assigned by the American Telephone and Telegraph Company to work with the O.C.D. staff. A similar appointment was made by the independent telephone companies. This arrangement resulted in a two-way flow of valuable information between the telephone companies and the O.C.D. To the telephone companies went information on the composition of the civilian defense organization and its various functions which was used to determine both the various specific communications requirements and the most effective and economical communication facilities to meet each need. To the O.C.D., for its consideration, went information on the many services available from the telephone companies, with suggestions as to the usefulness of each from the standpoint of civilian defense.

Out of the coöperative study which accompanied this exchange of information, plans for adequately meeting civilian defense communications requirements were developed. At the same time, the Bell System was determining how it could be most helpful to the civilian defense organization. Its opportunity appeared to be much broader than merely providing facilities and service for civilian defense use: it had, in reality, the responsibility of advising civilian defense officials on communications problems. The job, in effect, was one of acting as the "Signal Corps" of civilian defense.

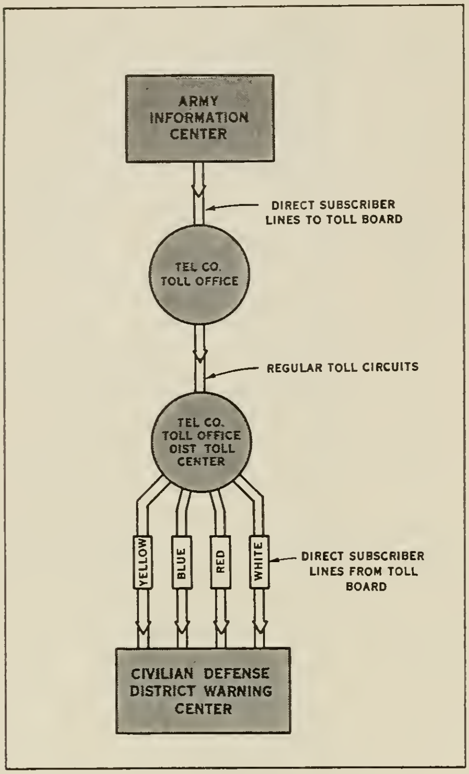
Preparations on the part of the Bell System to handle this new responsibility involved a major organizing and training program, carried out by the A. T. and T. Company. First, there was "recruiting" to do. It was necessary to select and make available in the Associated Companies throughout the country qualified telephone representatives to handle contacts with civilian defense officials. Second, instructive material had to be prepared for use in training these people for this new work. Third, courses of classroom training had to be conducted. This program has already been accomplished and hundreds of representatives throughout the System are now fully qualified to act constructively as communications advisors to civilian defense officials.

Other activities included regional conferences with Associated Company officials regarding the civilian defense program. Sound-pictures, slide films, and traveling demonstrations were created, and were used for the information of telephone employees generally. Such presentations naturally were submitted to civilian defense officials for their approval before being shown. The reaction of these officials to some of the presentations was most favorable and, as a result, the presentations are being used extensively to train civilian defense as well as telephone groups.

The Defense Organization and Its Major Functions

As mentioned previously, civilian defense communications requirements in a given locality depend upon the make-up of the organization and its functions. The extent of activity naturally varies widely between communities, depending upon such things as location, area, population, and other considerations. Furthermore, a given community may move progressively through several stages of preparedness as realization of the danger of attack increases. Communications arrangements, therefore, need to be "tailored" to the specific needs of each community, and modified as changes may necessitate.

The objectives and degree of preparedness appropriate for an individual community are determined by the



Air-raid Warning Channels

This diagram shows how both the Army Information Center and the Civilian Defense District Warning Center are directly connected to long-distance switchboards

local Defense Council, a group which includes authorities on fire and police protection, medical aid, transportation, communications and other such defense matters. Requirements are based on such considerations as the types of incidents the community needs to provide against (bombing, panic, evacuation, etc.), how they may affect the community (cause fires and casualties, interrupt vital services, etc.), and what action such emergencies call for (fire fighting, rescue and repair work, etc.). Such new requirements as develop are met both by strengthening existing agencies (police, fire, utilities, Red Cross, etc.) and reinforcing them with civilian defense volunteers.

The civilian defense organization can be thought of in three broad groups: the headquarters group, termed the Control (or Report) Center; the air raid wardens; and the various emergency services. In event of an air raid, these three groups carry out the following sequence of action:

1. Control Center receives and disseminates air raid warnings, activates the community, and musters defense workers for duty.
2. Wardens patrol and report incidents to the Control Center.
3. Control Center relays incident reports to emergency services.
4. Emergency services dispatch crews to deal with incidents.
5. Control Center exchanges help with other communities as needed.

Throughout this action chain there is a continuous, extensive requirement for communications which becomes apparent in the more detailed discussion which follows. It may seem to deal chiefly with the problem in larger cities. However, size usually affects mainly the size of the organization and the amount of communications, and has little bearing on the nature of the activities to be carried out.

Dissemination of Air Raid Warnings

"Telephone Lines and Air Defense," in the February, 1942, issue of this Magazine, described the system whereby the Army initiates warnings to communities lying in the path of approaching enemy aircraft. Before discussing the dissemination of warnings within a community, it seems appropriate to pick up where that story left off and tell of the arrangements for getting air raid warnings from the Army Information Centers, where they originate, out to individual communities.

The warnings are transmitted by message telephone service. Owing to the speed of aircraft and the uncertainty of their course, it is necessary to warn rather substantial areas. Consequently, Warning Districts, each having a Warning Center, are established in each state where air raid protection is necessary. The size of these districts varies but is illustrated by Massachusetts, where nine districts have been established.

There are at present four degrees of warning:

YELLOW—Air raid is possible.
BLUE—Air raid is probable. Enemy planes approaching.
RED—Air raid is imminent. Attack may occur in short time, say, 5 minutes. Sound public alarm.
WHITE—All clear.

A blackout can be ordered for a region regardless of the degree of warning in effect. This is likewise true of silencing radio broadcasts.

It should be pointed out that these warnings are the subject of continuing study and tests, and may therefore be changed from time to time as experience and circumstances warrant.

The Army arranges to have each Warning Center provided with a special telephone which has four keys. Each key is associated with a line to the long-distance central office, and with a lamp signal. There is a combination of line-and-key-and-lamp for each of the four degrees of warning; the key and lamp are of the same color as the warning they represent.

For example, when the Army sends a YELLOW warning to a Warning Center, a bell rings and the yellow lamp lights. The Warning Center attendant depresses the yellow key and, using the telephone hand set, acknowledges the warning with "Bridgeport

WARNING-RECEIVING EQUIPMENT

The keys in the base of the telephone, and the lamp caps of the visual signal, are colored yellow, blue, red, and white. Each is connected to a separate line operated on order from the Army Information Center

IN A DISTRICT WARNING CENTER

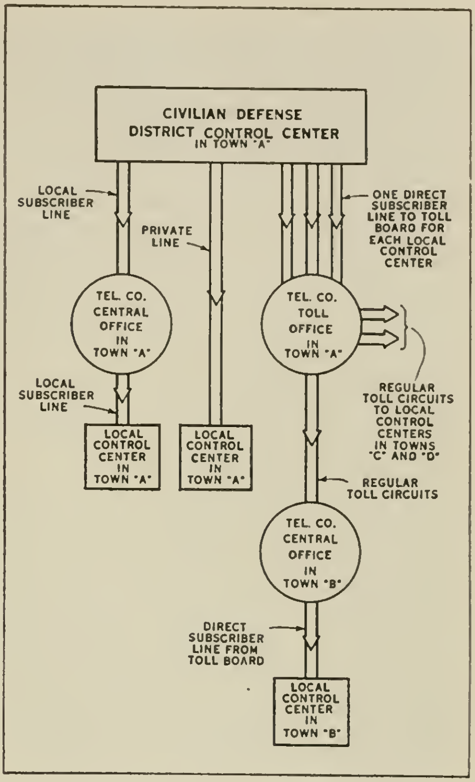
The key equipments, which speed up the warning calls by giving access to several lines, may be seen at the left of this picture

Warning District, YELLOW." On pages 64 and 65 are a schematic diagram of the air-raid-warning telephone communications channels between an Army Information Center and Warning Center and a picture of the warning receiving telephone equipment here described. Giving Army Information Centers and Warning Centers direct connection with long distance, rather than through local central offices, is a means of speeding up the service and further reduces the possibility of error.

At this point Army responsibility ends and civilians take up the job of disseminating the warnings within the Warning District. Generally the warnings disseminate from the Warning Center by message telephone service to the Control Centers of individual communities. However, there may be variations to this method of routing warnings; e.g., warnings are sometimes relayed through a District Control Center which has been established to coördinate the activities of several neighboring communities. Also, police and other teletypewriter networks are sometimes used for warning dissemination. Above is a picture of a District Warning Center, showing the key equipment used to expedite messages, and at the right is a schematic diagram of the warning telephone communications channels between Warning Centers or District Control Centers and local Control Centers. All of the above arrangements were worked out jointly by Army and Civilian Defense officials and telephone representatives.

THIS background brings us to the last link of the warning chain, which is forged largely by the individual community. Based on a study of the steps required to prepare for an attack and the time involved, lists are developed of individuals and groups to receive the YELLOW and BLUE warnings. Such lists include three groups: (1) Key people in the civilian defense organization, e.g., personnel required to operate the Control Center, and heads of such essential services as Fire, Police, Medical, Repair, Utilities, etc.; (2) Schools, hospitals, and other such institutions where special steps have to be taken to protect large groups of people located on the premises; and (3) Large war plants in those cases where the steps necessary to prepare for a raid require an appreciable amount of time. The exact composition of warning lists must, of course, be determined individually by each community, based on a careful review of its requirements.

Only a limited number of these advance warnings can be transmitted over regular message telephone service. Excessive use of the telephone at such critical times would congest the telephone system, and thus some calls most important to civilian defense might not get through. To avoid congestion of the telephone system, civilian defense officials and telephone people in each community jointly develop the warning lists, giving due consideration to the capacity of the telephone facilities for handling warning calls. Particularly dangerous at such a time are the so-called "chain calls" of excessive length, whereby a small group is called from the Control Center and they in turn call a larger group, and so on. To show how such calls "snowball," if an attempt were made to reach about 1,000 people in 10 minutes, there would be a wave of over 500 calls during the last minute and over 120 operators would be required in a



DISTRIBUTION OF THE WARNINGS

In this diagram, channels from a District Control Center to the Control Centers of several neighboring communities are represented

REPORTING AN INCIDENT

Wardens are the sentinels of civilian defense

manual central office to complete them within the deadline.

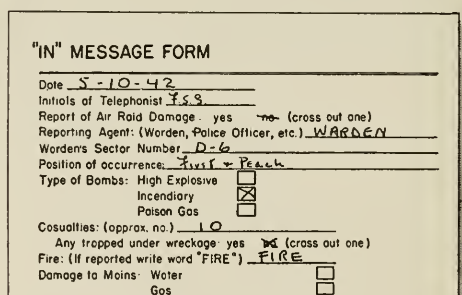
Mustering the Organization for Duty

EVEN though an efficient air-raid warning system has been organized, experience on the Pacific Coast, where actual warnings have been issued, indicates that the amount of advance warning of potential attacks will vary considerably, particularly in the coastal and border areas. While in some cases an emergency may be heralded by a YELLOW warning from the Information Center well in advance of any possible attack, in other cases the first indication of danger may be a RED warning.

In view of this, the following steps are being taken by defense officials of many communities to insure that the defense organization is available for duty as needed:

First, organizations are being built up of volunteers who are continuously available to assume civilian defense responsibilities. An example of good availability is a person who lives and works in a community, while the opposite is true of a commuter who is out of town most of the time.

Second, in so far as is practicable, civilian defense assignments are made so that the post of duty of each volunteer is in the immediate vicinity of his home or place of business. Wardens,



"IN" MESSAGE FORM

Date 5-10-42

Initials of Telephonist F.S.S.

Report of Air Raid Damage yes ~~no~~ (cross out one)

Reporting Agent: (Warden, Police Officer, etc.) WARDEN

Warden's Sector Number D-6

Position of occurrence: First & Peach

Type of Bombs: High Explosive ☐ Incendiary ☒ Poison Gas ☐

Casualties: (approx. no.) 10

Any trapped under wreckage yes ~~no~~ (cross out one)

Fire: (If reported write word "FIRE") FIRE

Damage to Mains: Water ☐ Gas ☐ Overhead Electric Cables ☐

Names of any ROADS BLOCKED

Position of any UNEXPLODED BOMBS

Time of occurrence (approx.) 10 P.

Services already ON THE SPOT or COMING

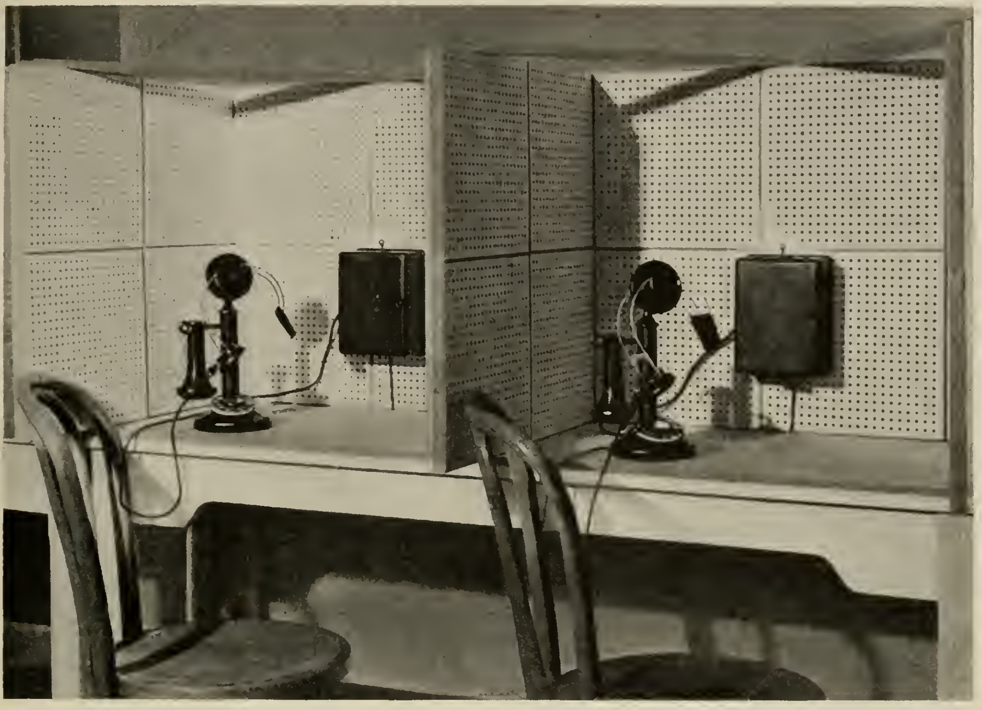
Remarks: — Large apartment on fire. Out of control. People trapped on top floor

Time message completed: 10.05 P.

Message no: 26

THE REPORT

This is the information about an incident as received and recorded at a local Control Center



TELEPHONISTS' POSITIONS

This is where wardens' "incident reports" are received. By removing the bells from the bell boxes, the clappers become visual signals, while use of the head receivers leaves both hands free

for example, are assigned for duty on blocks on which they live or work.

Third, schedules are being established so that each volunteer knows the specific hours and days when he is committed to be "on call," and someone is "on call" to cover all important posts "round the clock." For example, a volunteer fireman who is scheduled to be "on call" Mondays, Wednesdays, and Fridays between midnight and 8:00 A.M. would arrange his affairs so that he would always be available for duty during those periods if needed. This arrangement, of course, causes some readjustments on the part of volunteers, just as is the case when a woman agrees to work at Red Cross headquarters every Thursday from 8:00 A.M. to 6:00 P.M.

Fourth, the work of volunteers is being organized so that a minimum of time is required in making preparations for an attack. Control Centers, medical stations, etc., are being efficiently organized and equipped so that workers can go into action as soon as they reach their stations.

Fifth, certain important points, particularly in the critical areas, are manned by skeleton forces twenty-four hours a day. For example, this is the case in connection with Warning

District Centers and Control Centers in most communities in the North Atlantic and Pacific Coast States.

Once these measures have been effected, the sound of the siren musters the majority of defense workers and there is no need for long YELLOW and BLUE warning lists. This is in the best interests of our nation, which require that normal civil pursuits and business be carried on without interruption due to air-raid hazards, until the last possible minute consistent with public safety. Otherwise, widespread knowledge of advance warnings, particularly those which are not actually followed by a RED warning, would inevitably cause wasteful interruption of war production and affect public morale adversely.

Patrolling and Reporting Incidents

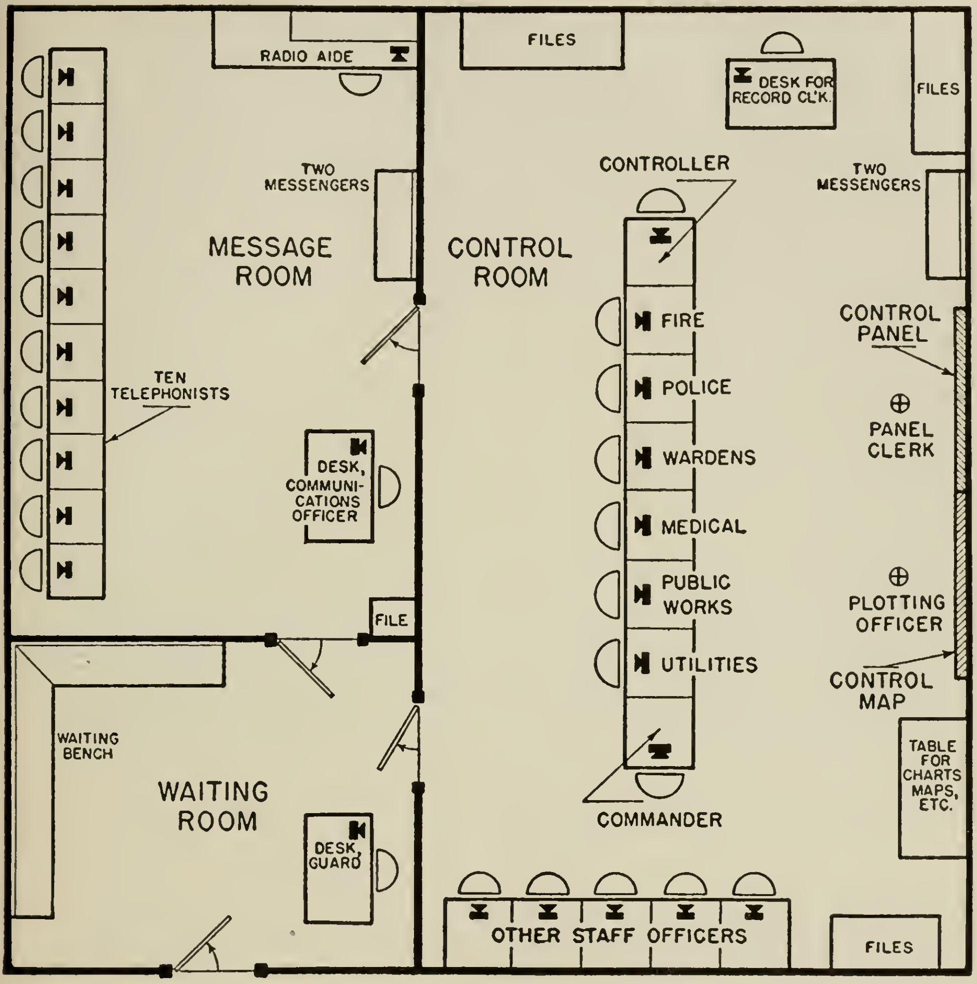
Wardens are the sentinels of civilian defense. Their functions are similar to those of police patrolmen or guards and watchmen in private business. They are mustered when such patrolling agencies require reinforcement. They start patrolling their posts when the RED (or public siren) warning is given, and (1) warn the inhabitants of impending danger, (2) prepare their area for an attack, e.g., effect blackout, clear streets of traffic, and help the public to take cover, (3) spot and report damage and casualties to the Control Center, and (4) render such other assistance as they can.

The areas covered by warden posts vary in size, depending upon such factors as topography and density of population. In urban areas it is a common practice to organize warden posts on the basis of one for each block or several square blocks. From those who live or work on the block, enough wardens are recruited to insure short-notice, 'round-the-clock, daily coverage. For the purpose of supervision, warden posts are grouped into sectors, precincts, and so on.

The wardens require communications primarily for reporting incidents to the Control Center. This need is being met by selecting existing telephones strategically located along each warden beat. Coin telephones as well as residence and business telephones can be put to this use. Arrangements must be made, of course, so that wardens have access to them at all times —day, night, Sundays and holidays.

By using existing telephones, a community saves considerable money and contributes to the conservation of telephone facilities which is so important under present war conditions. For example, in one city of about 500,000 population, wardens use about 3,000 telephones for reporting incidents. If the city had been unable to use existing telephones, a substantial amount of critical materials would have been required which can now be devoted to other war purposes. Also, the number of telephones required by wardens can be held to a minimum if such telephones are selected close to street intersections, since at such locations one telephone may serve as many as four warden posts. By putting this rule into effect, one community was able to reduce the number of telephones designated for warden use by over 30 per cent.

To reach the Control Center, wardens ask for or dial the telephone number assigned to the Control Center incoming lines. When the Control



LAYOUT OF A CONTROL CENTER

This typical arrangement is reproduced from "The Control System of the Citizens' Defense Corps," issued by the O.C.D. The symbols represent telephones

Center answers, they give a terse but adequate report covering the incident.

The Control Center

THE Control Center is the nerve center of civilian defense. It is usually established in a centrally located public building which affords adequate space and good protection. Larger cities may require several Control Centers which are coördinated by a main Control Center.

The Control Center force is composed of two groups. The first is a group primarily responsible for recording the incoming warden incident reports. They are stationed in a message room. The second is the staff organization, which analyzes each incident and notifies the various emergency services in cases where their help is needed. They are located in a staff room. The Control Center forces are all summoned for duty as promptly as possible following the recept of a YELLOW warning. However, as mentioned previously, many Control Centers, particularly in the zones of possible military operations, are manned by skeleton forces continuously.

The facilities used for receiving warden incident reports are another example of efficient planning. In a typical Control Center, the telephone set and signal provided at the incoming telephone positions in the message room were selected so as to meet adequately the needs without requiring special elaborate equipment. Desk stand telephones with head sets, giving the telephonists free use of both hands, are used. The signal of an incoming call is obtained from a regular bell box, minus the cover and bells, which is mounted before the telephonist. When there is a call on the line the clapper, which has been painted a bright color, vibrates to announce the call. By converting the bell box from an "audible" to a "visual" signal, room noise from a lot of telephone bells, closely spaced, ringing simultaneously, is eliminated. On page 69 is a close-up of telephonist positions.

The lines from the central office to these telephone positions are consecutively numbered. The Control Center number, mentioned earlier, which wardens call is actually a single telephone number covering this whole group of lines. By this arrangement the operators or machines in the central office seek out and complete calls to idle lines, obviating the need for a P.B.X. switchboard and attendants in the Control Center to distribute these calls.

The number of positions and incoming lines depends upon the volume and density of incidents anticipated. One Pacific Coast city felt it should provide enough lines to accommodate a flow of about 400 incident reports per hour. Tests showed that 40 lines would give such input capacity. A mid-west city of comparable size, on the other hand, might provide for a much smaller volume, in view of the better protection its location provides from attacks by air.

Dispatching Emergency Units

The Control Center staff is in charge of a chief and has the following members: a medical officer, chief air raid warden, representatives of the fire and police departments, the community's engineer or director of public works, and representatives of the water, gas, power, communications and transportation companies. In small cities, many of these jobs may be combined. As mentioned previously, the staff is assembled on receipt of the initial warning. Its function is to analyze incident reports and notify the emergency services involved.

As each member of the staff arrives at the staff room, he places a call to the dispatching point of the service he represents, using the telephone at his position. When it answers, he orders "Stand by for action." A private line connection for continuous, exclusive use between a staff man and his dispatching point may sometimes be required. More often, however, regular individual message telephone lines at

THE CONTROL ROOM OF A CONTROL CENTER

This is the main message center of the community. It is here that the orders are swiftly issued to meet the situations which are revealed by the wardens' reports

staff positions prove adequate, since a connection with the dispatching point, once it has been established via the central office, can be maintained continuously if required throughout the period of emergency.

Soon after the staff men reach their posts and establish contact with their dispatching points, incident reports start coming into the message room. Immediately after a telephonist completes recording an incident, she sends the report by messenger to the staff room. The chief reads the report aloud. Each member of the staff passes by telephone to his service dispatching point such details as affect it.

Tests may show that variations of the plan just outlined are desirable. For example, rather than passing messages directly to their dispatching bureaus, the representatives of the services might prepare "out" orders and have telephonists give these orders by telephone to the several services.

To hold down duplicate reports, each incident can be spotted on a map with a numbered pin before the report is given to the chief. If, when placing pin 23 at the location of incident number 23, it is found that pin 20 is at the same location, the report would be stamped, "Probable Duplicate." The chief and his service representatives can then treat it as such.

From a communications standpoint, the Control Center is the main message center of the community. Communications must be engineered so that incident reports can be translated into action at top speed. There must be no bottlenecks along the road to the Control Center, within it, or between it and the various emergency services. The whole system should be pointed toward getting appropriate help to the scene of an incident as soon as possible after it occurs.

Even more may be required, however. The Control Center must be ready to deal with severe and protracted attacks, resulting in hundreds of incidents: more than its people and equipment are able to cope with. It must be prepared, therefore, both to exercise selectivity in notifying the emergency agencies of incidents and to obtain help from other Control Centers when help is needed.

Here are examples of delays along the road into the Control Center which may involve communication arrangements. (1) Too much time spent by warden traveling to telephone to make report. Cause: Poorly located or too few telephones selected for wardens' use. (2) Incident reports blocked due to "busies." Cause: Too few lines to the message room. (3) Incident reports delayed due to "slow answers." Cause: Too few telephonists on duty, or inefficiency. Delays may likewise be caused, of course, by improper arrangements in other parts of the Control Center.

It is very important that checks be made within the Control Center to determine whether the staff is able to clear incident reports with the various emergency services as fast as the full complement of telephonists can accept them from the wardens. If this is not the case, incident reports pile up in the Control Center much as war freight would pile up at the dock terminal of a railroad if there were a shortage of cargo vessels.

The speed of the staff in clearing incidents can be determined during practice tests. Such a test, for example, might show that one unit of staff can clear incidents as fast as 10 telephonists can take them in. Then, if the Control Center requires 20 telephonists, it follows that two units of staff or a breakdown into two Control Centers are needed. Under these circumstances, of course, at the dispatching point of each of the services two people and two telephones for receiving reports from the Control Center would be required.

These figures are only illustrative, of course. Actual figures can be obtained only through tests conducted by the individual Control Centers.

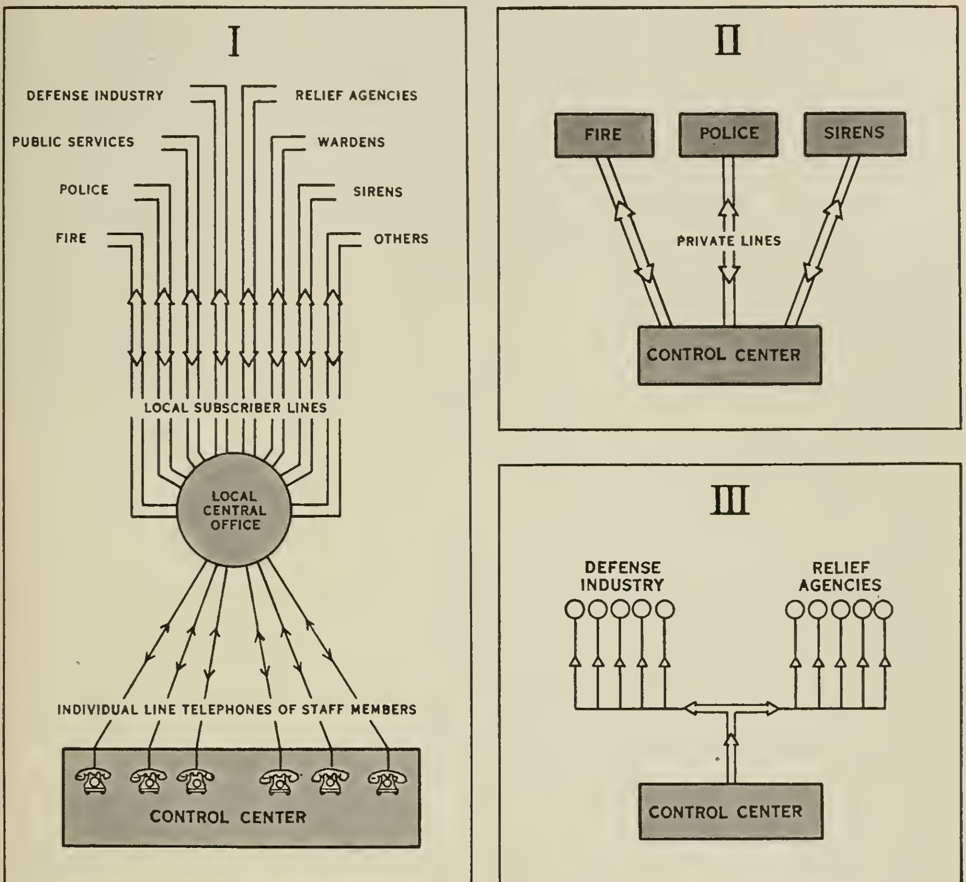
Telephone people are able to be helpful in organizing tests of this type, because of the years of experience in the telephone business of measuring telephone work loads and dealing with force adjustment problems.

Dealing with Incidents

THIS is the job of the third major division of the civilian defense organization, the Emergency Services, including such groups as the following:

(1) *Emergency Medical Units*

These groups are usually organized by the local hospitals, the Red Cross, and the municipal public



POSSIBLE COMMUNICATIONS ARRANGEMENTS

These diagrams represent the use of different methods by which the Control Center may communicate with its organization. I shows the use of regular message telephone service. II indicates private lines to certain important agencies. III represents a grouping of private lines over which messages may be sent to as many as 10 agencies simultaneously. Which arrangement best suits the needs of a community depends on many factors

health departments. Casualty stations, manned by doctors, nurses, and first-aid volunteer workers, may be established at strategic locations, such as churches, schools, and libraries. Casualties would be taken from the scene of the incident to these stations for examination and treatment and then sent home or to a hospital.

The existing telephone service arrangements at the location may usually meet the requirements of the station staff, their contacts being mostly with the scene of incidents, hospitals, the Control Center, and other casualty stations.

With regard to a hospital's regular telephone service, steps should be taken to insure that its service arrangements will be effective during emergencies or surges in telephone calls. Where nurses' homes and other

Above: An emergency medical unit leaves for the location of a reported incident

Left: Medical and other agencies converge on the scene

Below: A casualty is removed for more extended treatment, after having received first aid

It Can Happen Here

Scenes from a realistic test of Civilian Defense agencies carried out in a New England community buildings are to be used for auxiliary hospital accommodations, existing telephone facilities can be reviewed to see if they meet emergency requirements. The changes required, if any, are usually minor.

(2) *Fire Fighting*

A volunteer auxiliary may reinforce the regular fire department in activities to reduce fire dangers, as well as in fighting fires. In some communities their auxiliary volunteer fire stations are established at strategic locations, such as large service stations or public garages. In very large buildings and industrial plants, there may be volunteer fire-fighting groups.

For contacts with the fire department, the Control Center and other auxiliary fire stations, the auxiliary stations can use the existing telephones at the location. Several other conveniently located telephones can be spotted which could be used if regular telephones should be interrupted.

(3) *Repair crews*

Services such as power, gas, water, telephone and transportation companies have, of course, their own repair forces, which are generally sufficiently large and flexible to restore interruptions speedily during emergencies. For repairs to streets and public property, municipal agencies likewise have repair organizations and contractors or others who can help. Unless there is a disaster, such as a severe bombing, volunteers are not likely to be called upon to do repair work on an organized basis. The telephone arrangements of utilities and vital public services usually have been planned so as to provide for possible contingencies.

(4) *Police and Traffic Groups*

Volunteers may assist the regular police department in a number of ways. Some may take over certain police clerical and other routine duties, thus releasing policemen for more active assignments. Some may reinforce the regular police patrol when necessary. Others may guard bridge heads, aqueducts, and other vital points. Traffic duties also may be assigned to volunteers, such as guiding repair and rescue crews to the scene of an incident, forming a cordon around the incident, rerouting traffic around streets which are blocked, and the like. When on duty, they can use existing service such as police telephones, wardens' telephones, public telephones, and telephones in casualty stations.

From the Control Center, over the telephone facilities described above, goes information covering incidents which enables the emergency services to make the most effective use of their organizations and equipment during the period of emergency. It permits them to go only to those incidents where their help is really needed. It also gives them a good picture of the type and amount of work they will have to do. For orders and other communications between their main dispatching points and various emergency units of the several emergency services, adequate telephone arrangements are usually available for dispatching purposes. However, telephone people are taking the initiative in reviewing this situation with the services, and are suggesting changes if they appear to be needed.

When the several emergency services reach the scene of an incident, the senior official present may become the Incident Officer and coördinate activities, or the Control Center Chief may send an Incident Officer to the scene from the Control Center. He establishes a field headquarters and message center serving all the defense units, usually at the nearest telephone which can be used for communication with the Control Center. The nearest warden telephone or public telephone would preferably be selected. To insure that a telephone will be available for use in case of damage to a large defense industry, hospital, public utility, or other important unit, the authorities can get three or four subscribers in the immediate vicinity to agree that their telephones can be so used in case of an incident. Such telephones should be selected, if possible, so that they do not all work off the same cable.

Some communities plan to use a loud-speaker on a truck at the scene of the incident to call the supervisors of defense units and others to the telephone. "Runners" can also be used to carry written messages between the scene of the incident and the Incident Officer's telephone.

Each community strives to build for itself such protection as it may need. The possibility is generally recognized, however, that a catastrophe may be so severe as to require outside assistance. To facilitate the exchange of such assistance, communities are grouped together into Control Districts. Each such district has a District Control Center through which the Control Centers of individual communities work in exchanging help.

District Control Centers are normally established in the largest community in their respective areas. Suitable space can usually be found in a municipal government or other public building.

A District Control Center organization would normally consist of a Controller, Assistant Controller, Plotting Officer, Communication Officer, and several telephonists and messengers.

Several telephones are usually necessary at a District Control Center for contact with its local Control Centers. Each telephonist and each Controller usually has one telephone. If specially installed, they can be consecutively numbered, non-published lines. Local Control Centers requiring outside help would call these lines. After recording a request, the telephonist would pass it to the Controller for action.

Many municipal or utility services have procedures for exchanging help with neighboring communities even in normal times, and these may require some modification to facilitate coördination with the District Control Centers.

Important Guides in Communications Planning

The broad objective in any communications planning is to secure fully effective service arrangements at the most reasonable cost possible. This is the "Golden Rule" of telephone people whose job it is to act as communications consultants for civilian defense officials and all others who need help with communications problems. The application of this rule to the requirements of civilian defense clearly shows that the following important guides should be observed in communications planning:

(*a*) To use regular message telephone service wherever practicable.
Due to its speed and flexibility, it adequately meets most civilian defense requirements and it will usually be the most economical form of service. Because of increasing demands upon the communications system, it is in the national interest not to take long-distance lines out of general use by using them as intercity private telephone lines, unless unavoidable to insure effective functioning in connection with the war effort. The same considerations apply, although to a lesser degree in some areas, to local private line service.

(*b*) To use standard telephone equipment as far as possible.
Specially designed telephone equipment is rarely needed. Standard equipment is generally less expensive, simple, easy to operate, and readily available with no waiting for special development work or manufacture.

(*c*) To use existing telephone facilities wherever practicable.
Additional telephone facilities should be installed only when it is certain that existing equipment will not meet requirements. For example, wardens use existing telephones on their beats instead of installing special facilities for them.

(*d*) To plan for "all out" defense requirements, and to order service adequate to it, but only to the extent that the community is actually organized for it. In the meantime, interim telephone arrangements can be provided which will be satisfactory for practice or emergency use.

Above all else, any use of the telephone planned for civilian defense should be carefully coördinated with the usage of military services and war industry to insure the most effective use of facilities.

SOME THOUGHTS ON ORGANIZATION AND EXECUTIVE WORK

These Are the Tools for the Accomplishment of a Desired Result; In This Day of Statesmanship in Business, Those Who Use Them Must Be Leaders and Administrators as Well

By WALTER S. GIFFORD

When the BELL TELEPHONE QUARTERLY *was established in 1922 as "a medium of suggestion and a record of progress," the editors sought contributions from officials of the Bell System headquarters company which would state or explain the ideals, aims, and principles of Bell System management.*

The second issue, published in July, 1922, contained some notes on organization by Mr. W. S. Gifford, then financial Vice-President of the American Telephone and Telegraph Company. Mr. Gifford's views, thus expressed twenty years ago, are reprinted here since they are particularly interesting when read in relation to the System's growth under his leadership in the last two decades and its responsibility to-day in connection with the nation's communications needs.

THE EDITORS

WHAT is organization? And why is organization? What are the functions of an executive?

We hear a great deal about organization in the business world. We hear that this man is a great organizer, or that man is a capable executive. We still hear at times of "Captains of Industry." We occasionally hear of a good administrator, although the terms "administrator," "administration," and "administrative" are largely confined to governmental affairs. In business we hear more and more of "committees" and "conferences." All of these words and phrases are descriptive of certain types of machinery by which modern business is carried on.

In the hope that others might be stimulated to think about the subject, I have set down some notes as to the significance of these terms. They are simply suggestions based to some extent on personal experience and conviction, and even more upon observation of successful executives in their work.

In the first place, we are not in the business of being organizers as such, or executives for the sake of being executives—though indeed one might believe the reverse of this to be true, judging by the requests for employment which we frequently receive from men who "want a job as an organizer or an executive." These men might almost as well say they would like a job somewhere as a captain, and feel perfectly well qualified to fill the job whether it be a captain in the army or captain of an ocean liner.

Organization and all the machinery associated with it are not ends in themselves, but tools for the accomplishment of some desired result. This seems too obvious to need to be stated; but it is easy to forget the obvious unless we are constantly on guard. We must constantly study our organization to see if it is best fitted to give results. Moreover, we must not overlook the fact that while it is a tool, and in most cases an indispensable tool, it is not the only tool needed for accomplishment.

Organization is a rather simple tool to construct. The difficulty lies in first analyzing clearly the job to be done. For example, here are five men who want to unite to build a coöperative apartment house. Each of the five must not start off independently to buy lumber or engage an architect or dig the foundations. They must first lay out and plan what they want and then determine what needs to be done to secure what they want. After this has been done, the problem becomes one of setting up the organization. This involves a decision as to what part each can do best, and an agreement that some one of the five shall be in charge of coördinating the work.

Organization a Means to an End

Organization means order. We may of course become so fascinated with organization in itself and for itself, with the game of organizing, that we overdo it. We may, for instance, become so enamored of organization charts that because a particular setup, which we know works well and is useful, cannot be charted, we change the organization.

There are real temptations to the lover of order and system. His protection lies in constantly keeping in mind the end to be attained and making all of his plans with that end in view. To be a good organizer requires sound judgment, ability clearly to perceive the goal sought, an analytical mind, and a certain fondness for order. A real organizer is always creative: it requires a man with a creative imagination clearly to perceive the goal sought.

Many of us are asked from time to time for a good book on organization. It is true that much could be written on the fundamental principles of organization, but no book could be written which would properly instruct exactly how any particular work or business should be organized. Study and books may help define the problem somewhat and perhaps lay down some fundamental principles which will assist in solving it, but no textbook where you would find your problem stated and the answer given in the back of the book would be a safe guide.

There is nothing mathematical about organization in business. It is true, for instance, that probably no chief executive should have more than five or seven people reporting to him. This, however, is due to the average limitations on the part of the average man to direct and coördinate comfortably a number of functions. The exceptional man might find it quite possible to carry on his work as a chief executive with as many as twelve people reporting to him, or another man who might also be successful as an executive might prefer only three. In other words, you can never escape from the human side of the business and the fact that you are dealing not with machines but with human beings. So that even after you have organized your job and laid out the theoretical organization which can best accomplish it, you will almost always find it necessary to make variations from this theoretically sound organization to meet the peculiarities and temperaments of the individuals who are to carry on the work. It is always a good plan to have the ideal in mind and to work toward it; but by all means do not try to crowd human beings into a theoretical scheme when they do not fit.

Duties of an Executive

THE executive may be merely an executive; that is, he may carry out plans and programs which have been laid down for him. That is in fact the primary job of an executive. He must deal with men and women; therefore he must have sympathy, tact, and force, and must know when to be firm and when to be conciliatory. His must not be a single-track mind—he must be alert and able to see many things at the same time, but must not permit himself to be overwhelmed by details. He must always watch for actual results—must know the difference between real accomplishment and making a show of accomplishment. Above all must he be just and fair in his treatment of his subordinates, and should always be a leader.

An executive generally must be even more than this. He must be also an administrator. That is, he is not only expected to carry out plans laid down for him, but he is expected in part to make plans and carry them out on his own initiative and to assist in determining broad policies for the business as a whole. He must therefore have initiative, imagination, and judgment. These qualities are inherent; they cannot be acquired. They can, however, be improved by training and experience.

There are several ways of performing the functions of an executive. Sometimes a man's personality will enable him to be a good executive even though he disregard many of the generally accepted methods of supervising a large organization. Generally speaking, however, a good executive should not be too busy. This is particularly true if in addition to being an executive he is to do some general administrative work. The mistake should not be made, however, of assuming that because an executive's desk is always clear, he is a good executive. It is an admirable thing to have a clear desk, but with it must go certain principles of work which will keep the executive in touch with his department and enable him to impress his personality upon it.

More Than a Clearing-house

I REMEMBER once hearing of a boy who asked a man what sort of work he did in a company. The man was a high executive. His reply stated his job too modestly, but it illustrates the point. He replied that people came in to see him, stated what they wanted to know, and then he referred them to the proper department of the organization. The boy said he understood perfectly, because in his father's business they had an usher—he sat at the desk out in the hall—who did just that. An executive who does just that may really be somewhat more than an usher, but not much. He does not impress his personality upon his work. He is merely a sort of clearing-house.

It is necessary, of course, for an executive to see that work is properly distributed and coördinated in his organization, but it is also necessary for him to keep in constant touch with his men and with the work which is being done under him. He should always be available to his immediate subordinates. In my opinion, this is more important than that he should be accessible to people outside of his organization. He should discuss their problems with his subordinates and give them the benefit of his advice, and avail himself of every means of keeping in touch with them and keeping them in touch with him.

Besides this, an executive should have some line of contact with the men in his organization below the rank of those who report immediately to him. He should call for information from anyone in his organization from time to time—although, of course, he should never issue instructions or orders except through his immediate subordinates. By thus calling for information from anyone he is able to get a first-hand knowledge of the men working in the business and of their mental attitude toward their work. This seems to me a very important point, although its soundness from an organization standpoint is frequently questioned. People who are in love with organization as such feel that everything should "follow the lines of organization," with the result that a single fact wanted will often have to be requested through eight or ten people and after the fact is ascertained will have to be reported back through the same eight or ten people. Such a procedure reminds one of the old nursery rhyme, "Stick won't beat dog, dog won't bite cat," etc.

Getting the Work Done

It cannot be too frequently stated that really to be effective an executive must always keep his mind on what it is that he is trying to accomplish. Of course this will never be anything but what is for the good of the business. So it be consistent with the good of the business, ambition is a good thing, but the desire for self-aggrandizement and the desire for power not as a means to an end but as an end in itself, are most serious human failings to be dealt with in running an organization. From the standpoint of getting the work done, it often makes no material difference whether a particular line of work is in one branch of the organization or in another. The organization as a whole will never function without coöperation between the branches, and with coöperation, the placing of work in one department rather than another is often of no material consequence. A desire, however, on the part of one executive to build larger at the expense of some other executive is very often a cause of friction and difficulty. With the successful executive the problem is not one of finding additional work to add to his organization, but of preventing jobs which do not belong to his organization being assigned to it. The executive who works hard to add to the size of his department condemns himself as a good executive.

Another difficulty in the practical operation of a large organization is frequently due to a lack of clear definition of responsibility and authority. Every executive is entitled to know clearly where his responsibilities begin and end, and he is entitled to have definitely the authority which will enable him to meet his responsibilities. Not only is every executive entitled to this, but when he in turn divides up his responsibilities and authorities among his immediate subordinates he must be especially careful to see that those authorities and responsibilities are clearly defined and understood. He cannot under any condition blame a subordinate for something for which the subordinate has no authority because without authority he cannot properly be held responsible.

A good executive realizes that there are a good many ways, and probably several very effective ways, of accomplishing a given result. He will have no foolish pride of opinion, no troublesome prepossessions. He will welcome intelligent opposition and suggestion from anyone and be quick to surrender a prejudice. While he will impress his personality on his organization, he will not insist that everything be done his way, as this will kill initiative and enthusiasm and make his organization a mere machine.

A Good Judge of Men

Finally, a good executive must be a first-rate judge of men. Perhaps his most important task is the selecting of his department heads. If he does this wisely and successfully, a good part of his task is done. Having selected them, he must trust, inspire, and lead them. He must command and retain their confidence and must be frank with them and fair to them. A successful general is one under whose leadership a staff and rank and file will work and die with enthusiasm.

While authority and responsibility must be clearly defined for executive work, there is, as I have already pointed out, another type of work which I have called administrative. It is not altogether possible to define the authority and responsibility for administrative work. The responsibility for such work is to some extent joint with all the higher executives of an organization. The final decision undoubtedly rests with the head of the organization, but he will wish to take counsel frequently with those who are not primarily responsible for the matter under discussion.

This counsel the chief executive may obtain by discussions with one individual at a time, possibly asking the opinion only of those whose judgment concerning the matter in question is especially valued. Some executives from temperament or even preference have been known to follow this plan only.

It is my personal belief that by far the best results are obtained by conference. To some minds conferences are a waste of time. Much is said that does not appear to bear upon the point under discussion. There is often a good deal of talk, but when important matters of policy are to be decided, I feel sure that the time used or even used up in conferences is very much worth while. When the chaff has been winnowed out, the wheat will be found.

It is important in a conference that everyone be given an opportunity to talk at length, that ideas expressed be listened to with tolerance by all. A prominent man once said that people's personalities and peculiarities meant no more to him than the weather. While this is going too far, nevertheless a conference held with a view to determining policies is not a place where tact and finesse are so necessary as freedom of speech. I realize that in business, one-man authority and responsibility, with the speed of action which results therefrom, is thought by many to be a great deal more effective than the slower process of conferences. I feel sure, however, that in an organization where large matters are at stake and where military authority and discipline are not required, the only safe and efficient way to determine policies is to confer deliberately and at length. Of course, the head of the organization must finally decide, and after deciding, act with firmness and confidence.

The Uses of Committees

ANOTHER type of machinery, excellent for the accomplishment of certain results, is the "committee." A committee differs in my mind from a conference in that it usually has definite responsibility and authority and acts by unanimous or majority vote. The committee is a slow way of accomplishing results, but where several branches of an organization are involved and each is responsible for a part of the answer, it is proper under some circumstances that the final decision should be made by a committee in which every part of the organization represented thereon assumes joint responsibility. The race is not always to the swift, and to accomplish our end which we are constantly keeping in sight, in some circumstances a committee is a splendid piece of machinery.

A committee, it seems to me, should always have a chairman. I recall an incident during the war when the Secretary of War appointed a number of committees, each composed of representatives of our army and some of the Allied military representatives who were in Washington. The committees were appointed without chairmen. A most distinguished representative of one of our Allies respectfully suggested to the Secretary that their experience in the war had shown committees to be of little value unless a chairman, or at least a "convener," were appointed. No action was taken, however, and the next day the inevitable happened: the committees failed to meet, no one knew who was to call meetings, and in fact no one was quite sure who his associates were on the committees. It was a very striking example of the failure of committee work to function properly without a chairman or at least a "convener."

ORGANIZATION inherently imposes some restrictions upon freedom. Organization means teamwork, and teamwork means working for the good of the team. Pride of authorship, desire to be personally in the limelight, any tendency to build up one's own reputation by criticizing or belittling others, are all disastrous to the successful working of an organization. After all, common sense and hard work, combined with a sympathetic consideration for others and pride in the institution will result in each man going ahead as far as his inherent abilities will permit, in spite of the size and complexity of large organizations. "Captains of industry" belong to the pioneer days that are past. Large modern business organizations require executives who are also wise administrators. It is the day of statesmanship in business.

PLOWING CABLES INTO THE GROUND

Unusual Equipment and New Techniques Have Been Developed for Cutting a Furrow and Laying Cables in It as a Single Operation at the Rate of Several Miles a Day

By TEMPLE C. SMITH

This article was originally prepared as a companion-piece to "Engineering the Transcontinental Telephone Cable," which appeared in the MAGAZINE *for November, 1941. It amplifies a paper on a similar topic which was presented before the winter meeting of the American Institute of Electrical Engineers.*

ANYONE harboring an ambition to obtain a basic patent on the art of plowing cables into the ground should acquaint himself with an experience of Mr. Ezra Cornell, the founder of the university which bears his name. This incident in his life, which occurred long before the idea of the university was conceived, is related by former Ambassador Andrew D. White in his autobiography as it was told to him by Mr. Cornell. Back in the early 1840's, so the story goes, Mr. Cornell chanced to meet the man who had contracted to place the first telegraph wires between Baltimore and Washington, and learned from him that he was in grave doubts as to his ability to carry out his contract. It must be remembered that the simple expedient of placing wires on poles had not then been proposed, so that those first historic circuits were to be placed underground. Mr. Cornell offered to build a machine which would dig the trench, lay the "leaden pipe" carrying these wires, and cover it with earth, cheaply and rapidly. He devised such a machine, and demonstrated to the satisfaction of an investigating committee that when "the long line of horses" dragged his "ponderous machine" forward, it really did lay the leaden pipe (cable) under ground.

Apparently, however, difficulties were encountered, for the machine was later abandoned. Many years elapsed before a really successful wire and cable-laying plow was developed and used.

As this article is being written, nearly a hundred years after those first telegraph wires were laid, huge plow trains like the one shown in Figure 1 are doggedly working their way across the Great Plains, laying other history-making wires—the first transcontinental telephone cable. Today, through industrial magic, we find the modern equivalent of Mr. Cornell's

Fig. 1. Across the Great Plains

The cable-laying plow train, as shown here, consists of: a 100-horsepower Diesel-engine caterpillar tractor; an empty traction-loading cable reel trailer, used in changing cable reels; two more tractors; a rooter plow; a fourth tractor; the cable-laying plow; and, finally, two reels of cable on winch-loading trailers. The entire train is connected into one unit with a motive force of 400 horsepower and a weight of 100 tons

"long line of horses" in the four great caterpillar tractors, whose deep-throated exhausts bespeak a power undreamed of a hundred years ago!

Similar trains are burying telephone cable in other parts of the country. In fact, to meet the demands for additional toll facilities arising from the nation's emergency program, the Bell System found it necessary to secure equipment for and to train crews to handle ten complete plow trains.

The use of plows for burying cable and wires is not new. In fact, the first Bell System plow was built in Oklahoma some 12 years ago for burying cable there. It could lay cable at a maximum depth of 30 inches. Only recently, however, has an entirely power-controlled plow been developed which is capable of cutting a slot as much as 50 inches deep, where such depth is needed, and of burying either a single cable or a pair of cables, together with as many as three properly spaced lightning protection wires where they are necessary.

Some of the arrangements used, the principal features of the large units of the equipment, and the attachments employed to meet the varying conditions encountered are discussed in the following pages. It will be evident that to provide apparatus for plowing-in cross-country toll cables has required the design of many pieces of equipment which the word "plow" does not imply.

In the development of each unit of equipment, the matter of safe performance of the work has been given careful thought. The heavy and powerful equipment is new to the plant crews, and special safety precautions must be practiced in its use.

Arrangement of the Equipment in the Plow Train

VARIOUS arrangements of the equipment in the train are made to meet various conditions, in each instance building the operation about the all-important plow. In Figure 1, two identical plows are included in the line in which all plows, tractors, and trailers are connected from one end of the train to the other, either by one-inch steel cables or by direct-acting towing hooks and eyes. The front plow roots through the earth with a 3¾-inch share, loosening and breaking up the ground to a depth of from 30 to 50 inches, thus insuring uninterrupted passage of the following plow, which deposits two cables and the lightning shield wires, all properly spaced, in the ground. This 100-ton train, with its more than 400-horsepower pulling force, moves forward at the rate of a brisk walk, laying the cables and lightning protection wires as it goes. Pauses are necessary only to change cable and wire reels on the trailers and to remove any major obstructions encountered in the ground.

Where the ground is not hard and is free of rocks, and thus there is no danger of interruption to the plow from buried obstructions, the train make-up may omit the rooter plow, as in Figure 2.

On the other hand, it frequently

FIG. 2. VIEW FROM THE REAR

One tractor and the rooter plow are omitted in this train (cf. Fig. 1), since the rooting operation is unnecessary where the ground is free of obstructions

FIG. 3, *left: Where ground conditions are as bad as this, the rooter plow goes ahead, and the cable-laying plow follows as a separate operation.* FIG. 4, *below: Power applied from the single-drum winch of a stationary tractor comes in handy for pulling the train, or any part of it, up hills or out of mud*

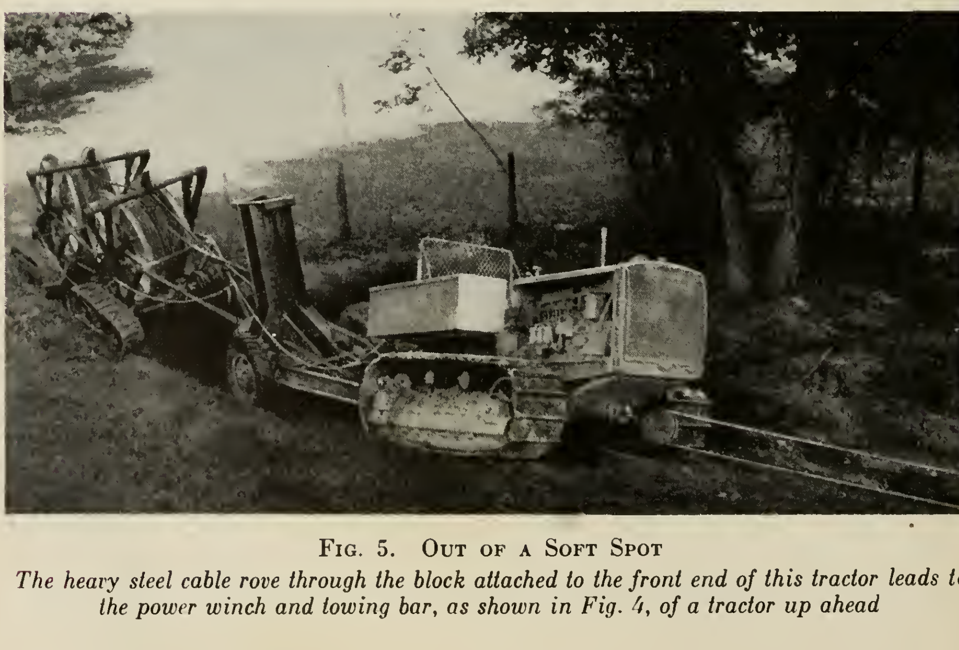


FIG. 5. OUT OF A SOFT SPOT

The heavy steel cable rove through the block attached to the front end of this tractor leads to the power winch and towing bar, as shown in Fig. 4, of a tractor up ahead happens that more difficult conditions exist, or underground obstructions are known to be present or are suspected —as, for example, when nests of heavy boulders extend down to the bottom of the trench (Figure 3). Here two or three tractors and one plow will first go over the line to root a trench. They are followed, as an entirely separate operation, by another plow train consisting of one or two tractors, a plow, and one or two cable reel trailers, depending upon the number of cables to be placed in the trench.

Winching the Train Out of Trouble

In rooting or plowing, occasionally the train may become stalled in pulling across a ravine or up a hill. The front tractor, with its powerful single drum winch (Figure 4), runs ahead to firm ground and prepares to "winch out" the train by making a two-to-one pull on the rear tractor, which remains coupled to the plow. (Figure 5.) When this operation is necessary, the driver of the front tractor first puts a tension in the steel winch line and sets the winch brake. Then he grinds the caterpillar tracks into the firm ground, pulling against the taut winch rope, until the tracks are sufficiently "dug in" to give the tractor a firm setting for a pull. Now, with the track brakes set on the front tractor and the winch pulling, and the rear tractor exerting whatever forward traction with its tracks the condition of the ground permits, the train moves ahead.

One caterpillar tractor's maximum drawbar pull is about 30,000 pounds on the level; but in moving up hill the pull is decreased in proportion to the steepness of the grade, since it is necessary, of course, to raise the tractor weight of some 41,000 pounds. With the aid of a double line pull from the heavy-duty winch of the forward tractor, the effort exerted may reach as much as 150,000 pounds. On a well chosen route there are few situations for which this set-up is not adequate.

Burying Cable on Steep Grades

By careful handling of the equipment, cable can be plowed in hillsides even where the grades are as much as 60 per cent. For instance, it has been found to be necessary to bury cable up hillsides such as shown in Figure 6. Here the cable will be buried in the "hog back" leading to the summit where the three poles are silhouetted against the sky. It will be evident that in such territory special attention must be given to selecting locations where cable reels can be changed on the trailers. Distances between locations thus determine the cable lengths per reel.

The preferred method of operation in these mountainside conditions is to root down the grade, leaving a tractor "dug in" on the top, with its winch rope attached as a safety line to the back of the rooter plow as it is slowly pulled down the slope by other tractors. The cable-laying train can be let down grade in the same manner. To obviate the possibility of buried stones wedging at the side of the plow share when placing the cable, the last pass of the plow doing the rooting work is in the same direction as the cable laying plow will take. Since the cable must be laid in continuous

Fig. 6, *left: Cable will be buried in the narrow "hog back" running from the top center in this picture down to the left.* Fig. 7, *below: Aerial photographs such as this, joined and mounted in panels, are of great value in planning the route of buried cable through difficult terrain*

Fig. 8, *right: "Buried treasure" detector—an electrical device which accurately locates underground pipes and cables both laterally and in depth.* Fig. 9, *below: A bulldozer at work. Leveling off sharp dips in uneven ground makes the subsequent passage of the plow train easier*

lengths which usually are about 1500 to 3000 feet each, there may be one or more up and down grades in one cable length, thus making necessary the pulling of the cable plow train up grade as well as down. Here again the trusty winch is brought into action after the tractor has been placed in a strategic position at the top of the hill.

Selecting and Preparing the Right-of-Way

Now that we have seen something of what the plow train is like and how it can winch itself out of difficult situations, let us go back in the sequence of the operations and see how the route for the buried cable is selected, surveyed, and explored so that the work of preparing the right-of-way can be started.

When it has been determined that a buried cable will be required between two points, possible routes are explored to establish the best location, keeping in mind such factors as accessibility, estimated cost of the construction, nature of the terrain, plant of other utilities, cost of right-of-way, and future developments. In rugged country this initial survey of the route may be made with the assistance of aerial photography. The airplane survey pictures are carefully studied through special lenses which give a three dimensional effect, and remarkable detail is afforded by the present-day photographic and viewing equipment (Figure 7). The relative heights of trees and buildings stand out with all the clarity of the old-time stereoscope. Since private right-of-way is generally followed, often over very rough terrain, the use of this ideal method of route selection is often found to be worth while.

The tentative route laid out on the aerial survey picture is now explored on the ground by engineers. Ordinarily the route goes across fields, woodlands, mountains and streams, but always consideration is given to accessibility from the highways, and to the other factors which have been mentioned. This is important for both the ease of installing the cable and maintaining it in the future.

Information regarding soil conditions and underground obstructions is very valuable in planning the route. Sometimes oil and gas pipe lines are encountered. Experience indicates that there are many pipes in the ground regarding which there are no accurate records—and in many cases no records at all. These underground pipes have to be located both as to where the proposed route crosses them and as to their depth, because the plow is sufficiently rugged and the tractors have ample power to snap a good sized underground pipe in two. This method of striking oil is not to be recommended.

On one 83-mile run there were 91 crossings of oil pipe lines at the time of the survey. Before the work was done, in a few months, four new pipe lines had been gained and three old ones lost. By the use of suitable apparatus, underground pipes and cables can be readily located without excavating. There are commercially available vacuum-tube type locators which indicate the vicinity of buried cable or pipe. To determine their exact location, a triple coil electrical detector developed by the Bell Tele-

FIG. 10, *right:* *A bulldozer has already opened up a passage for the plow train in the bank of this creek.* FIG. 11, *below:* *Crossing a road at an angle often obviates cutting away shoulders or banks*

FIG. 12. *A bulldozer "eased off" the sharp drop of the ditch banks in preparation for a square crossing of this road. Road surface and shoulders and ditch banks are always restored to their original condition*

phone Laboratories may be used (Figure 8). This device, which is primarily for locating cables, can be used also in exploring for buried pipes. It is so accurate that an underground cable can be located within less than an inch both laterally and in depth below the surface.

Through use of the information accumulated by the methods discussed, the line of the proposed buried cable can now be staked out in readiness for the work crews. Buried boulders, ditches, and other obstacles interfere with the cable-plowing operation. Whatever preparatory work can be done to prevent delays to the rooting and cable-plowing crews helps to "keep the train moving."

Preparing the Roadway for the Plow Train

One of the first jobs to be done in opening up the cross-country roadway is to build gates in all the fences encountered. These are necessary for future maintenance as well as for the passage of the cable-laying train.

At sharp ravines, road ditches, and stream banks, a roadway is made by a caterpillar tractor operating with a "bulldozer," as shown in Figure 9. A creek crossing as in Figure 10 becomes quite simple and no delay is involved if the bulldozer has first cut a road through the banks. It might be noted in passing that at such locations, if there is any danger of the cable being disturbed later by road construction work or earth washing, the cable is plowed in at full 50-inch depth and, to afford maximum protection, a covering of steel or creosoted wood is sometimes placed over the cable.

At road crossings such as is shown in Figure 11 the ditches may be shallow and the crossing made at an angle, so that it is not necessary to prepare a roadway crossing the ditch banks. Where the crossing is square and the ditch banks steep, as in Figure 12, it is desirable to ease the drop in order to facilitate pulling the train across and to minimize the tilting of the plow with the attendant tendency to raise the bottom of the share, thus laying the cable at a too shallow depth.

The plow operates satisfactorily across gravel and macadam roads as well as those which are not surfaced. After passage of the plow, the disturbed ground in the roads and the ditch banks is carefully restored to its former condition, thus preventing erosion.

The caterpillar-tractor-operated bulldozer, or its close relative the trail-blazer, is useful in preparing a roadway where it is desired to plow-in the cable along a hillside instead of up or down the hill. It is not safe to operate the train on more than about a 10 per cent side grade, due to the tendency of the pulling tractors as well as the plow and trailers to slide down hill. On such side-hill grades the winch is again useful in minimizing the tendency of the train to slide to the down-hill side.

Of course, in wooded country a roadway must be prepared for moving the cable reels and equipment along the right-of-way as well as to clear a place to plow.

On private right-of-way an easement on a strip of ground about one rod wide is ordinarily secured, anticipating the possible future need of

FIG. 13, *above: Only the winch power of the head tractor makes possible the plowing-in of cable here.* FIG. 14, *left: Oak "swamp grousers" on caterpillar tracks increase the supporting surface.* FIG. 15, *below: The skid under the plow helps to support the down thrust of the tongue*

FIG. 16, *above: The skid under the trailer gives additional support over soft ground.* FIG. 17, *right: Here the problems are depth and density of mud, weight of equipment, supporting area, and winch power.* FIG. 18, *below: The plow continues to bury cable as it is winched across the river*

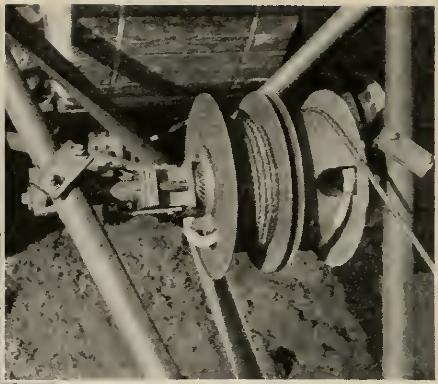
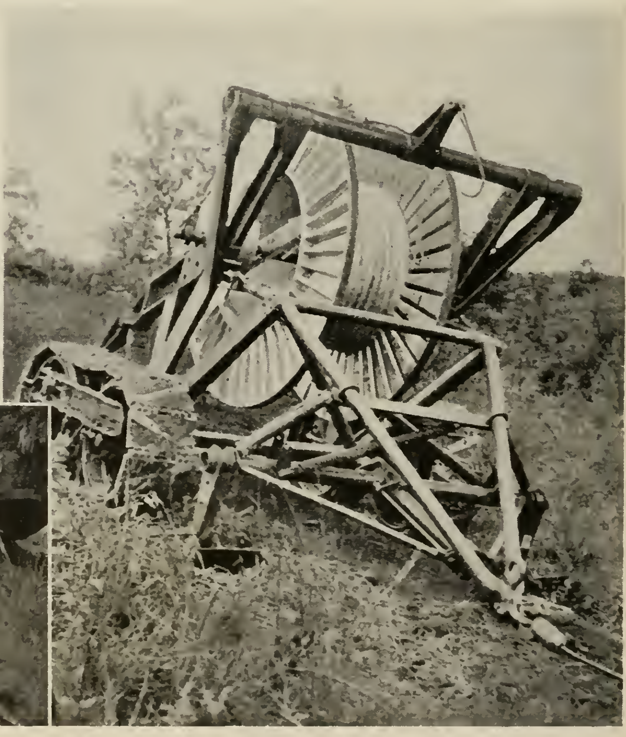
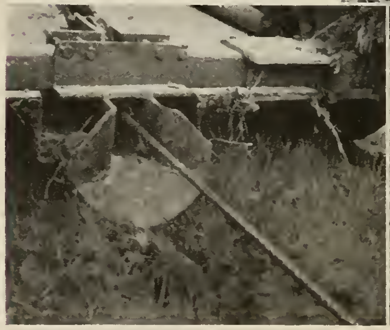


FIG. 19, *left: A multi-drum winch on a tractor. It is used for adjusting the depth of the plow, loading cable reels, and moving trailers.* FIG. 20, *above: This relay winch pulls the tongue end of the rear trailer into a special keeper which serves as a coupling. Paying out the wire rope permits the trailer to drop behind*

FIG. 21, *right: Release of the relay winch has halted the rear trailer. The bullet-nose connector is shown at the end of the trailer tongue, at the lower right.* FIG. 22, *below: This keeper, under the axle of the front trailer, receives the bullet-nose connector, which is held by tension on the rope from the tractor ahead*





a second buried cable. A passageway at least 10 feet wide is cleared, and at reel change points additional width is required to maneuver the equipment. The 10-foot width will permit passage of the train in rooting and plowing. However, unless the cost of clearing an extra three feet of right-of-way is excessive, it is very desirable to have a 13-foot passageway so that the 8½-foot-wide tractor can be used for tamping, as will be discussed later. Where practicable, the trees within the proposed plow-trench area are pulled out by the roots in order to eliminate the interference with plowing which the roots would cause, and also in order that the roots may not conduct lightning to the cable.

Crossing Swamps

It has been necessary in a few cases to bury cable across marshy ground or swamps (Figure 13). This has presented a difficult problem. However, because of the use of specially designed equipment and appropriate methods, there have been no cases where the heavy cable-plowing equipment has disappeared in the "black bog," never to be seen again, as did the helpless Carver in the story of Lorna Doone. It is gratifying to relate that all swamp jobs yet attempted, even those in the very soft and seemingly bottomless Dismal Swamp at the southeastern tip of Virginia, have been successfully completed.

Attaching "swamp grousers" made of overhanging, bolted-on oak cleats, to the caterpillar tracks (Figure 14) has helped materially, although if these alone were relied upon and an attempt were made to pull the train with the tractor tracks, a grave would be quickly dug for the machine. However, the tracks so equipped do permit maneuvering the tractor across a marsh, thus obviating traveling long distances to find firm ground or roads. In this manner the tractor can be quickly run ahead and located for a winch pull from firm ground or, if this is not available, with the front end anchored to some stable object.

For swamp work the plow tongue is supported by a special steel skid. In Figure 15 the skid seems small because of the large equipment with which it is associated. Actually it is 3½ feet wide and 11 feet long. When it is operating on mud, a large skid is placed under each wheel in order to give the plow better bearing surface to carry the load than is provided by the 12.75 by 24-inch pneumatic tires. Also, there are large bearing plates under the framework of the plow. In addition to the bearing surface furnished by the caterpillar tracks of the cable reel trailers, a large bearing plate extends from the middle of the tongue clear back to the under side of the axle, as shown in Figure 16.

By such expedients as these, the unit bearing pressure on the mud for each unit of the cable-laying train is so reduced that the train can be slid over the soft surface, while at the same time depositing the buried cable and wires at the proper distance beneath the surface (Figure 17).

Crossing Streams

The technique followed in crossing some types of streams is similar in many respects to that used in negotiating marshy ground. However, if the water is deep, it may be necessary for the tractor to detour to shallower wa-

FIG. 23, *above: Loading a reel of cable onto a trailer. The yoke is being pulled up by a line from a multi-drum tractor winch, and the latches will catch the spindle after another foot of travel.* FIG. 24, *right: The share of the cable-laying plow is in its upper position, so that the cable can be fed through it at the start of a laying operation.* FIG. 25, *below: This is how twin cables feed out through the foot of the plow share and are pulled through and staked before the train moves ahead*

Fig. 26. *Each succeeding cable is clamped to the end of the cable ahead, in order to pull it into the plow share*

Fig. 27. *Guiding clamped cables into the plow share. Cables must enter the share in proper position to obviate binding*

Fig. 28. *Lightning shield wire bracket. It is often necessary to bury properly spaced lightning-protection wires in the same furrow with the cable*

FIG. 29. CHANGING REELS ON THE FRONT TRAILER

The train must be broken in order to get a full reel of cable to the front trailer and remove the empty reel

ter or by the nearest bridge. It may be found desirable also to root across before laying the cable under the stream, whereas in the soft marsh the rooting may not be necessary (Figure 18).

If the cable plow is started on one river bank in the trench previously cut by the rooter, and the winch line pull is made from the same position each time, the plow will ordinarily follow the rooter trench. In some cases of this sort, the plow and trailer equipment have been almost completely submerged.

Important Features of Operation of the Plow Train

THE caterpillar tractor placed next to the plow in the train is equipped with a 4-drum winch (Figure 19) with independent lever controls conveniently located for the tractor driver so that he can exert a pull up to about 6000 pounds on any one or more of the four winch ropes.

Two ropes feed to pulley blocks at the base of the tower of the plow. One of these ropes pulls the plow share up to reduce its depth or to raise it entirely out of the ground. The other pulls the share into the ground, thus adjusting the cable depth to the desired position, where the share is locked. Depth markings of from 20 to 50 inches can be seen on the tower frame member in several of the pictures.

A third rope feeds to a new type "relay winch" mounted in the tongue of the front trailer (Figure 20), for use on dual cable jobs. It pulls the bullet-shaped connector at the tongue end of the second trailer (Figure 21) into its keeper under the axle of the front trailer (Figure 22). By this method of releasing the rear from the front trailer and of reconnecting it, the operation can be accomplished safely, quickly, and easily even though the coupling parts may be under water or mud. Also, the rear trailer is always under control, even when the coupling is released, by virtue of the steel rope from the bullet connector leading through the keeper under the axle of the front trailer and finally being secured by the relay winch. As mentioned later, this feature is necessary to permit changing empty for full reels of cable.

The fourth rope from the multi-drum winch leads to the arm of the reel-lifting yoke on either cable trailer, as shown in Figure 23. Pulling the yoke forward raises the loaded cable reel, which may weigh as much as 10,000 pounds, into the traveling position, where the reel spindle is locked. Reversing the operation and gradually paying out the winch line lowers the empty reel from the trailer.

Feeding Cables and Wires into Plow

In starting a dual cable job, the plow share is raised to the top position, as in Figure 24, and the cable ends are fed into the back of the share until they emerge from the opening at the bottom (Figure 25). The cable ends then are secured against movement along the ground, the share is gradually lowered to depth during the first few feet of travel, and the plow train moves forward for 1500 to 3000 feet, thus laying the two cables at the desired depth and leaving both reels empty.

The empty reels are lowered from the trailers and full reels loaded. Now the new cable ends must be fed through the plow share. This is done by connecting each new length of cable to the one which has just been placed, by overlapping the ends and binding them together (Figure 26). As the plow train now starts on the next installation, the connected ends are guided into the share and one cycle of operations has been completed (Figure 27).

Where lightning shield wires are required, the reels of wire are carried on a bracket at the top of the plow tower, as in Figure 27, or on the front trailer (Figure 28), and fed to the top of the tower as shown in Figure

FIG. 30. CHANGING REELS ON THE REAR TRAILER
After the empty reel is lowered from the trailer, the new reel of cable is picked up directly from the service trailer which brings it into position

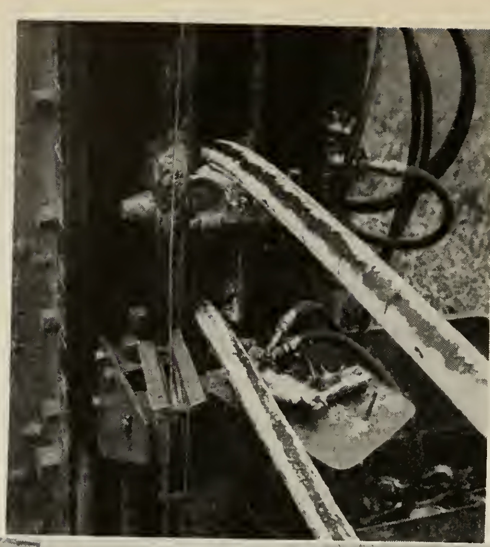


FIG. 31, *left: Oil is sprayed on the cable as it enters the plow, to reduce friction. About four gallons of oil per mile is applied by the spray gun seen at the right of the lower cable.* FIG. 32, *below: This shows the coupling between tractor and plow, released. When the shear pin—with a breaking point of 72,000 pounds—snaps, the heavy tubular guides hold the tongue in place so that recoupling may be quickly done*

FIG. 33. *Back-filling is part of the cable-laying operation. A device under the rear trailer mounds up the earth over the furrow, and a tractor runs over it when bringing up a new reel of cable*

24 and thence through special ducts in the share to the desired locations in the ground. This operation takes place, of course, simultaneously with the cable plowing.

Changing the reels is necessary for every cable length, usually at 1500- to 3000-foot intervals. Where only one cable is being laid, this is a simple matter; but where two reels are involved, the changing of the front one presents some difficulties, as can be visualized by referring to Figure 2. The rear trailer completely blocks the operation.

In order to leave space between the two trailers, thus permitting the front one to be loaded, the rear trailer is dropped from the train as it moves along, about 50 feet before the cable-end leaves the rear reel. This is accomplished by releasing the relay winch, thus disconnecting the rear trailer from the train, just as the engineer of a switching locomotive might drop a car from his train. The front trailer is now accessible from the rear so that the empty reel can be lowered from it (Figure 29). A tractor with a third trailer now moves a full reel to the front trailer and it is loaded. The relay winch comes into action at this point to pull the rear trailer with its empty reel up to its working position, where it is automatically coupled in the train, after which it receives a new reel full of cable, as shown in Figure 30.

Lubricating the Cable

The buried cables ordinarily used range in size from one to 2½ inches in outside diameter. However, cables as large as 3.2 inches in diameter may be used by employing a wider share, which the plow is designed to accommodate. Usually the cables are covered with a jute wrapping, under which, in gopher infested territories, there will be steel tape surrounding the conventional lead sheath. In some cases a thermoplastic rubber covering with a burlap wrapping is used instead of the jute.

But asphalt-impregnated jute covering and the impregnated burlap develop comparatively high coefficients of friction against the steel walls of the rectangular tube through which they pass while in the plow share. When two cables are buried, the top one in the ground may show a tension as high as 5000 pounds as it is being pulled through the share. This tension is objectionable for electrical as well as mechanical reasons.

In order to obviate this difficulty, an oil spray apparatus is used, from which a constant spray of oil impinges upon the lower side of the bottom cable as it enters the plow, thus reducing the tension in the cable to a safe maximum of less than 1000 pounds (Figure 31).

The Safety Shear Pin

With two or three powerful tractors pulling in series formation, what happens if the extremely rugged rooting plow hits, let us say, a buried ledge of solid rock? The plow is an integral part of the very heavy, briskly moving rooter train with its combined tractor pull of 200 or 300 horsepower. Recollections of the school-boy poser about the irresistible force and the immovable body come to mind.

Figure 32 shows the result of such an occurrence. A large safety shear pin, which releases at 72,000-pound pull, is located in the front of the plow tongue. It has just sheared, and the telescoping tubes have permitted the tractors to move forward until they can be stopped by their operators. The tractors will be backed until the tow bar enters the hole in the end of the plow tongue, a new shear pin inserted to hold it in the hole, the share raised sufficiently to clear the obstruction, and then the plowing will proceed. This operation requires less than two minutes' time from stop to start and can be done easily even under water or in mud. The shear pin, like a fuse in an electrical circuit, saves the equipment from damage.

Backfilling and Tamping

SOME soils, especially moist sod, are not sufficiently disturbed by passage of the plow share to require backfilling. Under other conditions the surface of the ground may be heaved from caterpillar track to caterpillar track by the 3¾-inch-wide share with extra ducts, familiarly known as "blisters," on the sides to carry the lightning shield wires. In Figure 33 is shown the result obtained under such a condition with the V-shaped backfiller under the rear trailer. A good job of tamping is done by running a caterpillar tractor so that its tread passes along first one side of the ridge and then the other. This may be done as an incidental operation by the tractor which handles empty and full reels.

The clatter of the several Diesel engines makes vocal signals impossible. This condition is met by such a device as the tractor exhaust whistle,

FIG. 34. SALTY RIGHT-OF-WAY
The transcontinental cables will be plowed into the salt bed at the left of the roadway, which adjoins the automobile speed-record course near Great Salt Lake

FIG. 35. NO CABLE PLOW GOES HERE

In this solid granite of the High Sierras, a trench for the transcontinental cables will be prepared by chain blasting

which can be blown by cords hanging at either side of the plow. Particularly when a quick stop is required, a loud signal must be used to reach the drivers of the noisy caterpillars which are ahead, as well as the near one.

UNDER ordinary conditions it is possible to place about 17 trench miles of cable per 5-day week with this equipment. This would mean that a foreman with his crew of about eight men, on a dual cable job, might, in a week, bury 34 miles of cable, together with whatever lightning shield wires are required.

Conditions vary widely, from the prairies with their black loam and clay to the steep mountains, or the soft marshes, or to soil sown thick with boulders. The mileage of cable buried daily naturally will correspond to the conditions encountered.

Burying Cable by Other Methods

BECAUSE of its speed and economy, the plow train is used wherever practicable for burying cables, and this covers all but a very small percentage of the buried cable work.

In extremely rough mountain territory some right-of-way may be too steep or rocky or inaccessible for the plow train, but it is surprising how relatively small is the footage even here which cannot be economically plowed. For instance, on the proposed transcontinental cable line, there was some question whether the plow could be used in the ten miles of hard salt beds shown at the left of the highway in Figure 34, adjoining the Bonneville automobile racing flats in Utah. However, in exploratory trials at this location, the plow rooted through the hard salt beds very satisfactorily.

On the shorter projects, trenching machines are employed to a considerable extent, and also on a few of the major undertakings where conditions are particularly favorable to their use.

In connection with cable-plowing, several variations of the plows and associated equipment have been tried in the course of the development of a satisfactory plow train. While experimental devices are of course under trial now, the units described in this article represent types which have proved satisfactory and are currently in general use.

There are some locations in the High Sierras where a relatively small portion of the Sacramento-Reno buried cable run must cross areas of practically solid granite (Figure 35). Here the engineers plan to prepare by chain blasting a narrow shallow trench in which the cables will be laid. The trench will then be filled with an asphaltic material which will hold its position, keep water out of the trench, and protect the cable.

In an article such as this, only the major operations and the principal items of equipment can be mentioned. Many others have had to be developed in order to make the use of buried cable broadly applicable. There are the jobs of passing under concrete arterial highways where the pavement cannot be disturbed and the soil may be either earth or rock. There is the matter of finding a way to cross under rivers too swift and full of boulders for submarine cable and having granite beds which cannot, of course, be plowed. There is the matter of avoiding buried pipes and other obstructions. These have been interesting problems in themselves—of whose solutions there is not space to write here.

Most spectacular will be the plowing-in of certain parts of the Omaha-Sacramento transcontinental telephone cable, which, upon completion late this year, will provide the first all-cable link between the eastern and Pacific Coast toll telephone networks. That is only one part, however, of the program of underground cable extension which the Bell System is now carrying on—a program which is being speeded to the utmost to keep abreast of the mounting demands for telephone service being imposed by the national emergency.

What has been told here is but one chapter in the story of the System's continuing search for better ways of doing the job entrusted to it; the job of furnishing telephone service for the nation under all conditions. The methods and equipment used in plowing telephone cables into the ground, here described, are the result of planning, designing, and testing; and have had as their objective the provision of more and better and safer speechways for the voices of a people habituated to rely on the telephone for swift communication of their thoughts and needs.

THE FUTURE OF TRANSOCEANIC TELEPHONY

Submarine Cables, with Integral Vacuum-Tube Repeaters at 40-mile Intervals along the Ocean Floor, Are Contemplated as Supplementary to Existing Radio Telephone Circuits

By OLIVER E. BUCKLEY

When Dr. Buckley, who is President of the Bell Telephone Laboratories, was invited by the Institution of Electrical Engineers (of England) to deliver the thirty-third Kelvin Lecture in London last April, not only was a notable honor conferred upon him, but the accomplishments of the Bell System in electrical communication were thus given recognition.

Lord Kelvin, in whose honor the lectureship was established, was one of the great physicists of the nineteenth century. He made many contributions to both fundamental and applied science; and of the latter, none has received greater public recognition than his development of a transmission theory for application to the second transatlantic telegraph cable (1866) which made of it a success where its predecessor had been a failure. This is regarded as perhaps the first great achievement in what is now the highly developed science of circuit analysis. In the light of this situation, the subject-matter of Dr. Buckley's paper is particularly appropriate.

In the first portion of his address, which is omitted here, Dr. Buckley reviewed the frequency-band requirements of various forms of electrical communication, described the development of transatlantic radio telephony, and commented on the application of magnetic loading materials to undersea telegraphy which has multiplied by four the traffic capacity of modern cables. Information gained in that work was in turn applied to the problems of submarine cable telephony, and in 1930 a short experimental section of such a cable was actually manufactured for the Bell System and was tested at sea. Advances in transoceanic short-wave radio telephony, and the business depression of the 1930's, made the possibilities of that cable less attractive and, although it appeared technically sound, the project was not carried beyond the experimental stage.

Since Dr. Buckley was unable to journey to London to deliver the lecture himself, he had a brief sound-picture of greeting recorded. After he had appeared on the screen before his audience in London, his paper was read by Sir Stanley Angwin, Vice-President of the Institution. The latter portion of the address follows.

THE EDITORS

To predict the future development of transoceanic telephony is presumptuous, to say the least. So rapid has been the advance in the art of communication and so revolutionary have been the discoveries in this field that one is quite unwarranted in setting any limits to the progress that may be achieved. However, there are some developments that have progressed far enough in the laboratory to discuss with reference to their early application; also there are pertinent indications as to the future of transoceanic telephony apparent from consideration of developments which have occurred in long-distance overland telephony.

Perhaps the most significant recent development in land-line telephony is that of broad-band transmission over open wires, cables, and coaxial conductors. Broad-band transmission means the transmission by carrier methods of a considerable group of telephone bands on closely spaced channels. Over open-wire lines and over pairs in lead-covered cables, 12 telephone bands spaced at 4000-cycle intervals are commonly transmitted in a group occupying a total band width of 48,000 cycles. With coaxial conductors, the band has been increased to 2,000,000 cycles, giving frequency space for some 500 telephone channels, and it may be expanded still further when more channels are required.

Broad-Band Methods for Trans-Oceanic Telephony

The application of broad-band methods to transoceanic radio telephony may be anticipated with some confidence. To achieve it requires broad-band amplifying systems capable of delivering high power without distortion. Commercial success has already been achieved with small numbers of channels in the Holland-East Indies and the United States-England single-sideband systems. More recently, by applying the principles of negative feedback, Bell Laboratories engineers have developed a short-wave transmitting amplifier of 200 kw capable of handling 12 or more closely spaced telephone channels.

One might visualize the broad-band transatlantic radio telephone system of the future as being built up of successive groups of these 12-channel blocks. The number of groups that might be used simultaneously is, of course, limited. Over any path where radio transmission depends upon reflections between the ionosphere and the earth, Nature sets a rather definite limit on the range of frequencies that is usable at any given time. In effect, there is provided a transmission path between transmitter and receiver which is capable of passing a broad but nevertheless limited band of frequencies. Frequencies above this band are not consistently returned to earth from the ionized regions. Frequencies below this range are absorbed. The high-frequency end is marked by a sharp cut-off, while there is a more gradual diminution of effectiveness at the low-frequency end. The position in the spectrum of the useful band shifts with time of day, season of the year, and phase of the solar cycle. Its width varies, too, being narrow at night and wider during the day.

Thus, for example, when the sun is over the mid-Atlantic in summer there is available a useful band of frequencies about 4 megacycles wide, extending from about 14 to 18 megacycles. It is not sharply defined on its lower side, and its position in the spectrum varies with the season of the year and the sunspot cycle. But we may say roughly that nature provides at any one time, at least during the most useful hours of the day, a band width of the order of 4 megacycles. If this entire range could be utilized for telephony over this particular path, and were subdivided sharply into telephone bands of 4 kilocycles width, there could be realized 1,000 telephone channels. These might be used in any of the several ways, as to two-way transmission and as to the points at which they terminate.

But public service transatlantic telephony is not the only service requiring these important short waves. There are many other uses of them, such as radio telegraphy, ship-to-shore telephony, airplane communication and navigation, and overseas broadcasting. There are also other natural barriers than the Atlantic to be bridged in this manner, and these short waves, because of their world-wide effect and despite the directivity that can be imparted to them, cannot be counted upon to be duplicated very often for simultaneous use at different locations throughout the world. So we must allow for the available 4 megacycles to be divided to meet a large number of requirements, perhape none more important than the Atlantic route, yet collectively of great consequence. Let us say that, in view of all the other requirements, public service telephony across the Atlantic deserves something like a tenth of the total facilities in this band. This would mean an allotment of 400 kilocycles or 100 one-way telephone channels, yielding 50 or more two-way circuits realizable under the natural limitations of the medium and the other requirements placed upon it.

Of course, the demand for such a number of transatlantic telephone circuits will depend in large measure upon the economy with which they can be realized, but the estimate serves at least the purpose of pointing out that short waves can provide physical facilities for a volume of telephone communication far beyond that now obtaining. Surely we can anticipate with confidence a great growth of transatlantic telephone traffic, but in proportion as the demands for service grow and we come closer to the realization of the ultimate physical possibilities, the more serious becomes the threat of interruption to this service by magnetic storms.

The Transatlantic Telephone Cable as an Auxiliary

These conclusions lead us to reconsideration of the transatlantic telephone cable as an auxiliary to short-wave systems. It is readily apparent now, however, that a single-channel cable such as we projected in 1929 would be of little value in supplement ing a radio telephone service of so many channels as there may be in the future. To be of any real value in this situation, the cable also must be capable of carrying a considerable group of telephone channels. It was toward such a possibility that we turned when the project of a single-channel cable was suspended. We have made considerable progress in that direction, and I would like to tell you about it, if you will excuse my presenting a proposal which has still many elements of speculation in it.

It was obvious at the start that a multi-channel telephone cable to cross the ocean would have to be provided with intermediate repeaters, since even a single-channel cable without repeaters required going to practical extremes in structural design. Consideration of mechanical difficulties ruled out locating the repeaters elsewhere than on the ocean bottom. Problems of laying and lifting made it obvious that the repeater housing should, if possible, be incorporated within the cable structure and treated as a part of the cable rather than as an appendage to it. Hence we were led to develop a small-diameter cylindrical housing to be incorporated as a part of the cable underneath its armor. The whole structure had to be flexible so that it could be bent around a cable drum and passed over the bow or stern sheave of a cable ship.

The structure of the repeater housing which was devised comprises first a succession of pressure-resisting steel rings each having a diameter of about 1½ inches and a width of three-quarters of an inch. Over these is slid a succession of thinner steel rings of the same width but so placed as to overlap the joints of the inner rings. So assembled, the rings form an articulated cylinder about seven feet long. To exclude water, there is placed over this cylinder an annealed copper tube with water-tight seals at its ends. The details of the seal are of the greatest importance. It combines a strictly hermetic seal, in which the conductors are brought out through glass, with a plastic seal through which diffusion of water vapor would be extremely slow, should the glass seal fail. Joined to the copper cylinder, and extending over the cable core for several feet, is a tapered copper sheath which serves to distribute bending strain and protect the conductor joint at the seal. Containers of the type described have been tested at pressures considerably higher than would be encountered in a transatlantic cable. They have also been subjected to repeated bending around a six-foot drum without failure.

Within the repeater housing the elements of the repeater are separately contained in plastic cylinders about six inches long, loosely fitting inside the inner steel rings. Connections between these units are made with flexible conductors.

Power for the Repeaters

A repeater must, of course, be supplied with power and, as it is impracticable to provide a primary source of power in such a small housing, power must be fed to the repeater over the cable from a direct-current supply. The supply voltage is one of the limiting considerations in the design of such a cable system. It must not be so high as to endanger the insulation of the cable or repeater elements. An operating potential-to-ground of 2000 volts oppositely poled at the ends of the cable was assumed. Power would be supplied on a constant current basis so that fluctuations of earth-potential would not cause variations of current-supply. The repeater elements were designed to withstand the anticipated voltage-to-earth. Tests of cable-core and joints over a long period of time have shown no observable change under this impressed voltage.

The difficulties of lifting a deep-sea cable for repairs are such as practically to prohibit frequent access to the repeaters for maintenance. Hence, the repeater must be provided with elements which will rarely, if ever, require attention. A period of 20 years without replacement of parts was assumed as a reasonable requirement.

Vacuum-tube Problems

THE problem of life and maintenance is principally the problem of a rugged long-lived vacuum tube. Ordinary vacuum tubes have limited service-life on account of evaporation of material from thermionic cathodes. By making the level of transmitted signals relatively low, the space current may be kept very small. By making the cathode surface relatively large, this small current can be obtained at a temperature so low that the cathodes of the tubes may be expected to last for a very long time.

This is a different approach to the tube problem than has ordinarily been made. New types of tubes based on these principles were developed and put on life tests more than five years ago. As yet they have shown no evidence of deterioration, and one now may be reasonably sure from their behavior and from physical considerations of a life of at least ten years. There is good reason to think that they should last several times that long, but further observation will be required before a life of as much as 20 years' steady operation can be confidently predicted. The tubes must also be more rugged than ordinary vacuum tubes since the cable will be subjected to considerable vibration and perhaps to heavy blows in the course of laying and lifting, though the tubes can be protected to some degree by resilient mountings.

Other elements of the repeater structure, such as coils and condensers, are also subject to special requirements both electrical and mechanical. These requirements have been met in a preliminary way and the assembled repeater in its housing subjected to mechanical tests in the laboratory.

Although the electrical requirements of such a cable are very severe, there are some respects in which the submarine telephone repeater is simpler than a land-line repeater. The temperature at the bottom of the ocean is nearly constant; consequently, the repeater does not have to be regulated to compensate changes of cable characteristics with temperature. Also, once the cable is laid, it is in a very quiet place, and except in shallow water near shore is not likely to be disturbed. True, the electrical characteristics of the cable may show effects of aging, but over a long period of time changes are not great, and they can be allowed for by providing some margin in the electrical design.

IN the circuit of the repeater the heating filaments of the amplifying tubes are placed in series with the central cable conductor. The fall of potential through the heater filaments provides the plate potential for the tubes. Appropriate networks compensate for variation of cable attenuation with frequency. A negative feedback circuit gives a high degree of stability over a wide band of frequencies and minimizes the effect of variations of tube characteristics. It is interesting to note that the amplification provided by a single tube could drop to a tenth its normal value with scarcely appreciable effect on the performance of the repeater.

The number and spacing of repeaters depends of course on the length and design of the cable. For a cable 2000 miles long to connect Newfoundland and Great Britain there was calculated a core comprising 516 pounds of copper per mile insulated with 370 pounds of paragutta, surrounded by a return conductor of 600 pounds. This is like the core of the 1930 Key West-Havana telephone cable but somewhat smaller. Paragutta was assumed as the insulating material because of extensive experience with it. By using for the calculation the characteristics of one of the newer synthetic insulating materials a somewhat more favorable design would have been obtained. On this cable 47 repeaters spaced 42 miles apart would provide for the transmission of a band 48,000 cycles wide.

Two One-way Cables

The repeater is a one-way device and to provide two-way conversations two cables have been assumed, one directed eastward and the other westward. This is the simplest solution of the two-way problem but it is not inconceivable that the problem could be solved with a single cable. Using two cables, each transmitting 48,000 cycles, the number of telephone circuits will depend on the band assigned per channel. If we adhere to the present best land-line practice, and assign 4000 cycles per channel there would be room for 12 telephone circuits. For a small sacrifice of quality the number could be materially increased. Even as many as 24 fairly satisfactory circuits could be provided by assigning only 2000 cycles per channel.

Although in Bell Laboratories we have gone a considerable distance in the design of a broad-band repeatered submarine telephone cable, and have developed many of the essential parts, I would not wish to give the impression that all the problems of such a cable have been solved, or that the time has come to proceed with its construction and installation. Indeed, it is only by building trial sections of such a cable and subjecting them to repeated punishment more severe than a cable is likely to encounter, that the problems can be fully recognized. Extensive electrical tests will also have to be made on a complete assembly of repeaters with artificial lines simulating sections of cable. These steps have yet to be taken.

A submarine cable requires a degree of care and precaution in engineering such as is required in few other situations. It is usually not possible to provide large factors of safety, and yet failure of a single part, such as a break in the conductor or a leak in the insulation, completely destroys the operation of the whole system. Experiences of over eighty years since the failure of the first attempt at an Atlantic cable have led to the development of practices which give good assurance of the reliability of cables of simple construction, but when a device such as the proposed repeater is made a part of the structure a new set of hazards is introduced. Whether these hazards can be guarded against well enough to justify the risks of such a cable project remains to be seen, but I am optimistic that by a sufficiently thorough job of cable manufacture and a well planned program of trials, the hazards can be reduced to an acceptable degree. It will take some years to reach this point, and at best it must be expected that some degree of hazard will still remain. Submarine cables, like all things that go to sea, can never be completely dissociated from some chance of disaster.

Estimating the Cost

As to the costs of such a cable project for establishment of broad-band wire telephony to England via Newfoundland, only the roughest sort of estimates can be made at this time. However, even applying annual charges somewhat higher than have commonly been used for cables, it appears that the total cost per telephone circuit for the system of two cables with associated equipment will be comparable with that of prospective short-wave radio systems. A considerable increment of cost of cable over that of radio would be justified by the better quality of transmitted speech and the very significant advantage of privacy. Added to this is the value of the cable as a supplement to radio systems to provide against their failure. Indeed, it is possible that, once the cable were in service, radio would be looked on as a supplement to it.

The comparison of cable and radio telephony is not easy to make. It is the composite of cable and radio that assures continuity of service, since, while radio is sensitive to disturbances accompanying magnetic storms, and cable less so, radio service is not so exposed to the possibility of interruption by mechanical accident or malicious intent. An advantage of radio systems is their flexibility, whereby new routes can be established or old routes abandoned without incurring excessive costs. Further, provision can be made for expansion of radio facilities as required without having to install so large a complement of circuits at the outset. The prospect of the combined radio and cable system is a happy one in that it affords the advantage of both types of facility.

In the foregoing discussion I have treated the tranoceanic telephone problem principally as the transatlantic problem and more particularly as the problem of connecting North America and Great Britain. Community of language and many interests lend particular emphasis to that connection, but it is, after all, only one of the many transoceanic links required to build the world-wide telephone network of the future.

When we come to look at other situations, the relative advantages of radio and cable weigh differently. Short-wave radio links have a great advantage in affording direct connection between points on the globe far apart, and the tendency has been to establish short-wave connections directly between large centers rather than through extensive land-line links, particularly where political boundaries have been involved. There has thus grown up an extensive network of single-channel short-wave radio connections operated at low power, giving good service part of the time but not to be depended on all of the time.

Most of these connections are over routes which would not support broad-band systems such as I have discussed. The introduction of broad-band methods for transoceanic radio telephony will tend to favor centralizing radio traffic at a smaller number of more important radio terminals, but it is hardly to be expected that all transoceanic radio traffic will thus be concentrated. Even with radio systems dispersed rather than centralized, broad-band cable may still serve as an effective supplement to radio not only between North America and Great Britain but also between North America and all of Europe, with land lines extending the circuits to all important centers of the European continent. It is to be expected, too, that the cable will find important application in other locations than across the north Atlantic. Notably, this type of cable is particularly promising for trans-Mediterranean service. Indeed, the same principles of construction which are proposed for the transatlantic cable may be applied over much shorter distances. With some modification of design, the repeater can be incorporated in lead-covered cables for shallow seas and afford transmission advantages of carrier as well as the economy of broad-band.

The Network of the Future

IF one tries to imagine the world-wide transoceanic network of the future, he may well envisage a net comprising a large number of light linkages plus a small number of heavy linkages over the most important routes. The light linkages will represent direct short-wave single-channel or twin-channel connections using relatively small power. The heavy linkages will comprise highly developed powerful broad-band short-wave radio systems making full use of frequency and directional diversity supplemented by broad-band submarine cables and in a few cases by long-wave radio as well.

From purely physical considerations, it appears feasible to provide all of the facilities for telephone connection between all points on the earth that its inhabitants are likely soon to require. To what extent these facilities will actually be developed will depend on demand and that, to a considerable extent, on cost. It will be interesting to survey briefly this question of prospective demand to see whether, after all, it promises to be great enough to justify the installation of broad-band cable and radio systems such as are here proposed.

THERE are so many factors that contribute to telephone demand that it is impossible to make any very reliable estimate. In addition to cost, there are factors of differences in time, in language, and in telephone habits, and also the factors of community of interest and speed of service. Similar factors affect the demand for telegraph service, but the transatlantic telegraph habit has had more time to mature fully and may reflect more accurately than the telephone the demand that exists for rapid communication between Europe and America.

One possible way to estimate what the future may have in store for transatlantic telephony is to compare the flow of telegraph traffic, say between London and New York, with that between New York and some west-coast American city, and then to examine how intensively telephone service has been developed relative to telegraphy over the two routes. Because of its comparative stability over a period of years, New York-San Francisco traffic provides an interesting basis of comparison. The distance and difference in standard time between these two cities compare fairly well with those between New York and London. Difference in community of interest is compensated to some degree by the difference in size of London and San Francisco.

Bases of Comparison

THIS comparison may be made on two bases not very different in character, but leading to widely different results. In the first, let us compare the two routes as regards telegraph traffic, using as our measure the total number of words transmitted in a single year. In the second, let us use as our measure the number of public service telegraph messages, excluding such telegraph business as is comprised under the headings of press service, leased-wire service, and code and cipher messages. In each case the estimate is based on terminating messages and excludes traffic routed via the cities named. Data for the year 1937 are available and this particular year has some further advantage in that it represents something between the peak of the 1929 era and the trough of the succeeding depression.

On the first basis of comparison we find that the total number of telegraph words transmitted between New York and San Francisco in 1937 was approximately the same as that between New York and London. On the second basis we find that the number of telegraph messages was about seven times as great between New York and London as between New York and San Francisco. The wide discrepancy between the two comparisons is doubtless accounted for partly by rates and partly by the character of business and social intercourse. Of the two the second, which is based on plain-word public-service messages, would seem to be more significant in relation to potential demand for telephone service. The information transmitted in press and coded telegraph messages and over leased wires is presumably business of record. Public message telegraphy, as a somewhat closer approximation to the informal exchange of ideas by telephone, may be a better index of telephone demand.

On the basis of these figures we may speculate that the potential demand for telephone connection between New York and London is somewhere between one and seven times that between New York and San Francisco. Actually, in the year 1937 the telephone traffic between New York and San Francisco was about three times that between New York and London. Thus it would appear that not more than a third, and possibly not more than a twentieth, of the potential telephone demand has been realized.

IF we assume, as seems reasonable, that the same ratio of potential to realized demand exists for all European-North American connections as for the New York-London connection, we may estimate that in place of the five pre-war telephone circuits across the North Atlantic there will be needed from fifteen to one hundred circuits. Which of these figures proves to be the better measure will doubtless depend greatly on costs that can be achieved but I do not think that I can fairly be accused of excessive optimism in predicting a demand for forty or more telephone circuits in the reasonably near future if full advantage is taken of technical possibilities already in view to decrease costs and improve reliability of service.

The Future Demand for Trans-Oceanic Telephone Service

In estimating the demand for growth it may be a mistake to attach too much importance to cost of service. Speed and reliability are, within limits, just as important. When it becomes possible to pick up a telephone and get a reply within two minutes, which is about the normal time for a long distance connection in the United States, and when the connection provides the clarity and freedom from noise of a local telephone call, then the transoceanic telephone service will, I believe, be used to a degree not even approached at present.

To provide this indicated increase in number of circuits, and to approach land-line standards of reliability and quality of service, will demand utilization of all three types of transmission systems: short-wave, long-wave and repeatered cable. Considerations of cost, flexibility and directness of connection suggest that the bulk of the transatlantic business will be handled on the short waves, but any service important enough to justify so large a group of circuits as has been estimated would have to live up to a higher standard of reliability than short-wave circuits alone can provide. A cable between America and Britain would provide this reliability, acting as insurance against serious interruptions of service that would result from a simultaneous failure of all the short-wave facilities during periods of magnetic storm. It would in addition set a high standard of transmission performance in competition with short waves. The cable and short-wave circuit groups plus a fw long-wave circuits should provide a high degree of reliability and excellent transmission at a level of cost such as would assure the continued growth of the service.

It may not be necessary to wait until the growth of transatlantic telephone business provides enough traffic to utilize fully a cable of the type described. When once the engineers are ready to give reasonable assurance of the cable, I believe that it will not have to await complete economic justification, because of the tremendous importance which it would have in insuring privacy and continuity of transatlantic telephone service. What the cable really waits on is technical development. To achieve this is fairly straightforward, since there do not appear to be any insurmountable difficulties. There is still much to be done, and many difficulties must be overcome before the broad-band repeatered cable can be installed; but it does not impress me as a more difficult problem than many that have been solved in the past.

In developing this picture of transoceanic telephony I have endeavored to stay within the realm of engineering fact, and not to count on products yet to be born from the inventor's fancy. Indeed, I may have been overconservative, for there are already partly developed inventions which might greatly modify the picture. One such is the vocoder, an instrument which, in a sense, compresses speech into a narrow band. More accurately, it dissects speech, transmits it in code, and recreates it at the other end of the line. With vocoders a hundred or more simultaneous conversations might be carried by a pair of repeatered cables. While the vocoder would transmit the primary elements of conversation, it would not provide all of those qualities of speech which words alone do not convey. The vocoder gains in band width at the cost of naturalness of speech, but even so, it may find important application.

Other inventions may extend the band width available for transoceanic communication far beyond the range here discussed. Projects such as repeatered ultra-short wave radio systems and undersea wave-guides, which today appear fantastic, may some day come within the range of practicability.

THE electrical channels over which peoples of one continent hold their more urgent communication with those of another have always been of surpassing technical interest. Ever since the first electrical impulses to carry words across the ocean were traced in the wavering beam of Kelvin's mirror galvanometer, the improvement of these channels has been a fruitful field for scientist and inventor. But these paths for the transmission of intelligence have a wider significance than mere technical achievement. They are strands of an ever-growing bond that unites widely separated continents. The newest of these strands, the overseas telephone, has yet to reach its maturity. Not until conversations can be carried on as easily and reliably between continents as between cities within a continent, can we claim that the art of transoceanic telephony has come of age. When this time arrives, we shall probably realize as we look back that the half-dozen telephone circuits of the 1930's formed indeed a slender thread to bind together in speech the people of North America and those of Europe. Some tens of kilocycles of band width may then appear as inadequate as the slowly dispatched words over the first transatlantic cable appear to us today.

"WHAT NUMBER ARE YOU CALLING, PLEASE?"

The Bell System's Intercepting Operators Ask That Question Six Hundred Million Times a Year to Straighten Out Calls That Have Gone Astray for a Variety of Reasons

By LINNÉA H. BAUHAN and GEORGE L. GOUDY

When people talk about telephone usage to friends in the telephone business, sooner or later comes the query, "Why is it that sometimes when I'm waiting for my party to answer, the operator comes in and asks 'What number are you calling, please?' Either I've already given her the number, so she should know it, or I've dialed it—and how can she get in on the connection then?"

The interruption is annoying to the customer who is making the call, to be sure; but not so annoying as the situation would be if the "intercepting operator" did not step in to straighten out a call which has, for some one of a number of reasons, gone astray. If, when he hears "What number are you calling, please?", the customer remembers the number he called, the operator will tell him what detour to take in order to reach the desired telephone; or, she may inform him that he is in a dead-end street, and can go no farther.

The telephone company is as anxious as is the user of its service to have each call go through smoothly, not only because it is always striving to make the service better, but because more work and more expense are entailed in handling a call that is delayed than one which goes through smoothly with no unexpected occurrence. Every effort is made to prevent situations where this phrase must be used, because it has long been recognized as one of the most annoying occurrences that occasionally mar telephone service, although perhaps not so serious as wrong numbers or cutoffs. Consequently, when the telephone user encounters this "What number are you calling, please?" it is because something has happened so that an operator must be called in to redirect the call. She has no previous knowledge of the number called and must, therefore, first ask for the number in order to determine what directions to give.

Actually, about one call in every fifty has to be stopped for this examination, and about half of these occur because the called number is no longer in service. In the aggregate, however, operators give this assistance—"What number are you calling, please?"—over six hundred million times a year on the thirty-five billion calls that are made, so it represents a very appreciable job in the handling of calls.

In a town or small city with manual telephone service, where practically all of the numbers called are within reach of the operator who takes the order, the question rarely occurs. In such a case, the operator has complete control of the call and can set it straight if need be, since she has all the information necessary to give reports herself. The same sort of situation applies, in general, when an operator receives an order for completion to a number in a very small dial office. Most operating, however, cannot be done under such simple conditions, and as the area of local telephone calling is extended, the whole system required to give adequate service becomes increasingly intricate and the problems of giving satisfactory service multiply: the call must be transported over a trunk between offices within the city; the order must be relayed to an operator in the called office who establishes connection; the existence of several central offices increases the possibility of reaching a wrong number; records regarding subscribers' lines cannot be accessible to all operators; operators cannot maintain the same degree of familiarity with thousands of subscribers' lines that they can when only a few hundred are involved, and so on.

These factors, despite efforts to the contrary, tend to produce many kinds of irregular occurrences, including those which give rise to the question, "What number are you calling, please?"

Why the Question?

Why do calls encounter this "Stop" signal? Some causes were implied in an earlier paragraph, but a glance at some of the by-paths into which a call may wander and which require this arresting "What number are you calling, please?" may be of interest.

Figure 1 shows in sketch form the risks that beset a call as it goes from the calling telephone through operators' positions or dial switches over a network of paths and intersections toward its destination—although it must be remembered that this alarming assembly of deterrents only succeeds in affecting about two calls in every hundred. Mistakes by operators and customers and failures of the equipment to function properly all together affect only about one call in a hundred, while some condition at the called telephone or number accounts for another one per cent, on the average.

When a subscriber moves to a new location, conditions in many cases require that his number be changed. This change is usually necessary because all the numbers having a particular central office name, or one of several in an associated group, are served from a given wire center. Obviously, if every subscriber who moved from East to South or North or Lindhurst retained his East number, his line would have to be run all the way across the city from his new location back to the East office. This would soon displace the efficient trunk groups, connecting the various wire centers, with a maze of subscriber lines running all over the area. In other cases, when a subscriber wishes to change his service, from a party

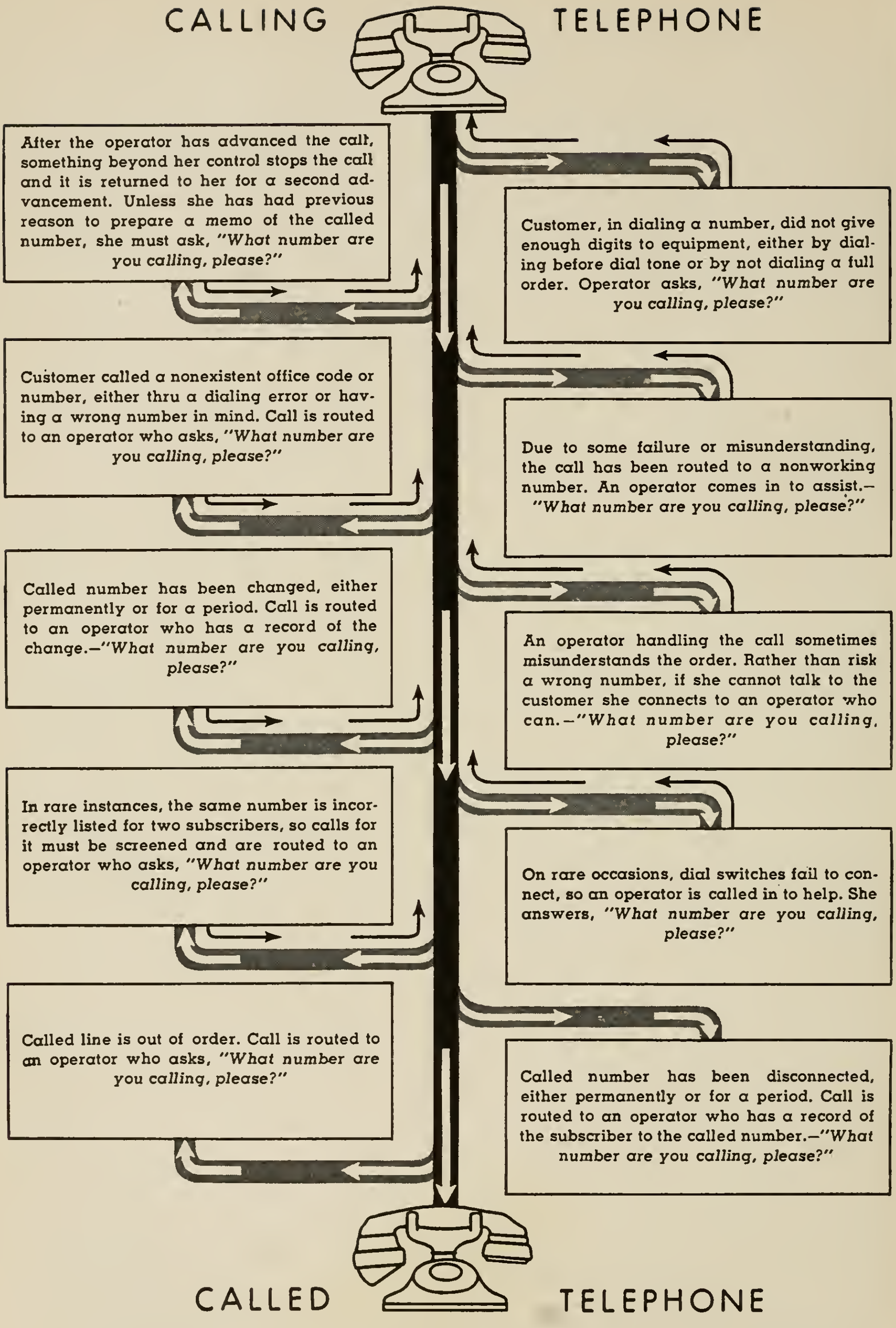


Fig. 1. Detours and Blind Alleys on the Highways of Speech

Calls which encounter these situations require the assistance of an intercepting operator to put them back on the right road to their destinations line to an individual line for example, it is necessary to move him from his old line, where other parties are still in service, to another line. In some cases, particularly in certain manual offices, this necessitates a change in the subscriber's telephone number, so that calls for his telephone on the former line must be intercepted.

Similarly, a subscriber moving out of town has his service disconnected, and provision is made for reporting where he may be reached by telephone if he has so informed the telephone company. There are also occasions for disconnecting a number temporarily, as when a subscriber is away on an extended trip or is closing his establishment for the season; and there are cases of temporary transfer of incoming calls which a subscriber may request when illness makes the ringing of a bell undesirable or when he finds it necessary to establish himself at a different location for a short period. Again, when a line is known to be out of order, it seems to be better to route calls for it to an operator who can report this fact than to let the calling party try again and again to no avail.

Situations such as those described above cannot, of course, appear in the existing directory, so provision must be made for informing people who call the numbers affected. In all these instances, calls must be intercepted. They must be redirected if possible, or the calling party must be told that the called telephone can no longer be reached—and, because the operator who has access to the records cannot know what number is being called, she must ask, "What number are you calling, please?"

Sometimes something happens in the progress of the call which leads to this question, and then, when the customer gives the number, the operator says, "Will you make your call again, please?" Reference again to Figure 1 discloses a number of occurrences which make it necessary to stop these calls and to put them back on the right road. They all add up to the simple fact that something went wrong on that call.

In spite of the old adage about the customer always being right, sometimes he calls a nonexistent number: for example, his finger slips in dialing and he gives the equipment an order for "9950" (as it happens, a nonworking number) instead of "9050." Sometimes he does not listen for dial tone before starting to dial, so that the equipment understands the order as being for a nonexistent office, "JX" (59), although he is certain that he dialed "OX" (69),—which, of course, is equivalent to removing the receiver from a nondial telephone and immediately speaking the number before the operator answers.

Then, too, occasionally an operator makes a mistake or misunderstands an order and the call goes astray, sometimes to a wrong number, sometimes to meet that irritating "What number are you calling, please?" and its sequel, "Will you make your call again, please?"—since there is nothing the matter with the number the customer called. Sometimes, too, in rare instances, the central office equipment that guides millions of calls unerringly through an amazing labyrinth of paths falters or makes a mistake, and rather than let the customer wait until he gives up in despair, the equipment tries to make amends by guiding the affected call to an operator who suggests that it be tried again.

Intercepted Calls

The sketch in Figure 2 illustrates the path of a call to a number which, for example, has been changed. There is no practical means of distributing information on all number changes and disconnected numbers to all the operators in all the central offices of a city, so calls for such numbers must be permitted to go through to the called office, where they are switched to an operator who is provided with suitable up-to-the-minute records for that office.

In a dial office, each telephone affected is connected to a so-called intercepting trunk which terminates before an intercepting operator, or the terminal of the called number is so wired that the equipment testing it is caused to route the call to an intercepting trunk. Thus, as shown in the sketch, incoming calls for a number affected by a change actually go to the terminal for that number in the called central office and then are "turned back" by the intercepting operator instead of being routed from that particular terminal out over the line to the called station.

This would seem to suggest that each intercepting trunk could be designated with the number that has been connected to it, so that the operator would not have to ask for the number when she answers. Some calls received on a particular trunk, however, are for numbers other than the one being intercepted, so that the telephone company is unwilling to have the operator merely report "The number you are calling has been changed to Cedar 7890," for example, without first definitely ascertaining that the call is for the number which has been changed to Cedar 7890. Such a plan would also require many times the number of intercepting trunks now used, since, because the volume of calls to a particular intercepted number is on the average very low, several lines are generally grouped on one intercepting trunk. This is a case where, in the interest of economy, it has seemed advisable to be satisfied with something a little short of perfection.

In a manual central office, an operation roughly similar to that shown on the sketch occurs when a call to a number must be intercepted. Here, again, the call must be taken to the called office, where the operator who tries to establish connection to the called number finds it marked to indicate that calls for it should be intercepted. Instead of completing the call to the line, she transfers it to the intercepting operator, who has a record from which she can report the status of the called telephone.

Ideally, all such intercepted calls should be completed to the desired destination without requiring the customer to make his call again, but in many instances this is not practical or economical. Equipment has been developed to make this possible in certain situations, and where it is feasible to do so, the intercepting operator completes the call. That is when she says, "One moment, please," after the customer has told her the number which he called.

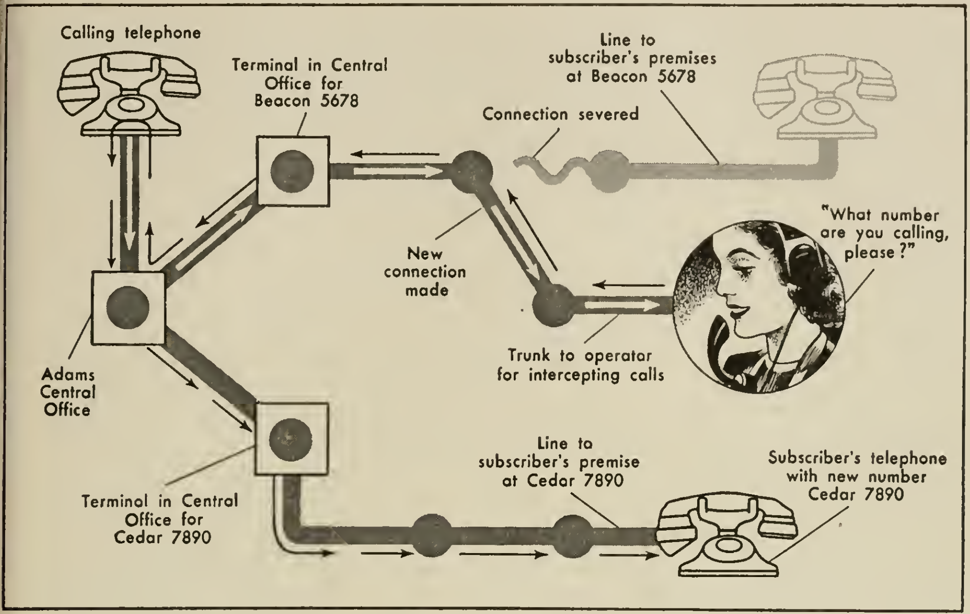


FIG. 2. "THAT NUMBER HAS BEEN CHANGED TO . . ."
In this simplified diagram, Beacon 5678 has been changed to Cedar 7890. A call from a subscriber in the Adams central office to the old number is routed through the Beacon central office (white arrows) to an intercepting operator, who has a record of the change and of the new number—which the subscriber may reach by making another call

One difficulty preventing extension of this practice is the physical limitation of speech transmission. In a multi-office city, the various offices are interconnected by a series of trunk groups in which each pair of wires is "balanced" by added electrical gadgets to carry speech satisfactorily between the two centers it connects. Whenever any two of these trunks are connected together, however, this balance may be disturbed, with resultant impaired transmission—unless the trunks have been designed for such a connection. The wizards of electricity could, of course, design universal trunk circuits that would permit satisfactory speech over any combination of trunks—but the cost would be prohibitive.

A still greater limitation on the extent to which intercepted calls can be completed without asking the user to make his call again is the rate structure as it applies to calls to different points. As already pointed out, when a call reaches the called central office and must be intercepted, it is routed over a trunk to the operator who answers such calls. She has no way of telling whether the call originated in a near-by community and bears a toll charge or whether it came from a customer in her own office; and if she established connection to the desired telephone, the call would be charged in the calling office in accordance with the rate applying from that point to the central office where it was connected to an intercepting trunk.

FIG. 3. AN INTERCEPTING OPERATOR

The records before her enable her to give a report to a customer in an average of twenty seconds

This might result in overcharging or undercharging on a particular call. For example, suppose a person called his next-door neighbor and, through some inadvertence, the call reached an intercepting operator in a distant community, who obligingly completed it back to the neighbor. The equipment or the original operator would charge the call at the rate applying on calls to that town, not knowing that it had been redirected. The intercepting operator performs an unpleasant duty, therefore, in saying, "Will you make your call again, please?" when this danger of an incorrect charge exists on intercepted calls.

Intercepting Positions and Records

MENTION was made earlier in this article of the millions of calls that are interrupted by the question "What number are you calling, please?"—although they represent only a small percentage of all the calls that are made. Then it developed that calls for intercepted numbers must be routed to a place where suitable records for the called office are available. The operators who answer these calls are generally seated at switchboard positions of which the one shown in Figure 3 is an example, or they are occasionally placed at low-topped desks on which the intercepting trunks terminate.

These positions are the point of origin of the question which the average telephone user may hear possibly once or twice a month but which these operators use thousands of times a day in the Bell System. Sometimes intercepting trunks from central offices in different parts of a city are brought

Fig. 4. An Intercepting Operator

The larger record book provides space for party-line letters. In a small central office, such an operator handles regular calls as well as those which must be intercepted together at a central point, so that one group of operators may handle calls for as many as a dozen different central offices. Generally, however, only those central offices located in one building are centralized in this manner, so that the operators at that point need have records for not more than five or six central office units—and when one thinks that a unit represents a possible 10,000 numbers, that seems quite enough.

The record the intercepting operator uses—the book on the keyshelf before her in Figure 3—is a splendid example of compactness. It must be small enough not to interfere with her other work by obstructing cords, keys, and signals, and not to be unwieldy on the frequent references to it each day. It must be, by all means, a ready reference type, because the customer must be given a prompt report. The average interval from answer to end of report is about twenty seconds, including the intercepting operator's question, the statement of the called number, her search among the thousands of numbers listed, and the report, which frequently involves discussion. And above all, the record must be accurate and complete.

The book in Figure 3 is one form of record, although there are other forms to fit adequately the different types of positions, to provide for the party line station letters commonly found in manual offices, etc. This particular book shows the working status of the numbers in three central office units—about 30,000 numbers.

A different form of record is shown in Figure 4, where it is in use by an operator who, while specializing in intercepted calls, is located in an office small enough so that her full time is not required for them. She therefore handles calls from regular subscriber lines when she is not engaged on calls for these intercepted numbers. The larger book is necessary to provide spaces for showing the status of each of the J, M, R, and W parties on a line—a requirement not present in a dial office, where every subscriber has a separate number.

Figure 5 might be called a candid camera picture of the intercepting record shown in Figure 3. There are, again, variations to fit different types of offices, but this one will suffice to illustrate how compactly the necessary information is entered.

Each page of this record has spaces for the block of one hundred consecutive numbers designated in the page heading so that, with the proper series of pages, space is available for an entry affecting any number in the office. Liberal use of codes is made to conserve space. Thus, in the illustration which shows the 1100 block in the West office, the number written next to "34" represents the number to which West 1134 has been changed, and the "V" next to "78" indicates that West 1178 is vacant or not working. Reference codes guide the operator to the larger spaces in certain instances where the small block is not large enough to contain the required entry. These more complicated entries frequently lead to more questioning, which may be considered annoying; but it has been found that on about ten to twenty per cent of the calls for disconnected numbers the customer is not calling the subscriber

11

WEST 1100

00	↑	20		40		60		80		A	Mrs. J. R. Doe & Miss E. Blake
01		21		41		61		81		B	{ Jones & Smith
02	PBX.	22	K	42		62	TD-AB HALL	82	TT-WA-1572	C	{ J. R. Jones-AD-4862
03		23		43		63		83		E	{ L. T. Smith-WA-5941
04	↓	24		44	J	64		84		F	TDR-Oct. 1-W. S. Rich
05	V	25		45		65		85		G	{ H. R. Black-Boston, Mayfair
06	V	26		46		66		86		H	{ Hotel
07	V	27		47		67		87		J	J. C. Whiteman-Move
06		28	A	48		68	F	88		K	{ Black & White Co.-MA-1234
09		29		49		69		89	CO-11-R2	L	{ J. Barclay Co. is 1220
10	B	30		50	MA-6609	70		90		M	
11		31		51		71		91		N	
12		32		52		72		92		O	
13	G	33		53		73		93		P	
14		34	BE-6789	54		74		94	W. J. ROE	R	
15		35		55		75		95		S	
16		36		58		76		96		T	
17		37		57		77	V	97		W	
18		38		58		78	V	98		X	
19		39		59		79	V	99	V	Y	

Fig. 5. A Page from an Intercepting Record

The space-saving codes have definite meaning to the operators who use the books as their working tools

listed for that number. So, since a disconnect report has such an air of finality, it is general practice, as a safeguard, to ask the name of the called party or to tell the customer the name of the subscriber for whom the number is listed.

Sometimes reference notes become quite involved. For example, when the law firm of Jones, Jones, Jones, and Jones dissolves and each partner sets up a separate office, the intercepting operator must question all calls for the old number, so that she may give the correct telephone number of the particular Jones the customer wishes to reach. This seems a burdensome practice, but it is necessary in order to maintain impartial service to all members of the dissolved firm.

Like the supply service of a modern army is the organization which keeps these intercepting records posted almost literally up to the minute and provides for routing calls to the intercepting positions. When, for instance, a subscriber tells the telephone business office that he wishes the service in his summer bungalow discontinued for the winter, several copies of a service order are prepared by the business office. One copy, sent to the plant department, is its order to do any work that may be required, such as connecting the number to an intercepting trunk as shown in the sketch in Figure 2. Another copy goes to the traffic department, where a clerk in the central office posts the record described above at the time the order is to take effect. In addition, if the office is manual, the clerk also goes along the switchboard and marks each of the several appearances of the line, so that any operator attempting to establish connection to that number will see that she should not do so and will, instead, route the call to the operator who answers with "What number are you calling, please?" and gives the information that Mr. Abernathy's telephone has been disconnected for the season.

On some changes, outside plant work must be done, and the traffic clerk's work on the order must be carefully timed so that calls for the number will not be intercepted too soon. As soon as the test desk-man knows that work has been completed, he calls the traffic clerk, and within a few minutes the changes are put into operation and incoming calls for the old number are being rerouted or calls for the new number are flowing smoothly to the desired station.

Trouble Monitors in Dial Offices

Millions of dialed calls are completed swiftly, silently, accurately by the switching equipment without human aid; but in certain types of dial offices, the moment a unit of completing equipment is delayed in its work or fails to perform its appointed task promptly, a signal brings the situation to the attention of an operator who answers with "What number are you calling, please?" Her position, known as the sender monitor position, is equipped with signal lamps and jacks associated with vital parts of the central office mechanism.

If a customer removes the receiver and waits too long before he dials, she is called in. If he dials before he hears the dial tone, so that the equipment does not receive an adequate number of digits, or if he does not dial the number of digits the equipment has been arranged to receive, she is called in. If the automatic equipment fails to advance the call within a reasonable number of seconds, she is called in. In each case, the distinctive nature of the signal has told her a part of the story as to what has gone wrong on the call, but she must ask for the called number in order to identify the condition completely and to prescribe the best action for that situation.

If one watched this operator for a while, one might receive the impression that she was careless in her attention to signals. Actually, however, she is especially trained for this work and knows that certain of the busily flashing or steadily lighted signals before her convey a meaning but do not require an answer. Other signals, she knows she has already taken preliminary action on or reported, but they will continue to burn until the difficulty has been cleared. In this way she can know at all times just the extent to which certain important channels in the office are being restricted by equipment being held out of service for examination. She knows also the number of pieces of equipment in each channel which can be safely "busied out" for maintenance testing without affecting service, and when this number is reached, she takes action to have some of the normal "checking up" by the plant forces postponed so that the highways of speech may be kept clear for all to use.

Most troubles that put a line out of service, and all cases where a receiver has been left off the hook for an interval, not only "busy" the line but seize and hold important equipment used in establishing connections. The equipment routes all such lines to special trunks appearing before this trouble monitor, thereby freeing itself for further use and enabling her to take suitable action. She challenges with "What number are you calling, please?" and if she receives no response she tests the line for trouble. In many cases, by her alertness to the rate at which troubles are appearing, she is able to start corrective action on major cable troubles sooner than would be done otherwise.

Perhaps this monitor's most fascinating function is to sense the approach of an overload on the dial equipment. Certain groups of signals appearing before her indicate, by the frequency and constancy with which they light, when the vital channels are becoming fully loaded by the thousands of calls surging through them. At the same time, the other conditions previously described tell her whether this loaded condition is due only to a large volume of calls moving properly, or to trouble that is partially clogging the main channels, or to customers who have been in too great a hurry to wait for dial tone. Before the situation has developed to acute stages, her skilled appraisal has started corrective action which in most cases relieves the danger of worse congestion. But in all of this, one of her most useful tools must be "What number are you calling, please?" and the request to make the call again.

The Question Itself

What number are you calling, please?" is not an easy phrase to repeat over and over, especially when it must be said each time so carefully and distinctly that the customer who hears it unexpectedly will understand it. At one time it was thought that the customer needed to be informed that the operator who asked this question was not the one who took his order initially, and so she used the introductory phrase, "This is a special operator," as a prelude to the question. That lengthened the transaction and came to seem unnecessary, so it is now generally omitted and reliance is placed on good tone and manner to convey, not only that this is a different operator from the one to whom the order was given originally, but also that she is interested in the call and would like to be of help.

Then again, the phrase used to be "did you call," instead of "are you calling," but it was very difficult to avoid slurring that into something like "didja call," which certainly did not convey the impression that this operator was trying to be helpful and painstaking. "What number are you calling, please?" is, therefore, merely a present view on the best way to introduce this unexpected interruption on a call that has gone astray and needs some extra attention which the operator will give,—with the necessary assistance of the customer.

Whatever words the operator uses, her meaning is always: "I'm sorry, but something has interfered with the progress of your call and I'd like to help you get on with it—if you'll tell me what number you're calling."

FOR THE RECORD

THE BELL SYSTEM IN WAR-TIME

Statement read by President Walter S. Gifford at the Annual Meeting of A. T. & T. Stockholders on April 15, 1942

OVER 9,500 * Bell System employees are already in the military services. The rest of us in the System are aggressively doing our part to win the war and to protect the liberties we so dearly cherish. We are determined to see to it that those in uniform are backed up on the home front with all the skill and energy and resourcefulness that we have.

I am sure that is what you, the stockholders, want us to do. You have provided the wherewithal with which the telephone lines, the switchboards and buildings have been built. You have invested your savings in a great public service in peace times and a vital part of the nation's defense in war times—vital to fighting the war through to victory.

As you have seen from the statement enclosed with your dividend check that arrived in your home or office this morning, the earnings of the System with present tax rates are more than covering the dividend. This, in spite of the fact that these taxes are nearly $5 a share per year greater than in 1940. You will also have noticed that the tax proposals of the Secretary of the Treasury would reduce earnings by an additional $4 per share per year, so that, if those proposals were enacted into law, the usual dividend would not be earned in full. In fact, the earnings on investment would be reduced to the lowest point on record, including the worst year of the recent depression.

* Now over 11,000.

During the depression, you will recall, the Company continued to pay dividends at the usual rate although, because of depressed business conditions, they were not fully earned and were paid in part out of surplus. There are too many uncertainties ahead today to say in advance what it might be wise to do if, due to war-time taxes and not to a depression, earnings again should not fully cover the dividend requirements.

Conditions are obviously not the same as in the depression. Then we had a telephone plant which could handle more business than we had, and it was clear that we would again earn the dividend as soon as we had more business. Now we have all the business that we can handle—with no spare or idle plant, in spite of having added nearly one billion dollars of telephone plant since 1935—and yet because of increased taxes needed for the winning of the war, we may not fully earn the $9 dividend. We are making all possible operating economies, and if and where it becomes necessary, we shall ask regulatory bodies to permit us to increase revenues by increases in telephone rates so far as is not inconsistent with winning the war or with the public interest.

Because of the urgent need of copper and other essential materials for the war effort, construction of new facilities to care for civilian demand for telephone service is being more and more restricted by government priority regulations. This will mean great inconvenience and even hardship for increasing numbers of persons. However, whatever the difficulties ahead for the Bell System and for telephone users, they are difficulties growing out of the war.

And how long will the war last? My own answer is, it will last until we win it. I have spent my working life with the Bell System—nearly 38 years. I have seen the System go through many trials and tribulations, but it has always come through stronger than ever. Because telephone service is worth so much more than it costs and because of the high character and ability of Bell System personnel and for other important reasons, as a stockholder myself—and nearly all my personal savings are invested in the business—I look to the future of the Company with full confidence.

For the duration, the Bell System, come what may, can be counted on to do its full part in the war, and by so doing it will be keeping faith with those in the fighting forces and on the fighting fronts who, after all, have the toughest job to do.

"THIS IS YOUR WAR"

A Talk Given by Vice President Arthur W. Page of the A. T. and T. Company before a Meeting of Supervisors of the New England Telephone and Telegraph Company in Boston on March 24, 1942

The fundamental policies of the Bell System have been:

1. to give the best possible service at the least cost consistent with the financial integrity of the business.
2. to carry on research and development for the development of the telephone art.
3. to protect the investment of the owners of the business for them and for the future use of the public.
4. to pay adequate salaries and wages, and provide the most opportunity possible.

At present there is a fifth part of the policy that overrides them all—

5. to run the Bell System so that it does its maximum service in winning the war.

And we are particularly fortunate in the fact that our business is vital in this national emergency. That does not make so much difference to those who are young enough or smart enough to go into the war directly, but for the rest of us it's a vast comfort to be in an enterprise essential to the nation in these times.

You read every few minutes that the United States is the arsenal of democracy, that our production is the basis of victory. We take it for granted. Let's analyze it a little. In Russia there is as much raw material as and more people than there are here. They have been working on their army and its equipment for many years. Yet everyone expects us to send them machines a couple of years after we start making blue-prints.

Why? Well, it's know-how and organization. That isn't just a number of people, nor just a number of smart or trained individuals. It's well trained teams.

The chief assets of the United States for this emergency are a number of well-trained teams, not the least of which is the Bell System. It's a team of 400,000. The 400,000 can play their positions and they all know the plays and the signals, and what this team does is absolutely vital, for over its wires go the signals of all the other teams that are getting things done.

We can be thankful that we are on the main line. We also have to be careful that we act like people on the main line.

Well, why not? What is to prevent us? I'll tell you. This country has been through a lot of wars and other troubles and it comes out in the long run and for one reason—and it isn't that everybody does his part. Everybody doesn't. It's because the real people who know how and have the character and guts get the things done anyhow.

There will be people who can't do anything, and people with mean and petty motives, blind spots, dishonesty, selfishness, all kinds of human impediments. You'll get rulings you just couldn't believe would happen in war time. You won't have everything you need to do your job. You'll have a lot of other difficulties. You'll have forty troubles about which you could complain all day if you have a mind to.

But you aren't going to do it, for the reason that this is your war.

I don't mean that it's your war in equal parts as it is the whole population's. I mean it's your war in the measure of your competence, and by that I mean it's a whole lot your war. We're going to be the least complaining and the most effective outfit in the United States. That's the over-all policy.

We've got a good place in the line and the job is to win as fast as the Lord will let us. If there are some people you think you just have to do something about—and I have that feeling quite strongly at times—they will just have to wait their turn behind Hitler, the Jap, and Mussolini.

At present and increasingly so in the immediate future we are going to be short of materials. We are not going to be able to give everyone everything he wants. We have had no practise in holding off customers, for nearly twenty years. But I do not expect any real public reaction if we are frank and honest in telling people why they can't have what they want.

And, after all, the material we are going to do without is so very little. To you who have always lived in the Bell System, the idea of losing most or all of the construction program may seem cataclysmic; but it isn't, for we are in a business of selling service and not materials.

When a tire company gets no materials, it has no business at all. When we get no materials, we still have as much business as we ever had before and the capacity to serve the vital needs of the country. What's happened to us is we just can't grow as usual—and as a matter of fact, we wouldn't be growing this way if it weren't for the war, anyhow.

What will happen to us after the war? I am sure I don't know, but I am equally certain that it is nothing to worry about now. If the Bell System is a rigid system and hasn't flexibility and imagination at the top, it may not be able to meet the inevitable changes and take advantage of them. But there is no reason why we shouldn't be flexible and alert.

There is sure to be change. Some people take advantage of change, others don't, but I don't know why we shouldn't make the most of it as well as the next man. People are going to keep talking, and one way or another we ought to be able to make it possible and pleasant for them to do so and profitable to us.

SERVICE OPENED TO DUTCH GUIANA

Telephone communication between the United States and Paramaribo, Dutch Guiana, was opened on May 4. The service is handled over a short-wave radio telephone circuit operated by the American Telephone and Telegraph Company in New York and by the Netherlands colonial government in Paramaribo. The rate for a three-minute conversation between these two points is $12 on weekdays and $9 on Sunday. The daily operating period is from 8:30 A.M. to 6 P.M.

CONTRIBUTORS TO THIS ISSUE

As our readers doubtless assumed from his thorough-going knowledge of the Civilian Defense organization and its communication requirements, F. SELWYN GAY is the man who was appointed liaison officer between the Bell System and the O.C.D. in June of 1941. The assignment has occupied practically all his time since then, and he has been largely responsible for the training courses and the training material which have enabled representatives throughout the System to act as communication advisers to local civilian defense groups. Since the appointment of a Defense Activities Engineer in the A. T. and T. Company last December, Mr. Gay has been a member of his staff.

Graduated from the U. S. Military Academy with the B.S. degree in 1920, Mr. Gay served as Second Lieutenant and First Lieutenant, C. A. C., until 1923. In that year he joined the New York Telephone Company, where he was successively a manager, district manager, and division sales manager. In 1929 he was transferred to the Commercial Division of the Department of Operation and Engineering of the A. T. and T. Company, where, prior to his present assignment, he had been in recent years a group head in charge of sales results and then of business exchange sales. He is the author of "Proving the Value of Telephone Orders to Department Stores," which was published in the BELL TELEPHONE QUARTERLY for July, 1938.

AFTER graduation from Harvard University with the B.A. degree in 1904, where he completed the four-year course in three years, WALTER S. GIFFORD joined the Bell System as a clerk in the payroll department of the Western Electric Company in Chicago. The following year he was transferred to New York, becoming assistant secretary and assistant treasurer of the company. In 1908 he joined the American Telephone and Telegraph Company, and from 1911 to 1916 was its Chief Statistician. Returning to the company in 1918 from his war-time responsibilities, he was appointed Comptroller. In 1919 he was elected a Vice President; in 1923, Executive Vice President; and in 1925, President.

Early in 1916, at the request of the Naval Consulting Board, Mr. Gifford directed the work of the National Industrial Preparedness Campaign. Late in that year Congress created the Council of National Defense, and from December of 1916 to November of 1918 he was Director of both the Council and its Advisory Commission. In July of 1918 he went to Paris, where he served for four months as Secretary of the American section of the Inter-allied Munitions Council.

At present, Mr. Gifford is Chairman of the Industry Advisory Committee of the Defense Communications Board.

Concerning Mr. Gifford's many charitable, educational, and scientific interests it is perhaps sufficient to cite that in 1938 he received the gold medal of the National Institute of Social Sciences in recognition of his services "as Director of the Council of National Defense; President of the Charity Organization Society of New York; Trustee of Johns Hopkins University, General Education Board, Carnegie Institution of Washington; Director of the President's Organization on Unemployment Relief; President of the American Telephone and Telegraph Company, the greatest non-governmental organized service in the United States; and as trustee of numerous educational and scientific foundations."

Graduated from Purdue University in Mechanical Engineering in 1910, Temple C. Smith immediately joined the New York Telephone Company, where he started work in plant engineering. After four years in that work, he spent two years laying out electric light plants. Returning to the New York Telephone Company in 1916, he was assigned to various outside plant problems for three years, ranging from motor vehicle equipment development to long-span-crossing design. In the two years which followed, he specialized on motor vehicle operation and maintenance. Since 1921 Mr. Smith's work has been concerned with automotive and construction apparatus engineering in the A. T. and T. Company.

His connections with outside organizations have included: work on A.S.T.M. committees and committees of the American Standards Association; membership on the Highway Research Board of the National Research Council; contributions to the work of the Committee on Winter Driving Hazards of the National Safety Council; participation in the studies of the Committee on Definitions of the National Conference on Uniform Traffic Accident Statistics; and an active part in the work of various committees of the Society of Automotive Engineers, of which he has been Chairman of the Highways Research Committee for many years.

President of the Bell Telephone Laboratories since October, 1940, Oliver E. Buckley joined its predecessor, the Research Department of the Western Electric Company, as a research physicist in 1914 after having received the Ph.D. degree from Cornell Univefsity. He had been graduated with a B.S. from Grinnell College in 1909. His first assignments were to the study of oscillators and the development of vacuum tubes.

During the first World War, Dr. Buckley served as Major, Signal Corps, A.E.F., in charge of the research section of the division of Research and Inspection of the Signal Corps in Paris.

Returning to the Laboratories after the war, Dr. Buckley undertook an investigation of submarine telegraph cables, and soon recognized the possibility of greatly increasing their message capacity by the application of new techniques and new materials. Among the latter were the new nickel-iron alloys, and notably permalloy. A practical solution of the problems of high-speed submarine telegraphy required, however, the solution of numerous subsidiary problems as well as that of the manufacture of a cable with a loading of permalloy tape wrapped around a copper conductor. First result of this development work at the Laboratories was the Western Union's 1924 cable between New York and the Azores, which under engineering tests transmitted 1900 letters a minute, as contrasted with the 500 letters of the corresponding non-loaded cable then in use. Other researches under his direction have led to a better understanding of ferro-magnetism and to the development of better magnetic materials for specific applications; and have also concerned discontinuities in magnetization, and the conduction of current in vacuum tubes and solid conductors.

Dr. Buckley was made Assistant Director of Research in 1927, Director of Research in 1933, and Executive Vice President of the Laboratories in 1937.

He received the honorary degree of Doctor of Science from Grinnell in 1936. He is Chairman of the Board of the Engineering Foundation, a member of the National Academy of Sciences and of the American Philosophical Society, and a fellow of several engineering and scientific societies.

After receiving a B.A. degree from Barnard College, Linnéa H. Bauhan spent two years as statistician to a financial engineer. In 1917 she joined the American Telephone and Telegraph Company in the Traffic Section of the Engineering Department (now the Department of Operation and Engineering) to work on local operators' training department methods and practices. She later became an engineering assistant on local operating methods and practices, and of recent years has worked exclusively on operating practices.

Entering the Bell System by way of the Chesapeake and Potomac Telephone Company from the Engineering Department of the University of Virginia in 1921, George L. Goudy was concerned with dial service inspection in Norfolk and Baltimore and dial traffic engineering in Washington until he was transferred to the Traffic Division of the Department of Operation and Engineering of the A. T. & T. Company in 1924. In this group his attention has been devoted to quantitative and qualitative measurements of traffic operation and, currently, to operating practices.

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OL. XXI AUGUST, 1942 NO. 3

WAR-TIME IN THE TRAFFIC DEPARTMENTS

DOING A BIGGER JOB—WITH LESS

THE ORGANIZATION OF LARGE-SCALE ENGINEERING WORK

PROTECTING THE SERVICE AGAINST FIRE

TELEPHONE STATISTICS OF THE WORLD

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE MAGAZINE

Continuing the BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

"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."

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SANDBAGGING AN INCENDIARY BOMB

This picture, taken in a Bell System building, shows a practice bomb, but illustrates the method of controlling the blaze by throwing bagged sand on and around it. *See "Protecting the Service Against Fire," page 177*

WAR-TIME IN THE TRAFFIC DEPARTMENTS

Many Problems Confront the Bell System's Operating Forces in Their Task of Furnishing a Service Which Is Essential to the Prosecution of the War and the Daily Life of the Country

By RAYMOND A. STEELMAN

Before the hordes of Nazi Germany invaded Poland in September 1939, the telephone central office at Mount Holly, a quiet town in the farming section of central New Jersey, was averaging about 1,000 long distance and 3,300 local calls a day. Now, with the nation all-out to win the war, the Mount Holly exchange, which serves nearby Fort Dix, is averaging 5,800 long distance and 5,400 local calls a day, increases of 480 and 64 per cent. Then the operating force consisted of 15 people; now there are 167.

This is not an isolated case. The impact of the war has had a tremendous effect on traffic volumes, notably long distance, in many places all over the United States. While the effect has been most pronounced in the smaller offices serving military establishments and war industries, many of the larger cities are also involved. At Washington, long distance calls are up 175 per cent, Norfolk 150, St. Louis 145, Detroit 143, Louisville 110, and Baltimore 93 per cent. On the west coast, long distance traffic is up 89 per cent at San Diego, 85 at Tacoma, and 56 per cent at Seattle. For the Bell System as a whole, long distance calls are running nearly 50 per cent above the level in August 1939, while the longer-haul calls are up about 85 per cent. Calls of all types are averaging 113,000,000 a day, an increase of 29,000,000 calls!

This all adds up to a large order for the traffic departments. Just what are some of the problems the war has brought? And more important still, what is being done about them?

How the Forces Have Grown

At the end of August, 1939, the traffic operating forces of the Bell System consisted of 114,000 people. Now, the number is 148,000. The increase in 1941 was the largest in any single year in the history of the business.

The take-off point in this matter of force is to determine exactly how many operators will be required. To the layman it has always seemed remarkable, even in normal times, that those in the traffic departments whose job it is to engineer the force can determine how many operators will be

Expanding to Handle the Army's Calls

The Mount Holley, N. J., central office, which serves Fort Dix, keeps on growing. The 11 switchboard positions before the war have been expanded to 74, and two additions have been made to the building

required at each hour of the day, evening, and night, on every day in the year, and in all central offices.

But these are not normal times. Traffic is not only increasing rapidly—it is increasing unevenly as between exchanges, and surges are frequent, often without warning.

Take a typical case. War maneuvers are to be held. Thousands upon thousands of troops will converge from all directions. Official Army calls, personal calls from the officers and enlisted men, calls from members of the press—all will have to be handled. How many operators will be needed? That was the problem faced in New England, in the South, on the Pacific Coast and in many other places last fall, and it will be faced again, and solved.

At Ayer, Massachusetts, for example, the operating force of 56 was expanded to 86. During the maneuvers, traffic increased almost 70 per cent in one week. Thirty operators were summoned from Lowell, Worcester, Gardiner, Athol, Pittsfield, and Springfield to help carry the load at Ayer. Other operators were brought in from distant points to swell the forces at such offices as Pepperell, Townsend, Ashby, Ashburnham, Fitchburg, Leominster and Clinton. Special arrangements to house, feed, and transport all of these operators were completed weeks before the maneuvers started.

Of course, not every future need can be forecast: sudden developments such as Pearl Harbor, the arrival of the fleet, and the canceling of leaves. To handle these sudden peaks, those on duty are requested to work overtime—and they gladly do it; or extra employees are called in under plans which have previously been prepared; or not unusually, sensing that they will be needed, they arrive before they are called. The Spirit of Service is a tradition in the traffic departments. Fire, flood, hurricane, explosion, war—there has never been a catastrophe great enough to prevent the operating forces from getting to their offices when they were needed, or at least doing everything human effort and ingenuity can do to get there. In some cases, of course, margins are carried in the forces so that the impact of sudden peaks will be minimized to the greatest possible extent.

Recruiting Begins

Telephone operating has long been regarded generally as a fine field for young women. The pay is good, increases are frequent, the work is interesting, working conditions are of the best. Consequently, prior to the war, most cities had large numbers of applications on file. The war changed that. Waiting lists became seriously depleted because of the large numbers of operators whom it was necessary to employ, and because of the thousands of other positions which were opening up for young women in war industries. At first only a few of the nearly 6,100 Bell System exchanges were affected, and those not to any considerable extent. Later, more and more places were involved—and to a much greater extent. Originally, most of the exchanges affected were relatively small, but by now a number of large cities have entered the picture.

Well before they were needed, plans were prepared to recruit large numbers of operators quickly, and to have them ready to operate the switchboards by the time they were required. This recruiting work is continuing, and at an accelerated pace.

In building up the forces, the cooperation of present employees is being sought. It had been the experience previously, and it still holds true, that this is one of the very best sources of obtaining good applicants. They know what it takes to be a good telephone operator. A poster such as "Girls Wanted" is one of the ways in which the employees are informed of the needs. Cards of introduction to the employment offices—which, in-

Special Installation
In preparation for Army maneuvers, the ten PBX switchboards at the left were set up in the Ayer, Mass., central office to handle calls made from 40 public telephones by the men in service. The permanent switchboard is at the right

Recruiting Poster

It asks present soldiers of the switchboard to enlist their friends in a vital war work

cidentally, in many cases had to be expanded substantially—have been provided for the employees to give candidates they send in for interviews. In some cases the assistance of the employees has been stimulated through pay-envelope inserts and articles in company magazines.

School authorities the country over have been most coöperative in this recruiting work. Many talks have been made before school groups by traffic representatives, company movies have been shown, recruiting leaflets have been distributed among students. These bear such titles as "Barbara Enlists in Service for Victory" and "Miss America Joins the Telephone Army."

In many places newspaper advertisements have been run, ranging from small want ads to large displays. The importance of telephone operating work in winning the war is the keynote of many, as shown by the wording of the advertisement in a Hartford newspaper that brought a fine response.

On the Move

Despite all such efforts, in some localities where employment conditions are most acute it has been necessary to

WANTED

Girls for work vital to the war effort with The Southern New England Telephone Company

THE ARMED FORCES, war industries, and civilian defense units keep telephone wires humming these days. To handle this flood of calls, your telephone company needs more operators — and needs them now. Here is your chance to make a real contribution to the war effort — and at the same time get a job with pleasant working conditions. You will join with an army of selected girls who have dedicated their best efforts to providing swift and accurate service in these critical times.

CAN YOU QUALIFY? To maintain the high standard of telephone service requires girls who have good eyesight, hearing, and voice. You should be right-handed, be in good physical condition and be a citizen. No previous experience is necessary.

HOW TO APPLY. If you have wondered "what you can do to help" . . . if you are interested in this opportunity for useful and agreeable work, simply **call Hartford 6-9221, Extension 210, Mrs. Moore.** She will be glad to tell you more about this interesting work and arrange an interview.

THE SOUTHERN NEW ENGLAND TELEPHONE COMPANY

Newspaper Advertisement

Many girls responded to this call in a war-busy area import experienced operating people from places less seriously affected. Washington is an outstanding example of this, and several hundred experienced operators and supervisors have volunteered for service there. These temporarily transferred employees have come from New England and from the middle west and from points between—from Rutland, Vermont, and Boston; from Grand Forks and Fargo, North Dakota, and Enid and Oklahoma City, Oklahoma.

The spirit of those people who have packed their bags and moved to the nation's capital, and to Newport, Hartford, Norfolk, Dayton, New Orleans, Charleston, San Francisco and other places has been inspiring. They are eager to serve where they are most needed, and the satisfaction they are getting out of their work is great.

OFF TO WASHINGTON

Vanguard of a group of twenty Chicago employees on their way to help at the Washington switchboards

Housing—a War-time Problem

THE high reputation of the telephone companies for taking good care of their employees is of long standing. The importation of women employees into localities affected seriously by the war introduces new kinds of problems for the traffic personnel staffs. Rooms have to be found and inspected—many are obtained in the homes of company employees. Here and there company-operated dormitories have been established—some in telephone buildings, others in large houses which have been acquired for the purpose. The problem is more than one of housing. Other factors are meals, recreation, and health. All are being cared for by people who are fully aware of the needs and who are well fitted for this important work.

"Induction"

MOST of the young women who come to work for the telephone companies as switchboard operators are having their first experiences in the business world. They not only have to be trained for their jobs; they have to become acquainted with their new environment and their new associates, and they have to become adjusted to their hours.

Further, it is only natural for new employees to want to be well informed about the practices of the company which affect them, and for the company to want its people to be informed about these matters and about the company itself: its objectives, its poli-

Right: Bell System employees who operate the Army's private branch exchange at Camp Claiborne, La., outside the dormitory built especially for them

Left: Traffic people at cut-over of central office at Starke, Fla., which serves Camp Blanding. A company dormitory is occupied by 25 girls out of a total force of 34

OPERATORS AWAY FROM HOME

cies, and the traditions and spirit of the service. When a person accepts employment in a small store or office to work along with one or two other people, not much is involved in this matter of "induction." But when so many new telephone employees are being added in so many different places, large and small, a real problem is presented.

Comprehensive induction plans have been developed. One of the cardinal principles in these procedures is considerate treatment of the new employee as an individual, beginning not when she reports for work but in the employment office. This is one of the reasons why so many of the new employees, and the older ones too, say that they "like to work for the telephone company." There are many informal discussions with individual new employees. Sometimes small groups are assembled for this purpose. Questions from the employees are encouraged, and they are answered then and there, and fully. Other means are booklets for new employees, movies about the business, visits to other departments, etc. Throughout, the very definite plan is to give the employees information at times considered most appropriate for each of the subjects involved, and not too much at any one time.

Training

TRAINING activities include the initial training of inexperienced operators, and their subsequent training as well

Left: A new operator meets her future associates in this pleasantly furnished rest room in Charleston, W. Va. Circle: The operator's headset is the badge of her career. A new operator in Los Angeles learns from her supervisor how to adjust it

Right: In Brooklyn a new operator sits at a real switchboard, completing practice calls similar to the actual customers' calls being handled by the experienced operators beside her

First Days on the New Job

—which is continuous. Moreover, as the number of operators in an office increases, more supervisors are needed, and they too, have to be trained for their new and important duties.

Present-day training methods are the result of long experience and lots of study and development. The fundamental principle is to conform fully with the individual needs of each person. The soundness of these methods is attested to by the smoothness with which so many thousands of new operators have been assimilated into the forces with so little reaction on the service.

In the present situation, two broad conditions are faced in training.

First is the general increase in the sizes of the forces. This increase is being met through the extended application of established training plans and facilities.

Next are those places where the forces are growing by leaps and bounds—where war activities are multiplying training requirements manyfold.

Because new operators are trained in the operating rooms and do their practice operating under control at regular switchboard positions, a short-

Long Distance Switchboards Are Busier Than Ever

These operators are helping to win the war at one of the four long distance switchboards in Los Angeles

age of these positions such as may accompany large increases in traffic reduces the facilities available for training. Where the problem is acute, special expedients are employed. These relief measures include the utilization of additional practice facilities, and training not only during evening and night hours but on Sundays and holidays as well; in some cases practically around the clock, seven days a week.

While geared up to meet wartime volumes, basic standards are being maintained. Each student continues to receive training which in all its essentials, including practice operating, is meeting the high objectives established long before the war.

Switchboards

Switchboards and their associated facilities are the matériel of the operators on the communications front.

It is the job of the traffic engineering groups to collect, summarize, and interpret cold statistical data and finally to convert them into what will be living switchboards. The war has created unprecedented amounts of this work. Five thousand is a conservative estimate of the number of traffic orders for facilities related to the war which have been turned out during the past twelve months. Almost 1,500 of these were of a major type related directly to long distance and local central offices serving Army camps, naval bases, air fields, ordnance plants and other military establishments.

Almost every type of switchboard and facilities associated therewith has been covered. The equipment specified ranged from minor additions to entirely new and complete central offices the principal purpose of which is to serve a war establishment, such as the new office at Cataumet, Massachusetts, that serves Camp Edwards and the new office at Starke, Florida, that

CENTRAL OFFICE ON WHEELS
This mobile central office has positions for five operators, and storage batteries and charging equipment, all mounted on a trailer. Always available for an emergency, it is an unusual feature of telephone plant in Southern California

serves Camp Blanding. In these and many other cases, due to a lack of basic data, "engineering on the cuff," backed by judgment developed from long experience, was the order of the day.

Speed has been an important factor in all of this work. A traffic engineer usually waits one, two, or even three years to see his mental efforts transformed into working equipment. But in time of war new switchboards spring into being, and others sometimes double or triple in size, in three to six months from the time they were first conceived.

The problem has been more than one of speedily engineering new boards and expansions that involved the use of standard facilities. Ingenuity of a high order has been called for in adapting available equipment to purposes for which it was not primarily intended. Means of speedily providing temporary facilities to meet the large increase in long-distance traffic include the use of local manual positions, dial service positions, and public telephone positions for handling outward long distance traffic, and arrangements for transferring

THE MESSAGE MUST GO THROUGH
This slogan is the living creed of these Long Lines operators in New York, as it is of all telephone employees

IT'S V FOR VICTORY NOW—
not "V for Victor," in the phrasing of this Chicago information operator

traffic to other long-distance centers where spare facilities may be available at certain times. Such expedients have required changes in operating methods and practices, or the use of varying practices within the same office and by the same operators.

Circuits

IT is the practice of the traffic departments to make comprehensive studies of the flow of traffic over the vast network of intercity circuits. From these studies of the number of calls, their distribution, their characteristics, and the rates of growth, circuit layouts are planned. These basic layouts are of course changed from time to time as the needs arise. Many months ago, in anticipation of more rapid growth in long distance calls, plans for a substantial increase in facilities were made. In addition, as great numbers of people moved from old localities to new in connection with industrial and military expansions, many more rearrangements than normally have been required.

Circuit layouts also have to be changed to care for temporary peaks. Some of these are known about in advance, such as a large convention coming to town, and holidays when long distance service is extensively used—Christmas, Mother's Day, Easter, and even Father's Day.

Other peaks about which there is some information in advance are the evening and week-end peaks in camp areas. Petersburg, Virginia, is an example. The Petersburg exchange serves Camp Lee. In the daytime there are normally four direct circuits to New York; in the evenings, when the men call home, these are stepped up to 20. There is one direct circuit to Pittsburgh in the daytime; in the evenings there are five. There are no direct circuits to Chicago or Philadelphia in the daytime; in the evenings there are three and four respectively.

The war has greatly increased the problem of unpredictable surges in long distance traffic. Here again, camp traffic provides a good example. When a large body of troops moves from a camp and others move in, who can name in advance, and come close to being right, the places these men will want to call and the number of calls they will wish to place to each location? Tonight most of the traffic from a certain camp's long distance center may be flowing north. To-

NEW SINCE PEARL HARBOR

This traffic control bureau in San Francisco functions as one of the "watch towers" for the Bell System's network of long distance telephone lines throughout the United States. Right: Colored plugs indicate line and circuit conditions

morrow night it may be flowing east or west or south.

One of the outstanding means of handling this unpredictable long distance traffic, and a means of getting the best and the most telephone service from the facilities that already exist—a most challenging problem under present conditions of very heavy traffic and shortages of material—is the traffic control bureau. Before Pearl Harbor there were three main bureaus—in New York, Cleveland, and Chicago. Since December 7, additional bureaus have been established at San Francisco and Atlanta.

These traffic control bureaus,* working together and with information obtained from other centers, have complete, up-to-the-minute knowledge of how the traffic is moving over important routes, and particularly the extent of delays actually being encountered in the various circuit groups. If the physical condition of any of the circuits is affected, as in the case of a storm, they know about that too. Delegated with authority to make de-

* For an account of the work of the traffic control bureaus, see "On Watch—All Over the Map," BELL TELEPHONE QUARTERLY, April, 1939.

IN BUSY WASHINGTON

This is the call-distributing information and intercepting desk of one of the world's largest dial private branch exchanges

cisions and to take immediate action, they re-allocate circuits on the basis of relative needs at different places, taking into account the total picture.

The aim is to preserve the best possible balance throughout, to the end that as many as possible of the thousands and thousands of people all over the country who want to talk to a distant point will be able to talk from the places they happen to be in, to the places they wish to talk to, at the times they wish to talk, and with a minimum of delay. During a recent five-day period, the Long Lines Department of the American Telephone and Telegraph Company alone made a total of over 3,500 circuit rearrangements.

Private Branch Exchanges

RAPID and unprecedented industrial and military expansion has brought with it the need for many new and many enlarged private branch exchanges in Government bureaus and departments, war plants, and military establishments in every section of the United States.

The traffic departments start on these projects by working with the other departments of the telephone company and with the customer in engineering the type and size of the system to be installed. Frequently, unusual problems associated with the war are presented; for example, a special type of switchboard for emergency operating.

Before the war, a company now having large war orders had a one-position manual private branch exchange. Now its telephone system, which serves employees located in 12 scattered buildings, consists of four dial private branch exchanges having a total of 17 switchboard positions. There are 1,500 extension lines, 130 central office trunks, and 64 tie lines. An interesting feature of this system is its flexibility. Extension users can dial from one branch to another branch in the system by code dialing through apparatus located in the main office. This particular feature called for special attention by the traffic department in the preparation of information for the customers' various directories, and the giving of verbal instructions to extension users.

There are 52 operators, 90 per cent of whom were obtained by the telephone company. The operators were trained on dial work in the telephone company's private branch exchange school. A complete training course was given the chief operator, who formerly was an operator at her employer's one-position board.

The telephone company has assigned private branch exchange instructors to supervise operations and collaborate with the customer's representatives on daily peg counts, force adjustment layouts, special operating features, and house directory listings.

This is a typical case, cited to portray expansions in this field and ways in which the traffic departments are working with large users of telephone service the country over. Some of the private branch exchanges are, of course, larger than the one described. A few are much larger. A private branch exchange now being installed for one of the large departments of the Government will have 125 switchboard positions and 13,000 lines initially, bigger by far than any other private branch exchange, even bigger than any single local central office in the entire Bell System!

Teletypewriter Service

The use of teletypewriter service by industry, military establishments, Government bureaus, and civilian de-

Teletypewriter Training

These Navy men are receiving instruction in "TWX" operation at the Illinois Bell Telephone Company's school in Chicago

"ALL CLEAR"

A traffic supervisor sends that signal to every telephone building in Dallas. The other three buttons at her fingertips give various air-raid signals

fense units has increased greatly because of the war. Here again, the traffic departments are active in training customers' attendants to operate the machines. This training is given either on the customers' premises or in telephone company schools.

Army Private Branch Exchanges

THE Bell System, in its full co-operation with the Signal Corps of the United States Army, has been requested since Pearl Harbor to take over the operation of the private branch exchanges at many Army posts throughout the country—supply depots, air fields, forts, camps and hospitals.

In quite a few cases this form of operation has introduced problems much the same as those previously described in connection with employees who volunteer for other work away from home, and including housing the operating forces inside the camps. While the service which has to be rendered at an Army switchboard is different in some respects from the handling of regular commercial calls in a telephone company central office, it is work which any experienced operator can learn with ease, and they like it. The Bell System now has over 800 operating employees at these establishments, and the number is increasing almost daily.

Pleasing Service for Service Men

MORE and more men are pouring into Army reception centers, training camps, flying schools, naval stations, and air bases that are getting bigger and bigger and bigger. That means that more soldiers and more sailors and more marines are making more telephone calls. One million men, two million men, three million men . . . millions of men wanting from time to time to call mothers, wives, friends, and sweethearts by telephone. A lot has been done to make this service adequate and satisfactory: new central office buildings and enlarged central office buildings in camp sections, more circuits, more public telephones. And better still, more will be done to make this service more convenient, more pleasing, more thoughtful, more personal.

Attended public telephone service is already provided at many military establishments and in nearby communities where service men congregate. Under this form of service the person wishing to make a call gives the details to one of the traffic employees on the spot. She takes the call, records it, passes it to the central office or handles the call herself, and notifies the man when the connection is made. At the larger places several girls are in attendance. If there will be a delay, the attendant personally explains the situation to the man. In many cases comfortable chairs or benches are provided. If he wishes, he can go away and come back later at about the time completion is due. It is not necessary for him to have the correct change—he pays the attendant for the call.

Attended public telephone service is telephone service personalized to the greatest possible extent, and the most efficient use of the trunks and other facilities necessary to complete calls is ensured. It is particularly helpful in peak hours. The soldiers like this form of service, and it is being extended.

Serving for Victory

In the traffic departments of the Bell Telephone Companies there are *148,000 soldiers of service*—all, truly, *serving for victory*. They wear no uniforms. But they're in the thick of war activity just the same.

That the Army recognizes this is plain when it says, "Every day millions of telephone calls help the Army to push forward on its all-important job. The telephone speeds production of planes and tanks and guns. Telephone messages direct the rapid movement of troops and equipment. Warnings of possible enemy air attack are flashed over telephone lines. On a war front stretching around the world, telephone and radio-telephone give instant communication. America's telephone system serves all industry that serves the Army, and it serves the Army all the time."

Service for the Men in Camp

These attended public telephones are in a separate building at a West Coast air base. The directories are also handy for looking up the addresses of folks back home

REMINDERS

Even when the goal was "national defense," such posters as that above reminded the traffic forces in Oregon that they have an important part to play. On the opposite page is a more recent poster used in Indiana. Both are in red, white, and blue

These operating forces are in all kinds of places: large cities, medium-sized cities, small country towns. They are working at all types of switchboards and at all kinds of operating positions—local, long distance, information, intercepting, teletypewriter, and others. Collectively, they are always on the alert: a 24-hour, never-ending alert. Too much cannot be said about the fine work they are doing. And it will continue.

A great satisfaction comes from knowing that one's job is contributing to the winning of the war. No one has to tell an experienced operator how essential she is to the nation's military and industrial drive to victory. She knows. But some of the newer girls have that to learn. The use of posters is one way which has been found helpful in getting this message across. Many have been designed and executed by the employees themselves. The wordings tell the story; here are a few:

Make no mistake—telephone service is vital to winning the war, and the work of every employee is vital to the continuance of that service.

*Everyone is working toward one end—*Victory*—the soldier, the sailor, the marine, industry, air wardens and* you. *The service which* you *give places* you *in the front ranks.*

Some of the other wordings in this group are as follows:

In Uniform or Not: Every one of us is a partner in our country's greatest undertaking. The better we do each telephone job the better we serve the united drive which must gain victory.

Are you not proud to be in this service to our great Nation? You are in the Front Line and on the Production Line! To preserve the Cause of Hu-

Your SWITCHBOARD POSITION IS AN IMPORTANT BATTLEFRONT .....

man Freedom—"The Message Must Go Through." Our country is depending on you.

This is our pledge: To give the most telephone service and the best each day, to help achieve victory.

Emergency Preparations

WITH the nation at war, protection of its telephone service assumes greater importance than ever. Much has been done: plans for protecting the forces in case of air raids, decentralization of long distance facilities, measures to guard against sudden overloads swamping an office, measures to avoid loss of service by important military and Government establishments, the building and setting aside of emergency units of equipment ready at all times for immediate shipment and prompt installation at the scene of a major disaster.

Employee Activities

IT is not only because of their work that traffic employees are so closely allied with the war effort. First Aid classes have been organized all over

A TRAFFIC CONFERENCE

These traffic supervisory people in Michigan are meeting to discuss ways to keep the quality of service at high level under the heavy demands of war-time stress

FOR THE BOYS IN SERVICE

Above: San Francisco traffic girls serving at a party planned by them for Navy men in San Francisco. Left: Needles click busily in Omaha for the Red Cross

the Bell System. In most cases the instructors are employees—people who have gone right through the regular Red Cross courses for instructors and are now teaching their associates what to do and how to do it.

Sewing and knitting for the Red Cross and the armed forces are widespread.

Many social affairs have been planned by traffic women for the men of the services—and of course they like to come. In Chicago the traffic girls presented a mobile canteen to the Salvation Army—the first of its kind in the middle west—for use in dispensing food to service men at recruiting centers and, later, for war emergency work.

During these times too much cannot be said about the tie-in between good health and the ability of the nation to produce what is needed to win. Health activities in the Bell System are of long standing. Notable in this connection is the current out-of-hour and voluntary course for Bell System women "Health, Appearance and Personality." Again, as in the case of First Aid, this course is given by employee instructors.

Service

BEFORE the war began the Bell System was furnishing this nation the best telephone service ever provided. The

Below: A class in First Aid in a Philadelphia traffic rest room

Above: A Princeton, N. J., chief operator posts the emblem which signifies that all in her office are buying war bonds

OPERATING EMPLOYEES TAKE PART IN MANY WAR-TIME ACTIVITIES

service was good technically. It was also a friendly, pleasant service—service that the customers liked and considered good. That was not enough. The aim was to make it still better. Then came the war.

Large numbers of inexperienced employees had to be hired to handle the unprecedented growth in calls, and to replace losses. Facilities became overtaxed. With these two factors working together, it was inevitable that the service would be affected somewhat.

What about the future?

Ask the operators. They are out to win. If eagerness, determination, and spirit are what it takes, then the quality of the service will be kept up.

Ask the supervisors, the chief operators, the traffic men, the executives. If skill and leadership and liking best to do the things that are the hardest to do are what it takes, then the quality of the service will be kept up.

Service is still good—surprisingly good, in the face of existing difficulties. The consensus is that it can be

FROM ONE OF THE POSTERS

"We are engaged in one of the greatest of human services, which must be continued, whatever difficulties nature of man may interpose. In times of stress its continuance often depends on the initiative and devotion of the individual employee"

maintained. In the case of long distance service, some delays are being experienced because of circuit shortages. As calls continue to increase and critical materials become scarcer and scarcer, delays may increase still more despite all the efforts which are being made and which will continue to be made, more zealously than ever before, to ensure the best possible use of all the facilities at hand. It is for this reason that advertising is directed towards the use of long distance facilities for essential calls only. The friendliness of the service has not diminished and it is not believed that it will.

No one can say how many additional employees will have to be hired. The number is sure to be large. Plans have been formulated to continue to recruit new employees so that they will be ready to operate when needed, and to shift experienced employees in still larger numbers, if necessary, to the places where they are needed most.

THE purpose of this review has been to present a brief picture of the traffic departments in time of war. The problems are many—not all can be covered. They are being approached with vigor, and they are being solved.

Traffic folks are alert. They are confident. They are looking ahead. They are working hard, and they like it. For they know that they are contributing to the winning of the war.

DOING A BIGGER JOB—WITH LESS

Western Electric's Conservation and Reclamation of Metals and Its Development of Alternative Materials Are Vital Factors in Keeping the Highways of Speech Open for War-Time Communication

By ALVIN von AUW

By broadcast and bill insert, through advertisements in magazines and newspapers, the Bell System is appealing for public coöperation in its effort to maintain an efficient telephone service at the disposal of war agencies, military and industrial. In certain abnormally war-busy areas, installation of new service or of additional equipment can be made only within definite limitations. Throughout the country, subscribers are asked to restrict their non-essential long distance calls to hours when they are least likely to clog circuits urgently needed for war business. On all calls, the public is being urged to remember that "telephone highways are overcrowded," that "war calls come first."

The long-range objective of these steps is, of course, the conservation of materials now urgently needed for war which might otherwise go into expanded telephone plant. The subscriber may rest assured, however, that this most unusual situation in which he is asked to coöperate is but one facet of an overall Bell System effort to maintain an efficient wartime communications network and, at the same time, conserve metals and materials vital to victory.

The conservation of metals and materials, although commonly regarded as an emergency measure unique to total war, is no new story to the Bell System. Principles of thrift in the use of materials have long affected the manufacturing operations of the Western Electric Company, the Bell System's organization of manufacture and supply, and the day-to-day practices of the operating companies. These principles, evolved in peacetime and put into practice as common-sense economy moves, stand the System—and the nation—in good stead today.

Down through the years Bell System engineers have been engaged in a continuing search for metals and materials which—for reasons of efficiency and economy—might replace others used in telephone manufacture. Today this same corps of engineers has mobilized its talents and experience for a wartime search for alternatives to replace materials normally used in telephone manufacture, but which the insatiable demands of the war machine have rendered scarce.

For decades one of the principal

functions of Western Electric's distributing houses has been the repair and reconditioning of used equipment for return to service. Today, with fewer and fewer *new* telephones leaving the assembly line, this activity has become more important than ever before.

Machine scrap and rejected parts from Western Electric's manufacturing operations, as well as junked telephone equipment, have long found their way, in the normal course, to reclamation furnaces to be melted down and recast as pigs and ingots of reborn metal to feed once again the assembly lines of its Hawthorne, Kearny, and Point Breeze works. War conditions have focused attention on scrap and junk as important reservoirs of essential metals, while principles of grading and segregation adopted by Western Electric many years ago as vital to successful reclamation are now being adopted throughout industry.

Supplementing these long-established metals conservation measures, the continuing researches of the Bell Telephone Laboratories through the years have turned up new telephone techniques, devised primarily in the interests of improved service, but which incidentally permit expansion of facilities with a minimum expenditure of metals—an "incidentally" that has become mighty important today. Thus, although carrier telephony was introduced into the telephone system some years ago, the Bell System's 1942 Long Lines expansion program features more prominently than ever before this technique to make less metal do more work.

In 1942 these conservation measures, for many years normal practice with the Bell System, have been geared to war conditions—all in the interests of keeping the telephone system at the highest level of efficiency consistent with the most efficient prosecution of the war effort.

Alternative Materials

To meet the equipment requirements of the nation's telephone network would normally involve vast expenditures of the very metals and materials now going into munitions manufacture. But Bell System engineers saw the pinch coming, in pre-Pearl Harbor days applied their group knowledge of the characteristics of materials to the job of finding replacements to release as much vital material as possible from telephone manufacture.

Ever since shortages first threatened, new materials have—after test and trial—been introduced into manufacturing procedure as part of a continuing, cumulative effort. And although telephone production was expected to drop this year, measures to save as much vital material as possible in the manufacture of each piece of equipment were promptly put into effect.

Alternatives introduced in the manufacture of the combined telephone set, for instance, have released hundreds of tons of essential metals and other materials for war use. Combined sets used to be made of an alloy composed of about 4 per cent aluminum, .05 per cent magnesium, and 95 + per cent zinc—all indispensable metals to a nation with a war to win. As an interim measure in the interests of saving aluminum and magnesium, the alloy's composi-

AMMUNITION FOR THE BATTLE OF PRODUCTION

Much of Nassau Smelting and Refining Company's present metals production goes into naval and ordnance production, as well as into means of communication for the Bell System

tion was changed to: 2 per cent aluminum, 1 per cent copper, .015 per cent magnesium, and the rest zinc. Meanwhile, however, production of plastic combined set housings had begun and by August, 1941, one-third of combined set production had been converted to the plastic molding process. By February of this year conversion was complete and combined set production, although running at a reduced rate, was 100 per cent plastic. Since its introduction the conversion to the plastic process has realized a saving in zinc alone of about 2,000,000 pounds.

But Western Electric's alternative materials program does not stop at the combined set's housing. It has, in fact, effected changes in the composition of scores of the more than 300 separate parts that make up the modern telephone set. Instead of aluminum, steel now goes into the dial finger wheel—saving to date: 128,000 pounds of aluminum. Steel supplants aluminum, too, in receiver and transmitter grids, while ceramic substitutes for aluminum in the transmitter barrier.

But before you begin to count the savings realized by the changes in

FIRST STEP TOWARD RECLAMATION

Reclaiming scrap metal successfully depends on careful segregation at the start. Scrap from the busy machines at Western Electric plants goes into plainly marked bins

combined-set specifications, remember that the telephone set itself represents but 10 per cent or less of the total physical plant of the telephone system and that combined set manufacture, therefore, represents but a proportionate percentage of Western Electric manufacture for the Bell System. The total savings effected by the introduction of alternatives in literally thousands of places throughout the full roster of W. E. telephone products run to really impressive totals.

Run down the roster of critical materials normally involved in telephone manufacture and you'll find that all figure in the Bell System's alternative materials program. Take copper, for instance. Copper-steel is now being used instead of bronze in drop wire, of which many millions of feet are used each year. The savings in copper effected by this change—in force since February—amount to 850,000 pounds. Another 900,000 pounds of copper have been saved by using copper-steel instead of copper for line wire.

Now look at aluminum. Upon completion of a few changes that are still in process, alternatives will have been introduced for practically all of the many telephonic uses of aluminum except in condenser foil for which, it appears, no less-scarce material can substitute satisfactorily.

Rubber stands high in the list of scarce materials essential to the war effort; stands high, too, in Western Electric's program of alternatives. Combined sets of recent manufacture, for instance, contain not a milligram of rubber. Impregnated fibre has replaced the rubber formerly used on the receiver cords, while felt pads made from reclaimed wool have supplanted rubber non-skid pads on the base of the instrument. The condenser within the set is now being wrapped with paper instead of rubber. Linoleum replaces rubber in telephone booth floor mats. "Presdwood" now goes into terminal strips, wood into telephone booth kickplates. Biggest single rubber saving of all has been effected by reducing by half the amount of "crude" in drop wire insulation—saving since the change was introduced: 185,000 pounds.

Continuing the picture of nonmetallic alternatives, cotton fabric ("leno" cloth) has replaced burlap in wrapping certain types of buried cable. Cellulose acetate rayon yarn is used instead of silk in switchboard wire.

Perhaps the most interesting of all "alternative" stories involves phenol fibre. This insulating material, used in great quantities in telephone exchanges, contains cresylic acid, a chemical now "drafted" for war use. In their quest for an alternative, engineers came upon a lignin resin plastic made from waste sulphite water from the manufacture of paper pulp. For years pollution of North American waterways by sulphite water had been a major problem with pulp and paper manufacturers. Today the use in telephone manufacture of the lignin resin plastic derived from this waste cuts Western Electric's use of phenol fibre by about 40 per cent.

All in all, alternatives have replaced strategic materials in more than 1,000 parts involved in telephone manufacture. When you add all these instances together, when you take into consideration, too, the necessary reduction of the Bell System's construction program, you find that the annual rate of use of aluminum has been cut by 90 per cent, crude rubber usage has decreased by 80 per cent, zinc by 75 per cent, and copper by 70 per cent. During this same interval, the Bell System's construction program has fallen off by about 25 per cent. Comparison of these statistics will readily reveal how large a share of the Bell System's materials savings can be ascribed to the program of alternatives initiated by the System's metallurgical engineers.

In the long run, however, it's impossible to freeze the whole alternatives program in statistics—the picture changes constantly. Not infrequently, essential materials gain the "critical" status on short notice, making coördinated efforts and rapid action imperative. Often the introduction of an alternative calls for changes in design, a problem complicated by shortages of skilled toolmakers and toolmaking facilities. Then, too, there is the problem of re-substitution: alternative materials themselves have—in more than one instance—appeared on the critical list a few short months after they had been introduced into Western Electric manufacture.

To cope with multiplexities of the conservation program, the Bell System, early in 1941, set up an Intercompany Committee consisting of H. S. Osborne, A. T. & T.'s plant engineer; D. F. G. Eliot, Western Electric's general purchasing agent; R. L. Jones, director of apparatus development, Bell Telephone Laboratories; and Stanley Bracken, W. E. vice president and general manager of manufacture.

Behind this committee stands the full Bell System corps of engineers, mobilized for combined attack on the materials problem. It's the job of

Into the Melting-Pot

Baled nickel-silver scrap here goes into an electric induction furnace, to be re-born and prepared for re-fabrication

Bell Labs engineers to consider the technical questions involved and to pass on the suitability of the alternative materials available. Western Electric manufacturing engineers review the parts affected by the shortage in question, make an inventory of available supplies, discuss manufacturing problems with their colleagues from the Laboratories and, upon agreement, revise manufacturing information accordingly. Western Electric's purchasing department places new orders immediately, revises outstanding contracts, makes every effort to insure a smooth influx of the new material. At Western Electric works locations, engineers make prompt arrangements for the new materials to go into stock, and as swiftly adapt operations to the new manufacturing techniques required.

Reclamation

In dire need of metals for war, America today looks to her scrap heaps and junk yards as veritable "mines above ground" which, if tapped, will yield ton upon ton of metal to feed the reclamation furnaces and, in turn, our gigantic war arsenal. For many years, however, Western Electric has been tapping the huge above-the-ground mine of obsolete and worn-out telephone equipment, of machine scrap and rejected parts from its own manufacturing operations. Removed from Bell System service, obsolete and worn-out equipment is collected and sorted in Western Electric's distributing houses, and then—for the most part—goes to Western's wholly-owned subsidiary devoted to reclamation of non-ferrous metals, the Nassau Smelting and Refining Company on Staten Island, New York.

In Nassau's fiery furnaces this old equipment is melted down to yield ingots and pigs of brass, bronze, babbitt, solder and other essential metals and alloys. Much of Nassau's production returns to Western Electric to be fabricated once again into instruments of communications. Nassau solder is in almost universal use throughout the System—3,000,000 pounds of it last year—while Nassau bronze now goes into propellers for naval and merchant craft, Nassau brass into ship fittings and ordnance parts.

In an average year the Nassau Smelting and Refining Company returns to Western Electric a total of 48,000,000 pounds of reborn metal. Nassau's 1941 production, augmented by deliveries to outside customers, came to nearly twice that amount.

Nassau, too, is responsible for the disposition of much of the Bell System's scrap iron, paper, rubber, and other by-products of telephone operation. The company employs more than 400 people, including a staff of metallurgical engineers whose tests control a quality output.

Nassau is not Western Electric's only metals reclamation plant. In its own works the company maintains furnaces for the reclamation of machine scrap—the punch press skeletons, the chips from milling operations, and the other odds and ends of metal that are the inevitable by-products of metals fabrication. There's only a trickle of scrap from each machine, but multiply that trickle by the thousands of W. E. metal working operations and you get a swelling stream of essential metals.

RECONDITIONING DROP WIRE

Wire removed from service is returned to W. E. distributing houses where, as in this picture, defective sections are cut out and serviceable lengths are spliced together for re-use

But miscellaneous metals, no matter how huge the volume, are relatively worthless until they are sorted according to grade and kind. Western Electric segregates its scrap at the source—at the machine. Carefully marked bins are available for each grade and type of metal. In the metals manufacturing plant this scrap metal is re-melted, refined, re-cast, rolled and shaped into strips of metal ready for fabrication once again.

No reasonable quantity is too small to reclaim. Here's an example. The acid baths used to remove the oxide coating from newly-made copper rod removes, too, an infinitesimal amount of copper from the surface of the wire. After several runs, however, the bath grows rich in copper, copper which Western reclaims by electrolytic processes. Copper reclaimed in this fashion runs to many tons in the course of a year.

Repair and Re-use

WHAT of apparatus not obsolete but which had been removed from service because of the failure of a single part? Here again Western Electric distributing houses move to the forefront of the Bell System's war on waste. In the 29 equipment supply centers serving System operating companies, shop employees disassemble telephones and other apparatus, remove and replace ailing parts, and return the equipment to the operating companies for a new term of service.

In the field, the materials thrift habits of Western Electric and telephone company installers help to cut down

REPAIRING TELEPHONE SETS

This W. E. distributing house employee is reconditioning subscriber sets, removed from service, to help meet the growing demand for telephones in areas busy with war production

over-all Bell System use of vital materials. Although it may cost more money to take down a damaged wire, repair it, and splice it to another piece, it costs less in materials. And this is a war of materials.

Emergency Engineering

PROGRAMS for Bell System expansion have—until today—been figured in long-range terms. For instance, it seemed but common-sense economy to engineer central office construction with a view to expansion over a period of years. But war has changed all that. Perhaps it will cost more to provide switchboard additions to meet requirements of a period of only a year, but it saves copper—and saves it now. It may cost more to install a small instead of a larger cable where indications point to the necessity of installing another small one a year or so hence, but it saves metal when it's most badly needed.

New Telephone Techniques

THE habit of long-term thinking is paying dividends, none the less, in another facet of the Bell System's program to do much with little. The fundamental researches of the Bell Telephone Laboratories in the interests of an improved service have yielded new techniques by which the System can carry a heavier load than ever before with a minimum expenditure of metals. "Carrier" telephony is one example.

"Carrier," a technique by which several conversations may be sped over the same pair of wires at the same time, has been the object of continuing development for a quarter-century, and had seen commercial use for many years before the war. Today multi-channel telephony is playing an important part in reconciling shortages of materials with an unprecedented demand for more and more long-distance voiceways.

Type "K" carrier, for instance, can carry as many as 12 conversations over two pairs of cable wires and, best of all, can frequently be installed on existing cables, multiplying their efficiency many times without significant expenditure of copper. So great, indeed, are the copper savings effected by carrier telephony that if the total carrier circuit mileage expected to be placed in operation at the end of the year were to be duplicated by ordinary open wire and cable construction, between 300,000 and 400,000 tons of additional copper would be required.

Another copper-saving product of Bell Laboratories research, the coaxial cable, can carry as many as 480 simultaneous conversations by the carrier technique. The wire-within-a-tube construction of coaxial involves far less copper than conventional cable capable of carrying a comparable load.

NONE of the Bell System's conservation measures is merely a blind substitution; all are products of coördinated organization and the "know how" of long experience. Peace-time precautions against waste are paying real dividends in war time.

By corollary, the experience gained in the test and trial of war-time operation will just as surely pay dividends in the form of improved service and economy after the war. Many of the alternative materials, having proved their efficiency and economy, are winning a permanent place in telephone manufacture. The extensive application of the standard carrier and coaxial techniques will, after the war, provide more and more voice channels to link a victorious nation together, bringing the telephone system closer to its permanent ideal of universal service, an ideal unobscured despite the restrictions of war-time operation.

THE ORGANIZATION OF LARGE-SCALE ENGINEERING WORK

Coordination of This Country's Unique and Unlimited Capacity for Productive Effort Is Engineering's Contribution to Victory over the Forces of Our Enemies

BY MARK R. SULLIVAN

The text of an address delivered before the summer meeting of the American Institute of Electrical Engineers in Chicago on June 25.

"THE road ahead is dim with the dust of battles still unfought but it is brighter than it would have been had our enemies not misjudged us and themselves, for when Hitler put his war on wheels he ran it straight down our alley. When he hitched his chariot to an internal combustion engine he opened up a new battle front—a front we know well."

These are General Sommervell's words. He is the head of the Service of Supply of the Army. Mass production of machines on wheels and machines that fly and the stuff that goes in them—that, he says, "is right down our alley." We can beat the enemy at that.

What that statement means to me is that "the organization of large-scale engineering work," which is the subject assigned to me today, is America's choice of a battle front. On that ground we are called to meet our enemies, and it is fortunate that this is true, for the freedom of the world depends on our acceptance of this front and our success on it.

The thing that distinguishes America on this front is its capacity for organization. The capacity to produce is not entirely a matter of raw materials and skilled labor. Other nations have as much or more of these than we have. Our ability to roll out the machines and munitions lies in soundly engineered, well trained organizations. It is a matter of organization—organization throughout, far-reaching and effective.

In more normal times, a discussion of the organization of large-scale engineering work would warrant, I think, initially defining the type and character of the particular engineering enterprise. In form and structure of organization and the procedures for its functioning, the controlling factor is the work to be done. Since the work to be done will vary greatly in different types of enterprises, the specific form and structure of the organizations would necessarily vary correspondingly. There are, however, many general functions common to all engineering enterprises. These include—

Determination of the basic requirements in accordance with the best known standards.

Preparation of specifications for technical apparatus and equipment.

Selection of the best route or location for the installation.

Obtaining and processing of the raw materials.

Employment and training of suitable construction crews.

Laying out of proper schedules for delivery of all materials to make for the most efficient and expeditious construction.

Preparation of proper operating procedures based on the engineering requirements.

Arrangements for cutting the project into service to obtain the maximum advantage of the new installation but with the minimum disruption to existing installations.

Following up the completed installation to ensure that it functions in accordance with its intended engineering design and to correct any defects in design or construction which may developed under actual operation.

To describe the organization features required for the various steps of any specific engineering project from inception to completion always makes an interesting tale. Today, however, any specific engineering enterprise, no matter how large, is dwarfed in interest and importance by the spectacular organization problem confronting the country in the conversion of our full productive capacity to wartime requirements. Under these conditions, rather than to describe the organization features of a particular engineering project, it seems to me more pertinent to treat the subject more in the abstract.

What are the underlying principles of organization, recognition of which has given this nation its power and its know-how? Organization is designed to bring all available knowledge and all available energy to bear upon the specific problem at the time most needed. It presents first a problem in specialization, or division of labor, and then a problem in coördination of each of the specialties and parts of the organization so as to function as a single, unified, and cohesive team.

Long ago, Adam Smith, pointing out the great economies which are the result of specialization of labor in the production of goods and services wrote: "The greatest improvement in the productive powers of labor, and the greater part of the skill, dexterity, and judgment with which it is anywhere directed, or applied, seem to have been the effects of the division of labor."

In principle his statement is as true today as it was a century and a half or so ago when it was written. In practice specialization has been carried to an extent undreamed of then. And the more you divide the work in order to specialize on the particular parts, the more you have to coördinate in order to bring all the parts together in a whole. As degree of specialization increases to improve the productive power of labor and the necessary coordination follows, obviously the greater the supervision necessary—in other words, the more the whole enterprise depends on sound and able organization. There has been so much discussion of the wonderful results of science that I think the public has lost sight of the fact that science by itself does not produce the goods and services that benefit the public, that until a competent organization takes the results of scientific research and translates them into products of service with precision and economy, the public gets little good from the research.

Industrial organization for large-scale production is particularly American. Relatively to other countries, we have advanced more in organization than in science. That is why making planes and tanks is down our alley even though we had made fewer planes than others and no tanks. And the capacity for organization functions in the building of ships, guns, radars, and all the other engines and gadgets of war.

Divisions of Labor and Functions and Their Coördination

In large scale enterprise, consideration of divisions of labor and functions and of their coördination should embrace:

Separation by broad categories such as research, engineering, manufacturing, and operations.

Specialization within each category in order that the work assigned to each individual in each part of the organization may bring to bear, recognizing the limiting capacity of the individual, the maximum dexterity, efficiency, and knowledge in handling the assigned work.

Recognition of the distinction between the respective functions of line and staff work. The line work which has to do with the actual on-the-job operations inherent in the work to be done must be supported by staff work responsible for methods, procedures and general direction of the work.

Decentralization of the work, taking into account geographical factors, to the end that the work will be performed where it can be most economically and effectively handled.

Recognition of the proper relationship of supervisory people to the total force. The importance of an adequately trained and numerically sufficient supervisory force, commonly referred to as "overhead" is worthy of emphasis. Overhead is essential because without it the result would be an untrained, undisciplined and undirected force. The exact relationship which will produce the most effective results is dependent upon the type and amount of work to be done, but even in the simplest operation some overhead is necessary. It is an established military fact, for example, that an adequately supervised army is more effective than many times its numbers of unorganized, untrained people. Hence, separate branches of the army are organized into squads, then grouped into platoons and so on until arriving finally at the collection of Army Corps, constituting the entire army. Each unit is given suitable leadership—Corporals, Sergeants, Lieutenants and on up to the Commanding General. Any other organization must follow much the same pattern.

Flowing directly from the division of labor comes the second type of problem, namely, the coördination between all units of the organization. Coördination involves:

A common objective mutually understood and subscribed to by all in the organization.

Cohesive direction accomplished by having definite lines of responsibility spreading out from the executive head of the enterprise so that each individual in the organization knows what his definite responsibilities are and to whom to turn for decisions and assistance.

Understanding on the part of each unit of the functions and responsibilities of every other unit. Such mutual understanding is, of course, essential for smooth coöperative working.

A sympathetic understanding by the personnel as a whole of the ideals and traditions of the enterprise and of the general reasons for approved procedures.

The aim of coördination is that the organization as a whole shall function as a single team; no organization can be successful unless this result is effectively achieved. This coördination, to be fully effective, must represent all work done by the various branches and individuals of the organization, usually each doing a clearly defined and component part of the whole, but all subordinating individual prominence to the efficiency of the whole.

I am but quoting the definition of teamwork. It is an intangible quality of organization; one which cannot be shown on charts; nor can any very precise formula for attaining it be stated. Above all, it should embody a spirit of service, the significance of which should instil an appreciation not only of the importance of the individual's contribution, no matter how humble the assignment, to the success of the enterprise but should also bring about a realization of the deeper meanings and values of the individual's way of life to be achieved through his part in the skilful execution of soundly conceived and well organized plans.

The Bell System Team

MANY teams are working together in this country to meet the challenge for maximum production under the impact of war. The Bell System is one such team, and I think I may say, an important team. Since I am more familiar with this organization than with others, it may prove helpful to sketch briefly the following aspects of the Bell System organization.

Since the Bell System Companies are responsible for the rendition of a large part of the telephone service to this nation, they necessarily constitute together a large and geographically extensive organization. There are about 400,000 employees, inclusive of about 10,000 engineers and scientists (the exact number being somewhat a matter of definition) located throughout the continental United States.

The nature of the enterprise embraces a very broad scope of activities related to electrical communication. These activities run all the way from the elements which enter into an electrical communication system including raw materials and ideas, go through the gamut of research, development and design of apparatus and equipment, manufacture, fundamental engineering plans for future development, design and construction of operating plant, technical problems of maintenance and operation, and studies of technical quality of service—the final product of the organization.

An important requirement is to insure that no new device or equipment is introduced in general public usage until it has been subjected to such engineering and laboratory tests that any question as to its adaptability is resolved beyond a question of doubt. Thus it is never necessary to put into public usage untried and unproved devices, which if not suitable could have, because of the highly coördinated nature of the telephone plant, seriously adverse effects.

How the Work Is Divided

By broad categories the work is divided as follows—

Research and development is concentrated in one large organization (Bell Telephone Laboratories, Incorporated) which carries out fundamental studies in the branches of science underlying the industry, studies new ideas which relate to telephone equipment and materials, and constantly develops new or improved apparatus and materials for use in realizing the objectives of the enterprise.

The Bell System source of supply (The Western Electric Company) is responsible for providing apparatus and materials as required, manufacturing them in accordance with Bell Laboratories specifications or arranging for their manufacture by others, making complete installations of telephone central offices or other equipment, repairing recovered apparatus, and salvaging useful materials from discontinued plant.

A centralized general staff is maintained by the American Telephone and Telegraph Company to carry out staff work of such a general nature that it is applicable to all the operating companies in variparts of the country and therefore can be done once for all. This staff work includes the investigation of new ideas, the study of service requirements, determination of field of application and programs for the introduction of new types of telephone equipment and materials, preparation of general technical information, including that required for the design, construction, maintenance and operation of the plant.

There is a series of autonomous operating companies, known as Associated Companies, each with its engineering and other operating departments and each responsible for telephone operations in a particular part of the country. There are 19 such Associated Companies, and in addition, there is the Long Lines Department of the American Telephone and Telegraph Company, which provides long distance service to tie together the long distance facilities of the System. Individual operating companies are subdivided geographically into divisions and districts in accordance with their operating requirements. The engineering work is in part concentrated in the headquarters of the companies and in part distributed geographically by divisions and districts according to the nature of the work and the most effective and economical procedure for carrying out each part of the work.

Further specialization is attained within each of the broad categories:

Each company is departmentalized and the work divided within each department to meet its specialized requirements. Highly functionalized staffs are necessary and provided for. This is particularly true within the engineering and research departments, which are organized and equipped to go deep into the heart of all communication techniques. The diversity of the research work, for example, is most impressive, the research problems being scattered all along the whole frontier of the sciences, extending through the field of physical and organic chemistry, of metallurgy, of magnetism, of electric conduction, of radiation, of electronics, of acoustics, of phonetics, of optics, of mathematics, of mechanics, and even of physiology and psychology and of meteorology.

All of the work, of course, whether line or staff, engineering, research, or operations, is under the direction of competent supervision of varying grades. On the average, one out of each eight employees is a supervisory employee.

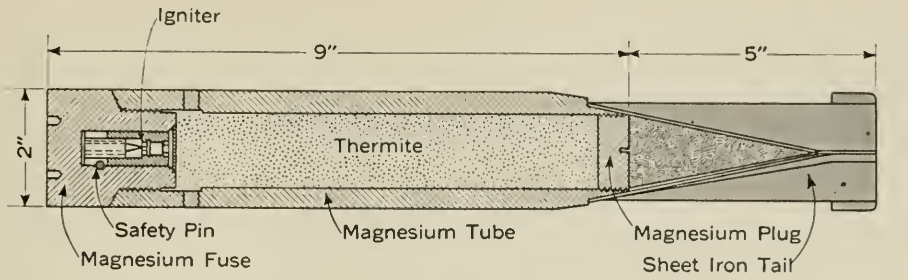
An unusually high degree of coördination is required. In handling even the simplest telephone call, for example, the procedures at the originating and terminating points, as well as in all the intermediate links, must be carried out in coördinated precision. The Bell System has been described as a team of 400,000 persons; an organization where the 400,000 can play their positions knowing all the plays and all the signals and knowing that what this team does is absolutely vital —for over its wires go many of the signals for all the other teams that are getting things done. To explore the conditions and to depict the practices, at any length, which have brought about this coördination and teamwork would require more time than can be devoted to the subject here. Suffice it to say that the high degree of coordination of the organization reflects in a great measure the ideals and traditions with which the service is endowed and the common bond between people who know the real significance of working together to serve an outstanding common purpose.

The organization features described for the Bell System are but typical of those of many other large enterprises. And of course the Bell System is only one organization, collaborating with many others, to effect maximum production for the war effort—in which effort the engineering departments have a unique responsibility.

ENGINEERING, embracing as it does the origin, cultivation, and integration of powerful forces, has a major rôle in the full, complete, and far-reaching organization of America's productive forces for total war. The military objective is not new. On the contrary, history records that engineers were first military men. In English history, for example, the word "engineering" was originally applied to "the operations of those who construct engines of war and execute works intended to serve military purposes."

Now again, engineering must concentrate on military rather than civil objectives. The responsibility is grave, since the military outcome holds in its crucible the destiny of mankind. But with confidence born in the knowledge of the integrity, wisdom, and ableness of our organization leadership, we may have faith that our capacity to produce will be organized with maximum effectiveness in this our most troubled hour.

Looking beyond that, our work and spirit of today nourishes the aspiration of tomorrow—for a new world, unhampered by oppression and tyranny, a world in which the full power of organization will be utilized to produce a civilization dedicated to the well-being of mankind and bringing benefits to the individual which the boldest of men cannot now visualize.



INCENDIARY BOMB

PROTECTING THE SERVICE AGAINST FIRE

Incendiary Bombs Are Now Included in the Hazards Against Which the Bell System Takes Precautionary Measures to Safeguard Its People, Buildings, and Equipment

By IRVIN M. CUPITT

War conditions have kindled in the popular mind a new interest in what has always been a most important science: fire prevention and protection. Probably never before has public consciousness of the loss and grief caused by fire, man's best friend and also his worst enemy, reached its present high level. For fire has once again assumed proportions of a major weapon of warfare.

This is due, of course, to the bomb-carrying airplane, and brings the burden of fire defense to our own front doors. Today, civilians are called upon to a greater extent than ever before in the defense of their homes and country.

It took the grim news of the London fires to set the present generation wondering about the safety of the roofs over their heads, whereas, before, fire was something to cause a stir mostly when an alarm was sounded. It has been a long struggle, never ended, to try to make the average person "fire-prevention conscious" — to convince him it is necessary to do things and spend money to take care of conditions he hopes will never arise. But the record shows only too well the need for maintaining a day-in and day-out interest in this major problem involving a yearly U. S. fire loss of some three hundred million dollars and 10,000 lives.

The present situation, with war defense uppermost in the public mind, affords an opportunity to translate this interest into action, particularly the cultivation of personal habits of carefulness. Avoiding fire loss is, moreover, a distinct contribution to the war effort.

While the state of war now lends additional emphasis to the outstanding importance of the various phases of fire prevention, nothing has developed to change the fundamentals. It is reassuring to know that fire prevention practices developed for peace-time conditions are equally sound under conditions of war—with some precautions added for incendiary fires. Efforts expended for adequate peace-time defense in fire-resistive construction and fire-extinguishing facilities will go a long way in war-time fire defense.

Incendiary Fires

The problem of protecting against incendiary bomb attack from the air is quite similar to normal fire protection, differing chiefly in the larger number of fires and in the peculiar action of the incendiaries. The new factors, then, for wartime conditions are the need for additional fire watchers and fighters, knowledge of incendiaries, and equipment for combating them. The burden of war-time fire fighting, therefore, falls very largely on civilians as auxiliaries to the fire departments. This is readily understandable when it is realized that the number of fires which may be produced by an incendiary attack would be many times as great as the peace-time organizations and equipment of municipal fire departments are designed to handle.

The Bell System is organized and prepared, therefore, to do its part in looking out for its own people and its own property in this as well as in the whole range of air raid precautions. This activity, broadly stated, is responsible for safeguarding telephone employees and property during an air raid. It has organized floor wardens, and patrol, fire-fighting and first-aid squads. These squads, covering various specific assignments, head up to group warden, building warden, district warden, and area warden or director—who forms the point of contact with the Civilian Defense authorities.

Each member of the organization, trained in his duties, is listed on a chart, together with his whereabouts. Periodic drills are carried out as an important part of the training course. Regular and frequent fire drills by the operating forces have been standard practice for years. Posted diagrams indicate the routes of exit to be taken by employees in case of a fire drill or actual emergency. Fire drill bells, tested daily, are a standard part of the telephone switchboard installation.

Bomb Penetration

Fire bombs may use any one of several incendiary agents, with magnesium most commonly employed so far. The magnesium bomb, with its lightness of weight and intensity of heat, best fulfills the enemy objective of simultaneously starting the most fires, on account of the possible concentration of a great number of the smallest sized bombs in the limited carrying capacity of an airplane.

The magnesium bomb most generally used to date, weighing a little over two pounds, would not be able to penetrate the usual reinforced concrete or hollow tile roof on a fire-resistive telephone building. It would, however, pierce any ordinary roof of slate or tile on wood sheathing, and land on the floor below unless it should strike a beam or other roof member. In the usual case of a fire-resistive structure, the bomb would come to rest on a flat roof and burn itself out if left undisturbed. The only measurable dam-

Right: Water spray speeds combustion relatively quietly

Left: A full stream of water does a quicker but explosive job

TWO METHODS OF EXTINGUISHING MAGNESIUM BOMBS

age, it is expected, would be to the tar and gravel roofing or insulation where this type of finish is used. It is to the roofs which are not fireproof, and also to nearby buildings, that special attention would have to be directed. Skylights, which are not very common in telephone buildings, have received special consideration, in many cases being eliminated in favor of a reinforced concrete slab.

The magnesium bomb, on account of its shape and light weight, has relatively poor directional characteristics, and the bombs have a tendency to spread out as they fall. It is interesting to note that this type of bomb attains its maximum velocity after dropping a mile, beyond which its speed is uniform. Where better aim at strategic targets is an important factor, such as warehouses, docks, factories, or munitions stores, heavier bombs of equivalent construction and ranging up to more than 50 pounds in weight, are used.

What the Magnesium Bomb Is

CONSIDERABLE information has been made available on the details of the magnesium bomb used by the Nazis, but a brief look here at the chief offender might be of some interest. This 2-pound bomb, shown at the head of this article, consists of a thick-walled 80 per cent magnesium tube 9 inches long and 2 inches in diameter, filled with thermite, which is a mixture of iron oxide and powdered aluminum. One end of the tube has a 5-inch sheet iron tail to steady the bomb in flight. The bomb operates on impact, which drives a needle into the percussion cap, which in turn ignites the thermite. The thermite, which supplies its own oxygen, burns with a somewhat violent reaction for nearly a minute and its great heat serves to ignite the magnesium. Jets of flame are emitted from vent holes designed to permit the escape of hot gases formed during this initial period, and bits of molten magnesium, which are forced through these holes, scatter in every direction for a considerable distance. The pressure in the tube diminishes with the completion of the burning of the thermite, and the bomb becomes correspondingly less active. By this time, the magnesium has been well ignited and will burn for 10 to 15 minutes if left unmolested, setting fire to any combustible material within a few feet.

For the purpose of discouraging persons from approaching the bombs, some of them are equipped with an explosive capsule on the tapered end which is covered by the tail. The explosive charge, when present, is fired by the heat from the burning magnesium in about one to two minutes after the bomb has started to burn.

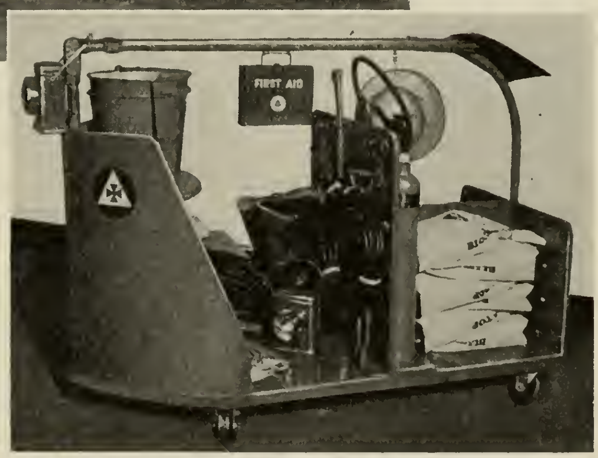
Handling the Magnesium Bomb

Incendiary bombs produce a very intense heat. This fact, coupled with the probability of a large number of fires being started at one time over large areas, makes it imperative to extinguish these fires promptly, not only to save individual properties but also to prevent widespread conflagrations. All possible precautions should be taken in advance to eliminate, as far as practicable, any fire hazards that needlessly exist in buildings. This will not only reduce the exposure of combustible materials to fire but will also facilitate the fighting of fires that do get started. Another important consideration is the prompt detection of the presence of a bomb after landing, and this requires close observation of the area by lookouts liberally provided for this purpose.

As soon as a bomb has landed where it can do any harm, it becomes immediately necessary to control the bomb and prevent it from burning through the roof or floor, and to localize and subdue the resulting fire before it gets out of control. At this stage, time is of paramount importance and none should be lost, especially since these sparklers may appear in a swarm.

The recommended procedures for combating incendiaries have been passing through more or less of a state of evolution since the first bombs fell from the sky over England.

Magnesium has a strong affinity for oxygen, which, in conjunction with its high combustion temperature, makes it very difficult to deal with when once ignited. Water will not extinguish burning magnesium, but it does provide a practical means of controlling the fire. When water is applied, the intense heat of the burning magnesium breaks down the water into its components of oxygen and hydrogen. The supply of these elements thus released greatly accelerates the combustion of the bomb and reduces the time of burning from 10 to 15 minutes down



TWO TYPES OF "EMERGENCY WAGONS"

These can be brought quickly to any endangered location in telephone buildings having elevators. Note the variety of bomb-fighting equipment assembled in a compact unit

to two or three minutes. This is, of course, an advantage where the surrounding fire can be restrained while the bomb is quickly being consumed. But the important thing is to have a reliable supply of water and to know how to use it.

When water is applied to the bomb as a spray, the time of burning is effectively reduced and there is a minimum of sputtering and violence. When applied as a solid stream, however, an explosive reaction takes place and white hot metal is scattered over a considerable area. During England's early experience of fighting the fire bomb, the use of a solid stream of water was considered to be the wrong procedure and was discouraged. Stirrup pumps or garden hose with dual spray and jet nozzle were accordingly recommended. The spray was used on the bomb itself, while the jet was available for dealing with any fire in the area surrounding the bomb that might require attention. This general procedure is still recommended when combustible and vulnerable equipment is exposed to the effects of a fire bomb, because of the importance of avoiding scattering sparks and splashing of water.

In the telephone equipment rooms and other spaces containing valuable contents subject to fire and water damage, the spray method would be followed in accordance with the practices as outlined for the Bell System.

These practices call for the use of water, applied in spray form by a stirrup pump or garden hose, as a first line of defense. Dry sand is also provided, preferably in bags, for placing over the bomb to reduce scattering of sparks and emission of heat.

While water is by far the best weapon for use on bombs, there are several situations where sand will be useful: 1) if the bomb is where it cannot start a fire, sand may be dropped on it; 2) if no water is available, the bucket-and-shovel technique using sand may be used; and 3) if several bombs have fallen in one part of a building, those which cannot be tackled at once with water should, if possible, be covered with sand to prevent the sputtering of the bomb from setting fire to combustible materials and to keep the fire in check until the bombs can be dealt with.

Where the bomb rests on wood, it is important also to try to get a few inches of sand under it to help protect the wood from burning. But bombs so enclosed in sand are not extinguished and may burn through the floor, if it is not fire resistive, into the room below; consequently, they must never be left without further attention under such conditions.

Where possible, the bomb should be attacked from behind cover, such as a door, metal plate, chair, or other protection, remembering that the bomb may be one which will explode at any time within the first two minutes of ignition. Asbestos gloves and safety goggles provide additional protection. Buildings in the various territories, depending on their locations, size, and relative importance, have been equipped in the present emergency with various supplemental equipment, in addition to the usual fire-fighting apparatus. This includes such items as a fully equipped rolling fire truck for a building with elevators; or separate long-handle flat shovels, axes, pinch bars, jacks, helmets, etc., placed at strategic locations.

It is not planned to use the regular complement of fire extinguishers in the handling of bombs, except in case of emergency where the supplemental stirrup pumps or hoses may not be adequate. The regular apparatus is held in reserve as far as possible for application on fires involving central office equipment, as provided in the Bell System normal fire protection practices. As a matter of fact, the carbon dioxide extinguisher is not effective on a magnesium bomb, but it can be effectively used on equipment fires started by the bomb. Soda-acid, water, and foam types of extinguishers can, in an emergency, be used with the thumb held over the nozzle. But even in the case of the water and soda-acid types, two or three extinguishers would be required to dispose of a bomb if the spray method were used.

Other Telephone Rooms

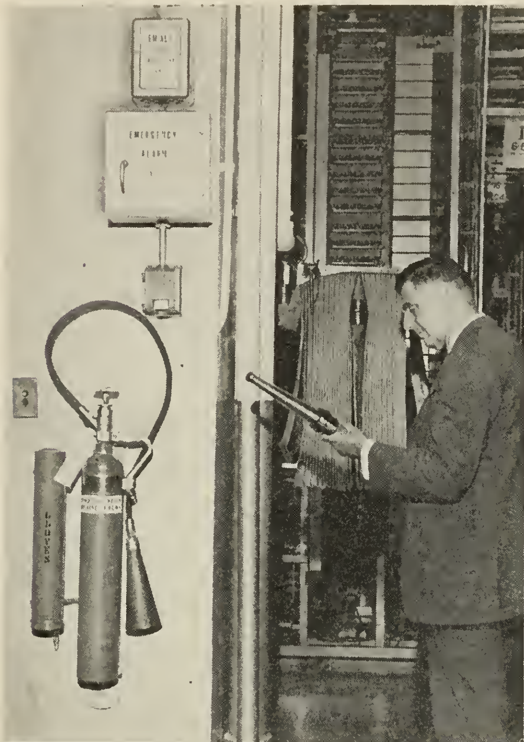
For spaces not involving combustible contents or intricate apparatus, the newer instructions to the public

TEST MOBILIZATION
Air raid fire and rescue squads assembled in the control room of a Bell System building after the "all clear"

recognize the advantages of shooting a jet of water directly at the bomb without delay, to put it out of action and leave the fire fighter free to deal with other bombs and fires. This procedure would be applicable, for example, to bombs falling on the roof or other open spaces and particularly on wood floors; but, as previously indicated, it would not be desirable in a telephone switchroom or operating room as compared with covering the bombs with sand and applying the spray of water.

The advantages of the jet or solid stream, as based on the most successful air raid defense abroad and on U. S. tests, rest on the desirability of speed and the use of less total water as compared with the spray treatment. Moreover, the fire fighter can stand farther away from the bomb when using a jet than he can when using the spray, and the directional force of the jet scatters the metallic fragments away from him. When the jet of water hits the bomb, there is a momentary flash of light and flame and a scattering of molten metal. An instant later, however, nothing is left but scattered fragments and the unburnable part of the bomb. These fragments, together with the fires which may have been started, are then quickly extinguished by the jet. The scattering of the bomb may also forestall the action of an explosive capsule, should there be one attached to the bomb.

As other evidence of evolution, the Russians are said to have extinguished incendiaries by throwing the bombs into barrels of water. The success of



TWO KINDS OF PROTECTIVE EQUIPMENT

Left: "Normal"—racked hose at standpipe, carbon dioxide extinguisher, asbestos gloves, alarm box. Below: Fixed emergency unit with sand, stirrup pump and pails, shovel, flashlights, goggles in box on rack, all for use against incendiary bombs

this method depends on complete "drowning" of the bomb. Also, we have read of the bravery of the British in flinging incendiary bombs from the roof of Canterbury Cathedral as fast as they were dropped from Nazi bombers. These comprise the acts of heroism outside the rules in the book as so far written, but emphasize again the courage of our allied defenders.

Other Types of Fire Bombs

It may be interesting to note some other types of fire bombs. These have seldom been used, however, for various reasons, such as their less intensive heat or greater weight. There is the so-called thermite bomb, with its thermite encased in a thin steel shell; and the oil, the phosphorus, and the sodium and sodium-potassium alloy bombs, the make-up of which can be judged from their names.

The thermite bomb is handled in the same general manner as the magnesium bomb, while the oil bomb should be fought as any other flammable liquid fire, with foam or carbon dioxide extinguishers. The phosphorus bomb is easily extinguished with water or wet sand but re-ignites on drying. After a phosphorus fire has been extinguished, it is therefore necessary to keep all contaminated material wet until it can be carefully removed. This removal should be effected with great care because phosphorus is poisonous and will burn the skin. The sodium-type bombs can easily be extinguished by dry sand.

It's just as well to keep these other decoy bombs in mind and be prepared for enemy tricks of mixing up the types. But trickiness is not a monopoly of the living enemy. Blazing fire can always be counted on as a treacherous traitor, striking from seeming nowhere—at any time—in war or in peace.

Year-'round Fire Protection

Let us go back for a moment, then, to the solid foundation of peace-time fire prevention and fire control, and consider the means whereby the Bell System safeguards the reliability of telephone service by protecting its personnel, buildings, and equipment against fire.

Protecting the service against interruption from this cause includes not just fighting fires effectively but also the more necessary fundamental effort to prevent fires from starting in the first place. Many of the oldest telephone buildings were of what was considered fire resistive construction and, with these as a start, the record of the Bell System has been one of continuous and aggressive progress in the direction of more and better fire protection as the science advanced. These changes and developments over the years have made it necessary not only to keep abreast of the latest practices for incorporation into new buildings, but also to review existing structures in the light of applying these improvements to them. This is especially so in the case of quarters in leased buildings, of which there are a considerable number, generally involving the smaller telephone equipment installations.

Environment

All of this effort has involved the full and continued coöperation between staff members of the A. T. and T. Company and of the Associated Companies, together with advice from authorities outside the Bell System. The recommended practices of the National Fire Protection Association, the recognized source of information on the subject of fire protection, form the general basis of procedure, along with the standards of the National Board of Fire Underwriters, and State and Municipal regulations. Underwriters' Laboratories, Inc., test and list fire prevention and protection equipment, such as metal windows and doors, oil burners, and fire extinguishers. In addition to regular Bell System fire prevention activities, annual inspections of buildings are made by an independent firm of fire and safety experts retained to furnish advisory and inspection services. Their engineers also advise in regard to plans and specifications for new buildings and alterations and additions; and before any major work is contracted for, they review the project to determine the adequacy of fire protection features.

In the first place, over and above the many other considerations involved in establishing a location for a new telephone office, the selection of the site is influenced by the degree of exposure to fire from the surroundings. Adequate land to locate the building to the best advantage, and a corner lot where feasible, affording an extra street separation between buildings, contribute toward fire protection. The type of buildings and the character of occupancy in the neighborhood also have an important bearing on the selection of the office location.

Protective Armor

After selecting the site and determining the location of the building on the lot, the aim to prevent damage by fire is maintained in carrying out the detailed plans. Efforts are directed to keeping fire out of the building and likewise to preventing fire from starting inside, or spreading if it does get started; also, to put it out in any event. In the layout of the floor plans, the telephone equipment arrangements are conceived to reduce risk of fire as far as possible. The equipment and cabling, for example, are arranged in an orderly way to reduce concentrations at any one point. The layout is further planned to permit ready access for fire fighting purposes.

Fire cut-off walls are provided and all openings and shafts for cables between floors are protected. The more important company-owned central office buildings are of fire-resistive construction; that is, they have masonry and fire-proofed steelwork, non-combustible floors, metal doors and metal windows with wired glass. Where the exposure is severe and a fire in an adjacent structure might be too great for the wired glass to resist the heat, fire shutters over the windows, designed to close automatically, are provided as additional protection. These are frequently built into the masonry for concealment from view.

In contrast, protection in some cases has been provided by installing open sprinklers, or water curtains, over the exterior of windows where practical difficulties and the cost of replacing ordinary windows with metal and wired glass were considered to be

MORE "NORMAL" FIRE FIGHTING EQUIPMENT
Water type extinguishers and, in the cabinet at the right, tarpaulins to cover equipment. The alarm boxes designate different locations

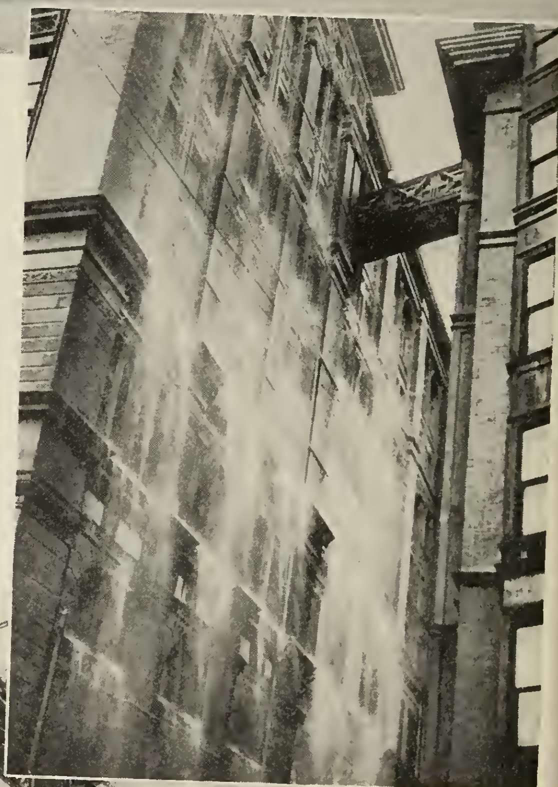
prohibitive. Such piping, exposed as it is outdoors, is normally free of water to prevent freezing. In case of fire in adjacent buildings, the water is turned on as shown on page 188. This protection is considered quite effective where provision has been made for reliability of water supply, which sometimes involves installing pumps and water storage tanks.

The very small owned offices, which would be comparable to those housed in leased quarters, usually have walls of some fire-resistive material. They are safeguarded from adjacent fires by locating them on sites sufficiently large to provide suitable clearances, or are protected on the exterior in much the same manner as the larger ones.

While the risk of a serious fire starting inside the telephone building is considered rather slight as compared with the possibility of a fire from sources external to the building, extensive measures are nevertheless taken to equip the building with fire-fighting apparatus and to provide safe exits in the form of fire-proof stairways, fire towers, or fire escapes.

Fighting Arms

IN selecting fire-protective appliances for use in telephone equipment spaces, their suitability is determined not only by the effectiveness in extinguishing fires, and approval of Underwriters' Laboratories, Inc., but also from the standpoint of causing the



PROTECTION AGAINST FIRE IN NEIGHBORING STRUCTURES

Above: This central-office building, standing on an ample corner plot, has no close neighbors

Right: Test of water curtain used on a telephone building as protection should a bad fire occur in the adjacent building at the right in this picture

Below: Structural steel, reinforced concrete, and brick are used for an addition to this telephone building

least damage to the telephone equipment. The fact that the usual telephone building is occupied twenty-four hours every day in the year provides supervision for the discovery of a fire in its incipiency and offers a valuable first line of defense.

It is, moreover, a fundamental objective of the Bell Telephone Laboratories in the development and design of telephone equipment, and of the Western Electric Company in its manufacture and installation, that every reasonable safeguard be taken to prevent the start or spread of fire in the telephone plant. Provision is made to limit the flow of current under trouble conditions and to design the wire and apparatus so that they will safely withstand the maximum temperature to which they may be subjected. Flammable materials such as shellac and insulating wax are avoided or carefully restricted. Likewise, great care is taken in the selection and treatment of materials to minimize the possibility of insulation breakdowns and fraying, for example, at the points of termination on the apparatus. An outstanding example in this direction is the development of washed textile and cellulose acetate insulation on the wires used in switchboards, frames, racks and elsewhere.

Another Bell Laboratories contribution is a fire-detection system, consisting of a continuous cotton-braid covered solder wire with flux core run through the telephone equipment at strategic locations. This fire detection system automatically sounds an alarm and identifies the location if an incipient blaze occurs in the wiring of the equipment—fortunately seldom experienced. Provision is also made in the circuit for manually sounding an alarm from conveniently located pull-boxes in case of any emergency.

The carbon dioxide extinguisher provides a medium whereby the blaze can be immediately extinguished by smothering without wetting the equipment or depositing harmful salts on it. Because carbon dioxide is so nearly ideal for extinguishing fires in electrical equipment, the Bell System has made contributions to its present-day effectiveness and was among the first to use this type in its plant. This extinguisher, of which there are two sizes, contains 7½ or 10 pounds of carbon dioxide gas under pressure which, in its operation, discharges a jet of gas for a period of some ¾ of a minute.

As a secondary means of fighting the fire in the event that its scope is beyond the effectiveness of the carbon dioxide extinguisher, portable 2½ gallon water-type extinguishers are provided in strategic locations. This extinguisher, with its greater range of discharge and quenching and cooling action, would be used on a fire if it has made substantial headway. This type has a cartridge of gas which when punctured in its operation furnishes the pressure for expelling the water. The plain water used as the extinguishing agent has, of course, the disadvantage of wetting the telephone equipment, but this nevertheless is considered next best to the carbon dioxide.

The next resort would be to use the fire hose attached at each story to one or more standpipes, which are usually installed as part of the mechanical equipment of the buildings. The standpipe and hose equipment is intended for use on interior fires only in the event they should reach such proportions that they could not be successfully handled with fire extinguishers.

In the higher buildings, generally over two or three stories, hose stations are also provided on the roof for use in protecting against adjacent fires menacing the telephone building. The regular water supply is used for the standpipe and hose system except where the pressure may be inadequate. In such cases, water is supplied by gravity tank or fire pumps. Arrangements are generally made for connection of Fire Department equipment at street grade.

SODA-ACID extinguishers, which some years ago were superseded for telephone equipment spaces by the water type extinguishers, are now generally used only in such areas as operators' quarters, office and clerical space, and storerooms. The operation of this more commonly known extinguisher depends on gas formed by the mixing of soda and acid to expel the water. But the disadvantage of this is that the water carries the resulting salts along with it, and this makes it unsuited for use on fires in telephone apparatus.

The foam type extinguisher, as an alternative to carbon dioxide, is used in kitchens, garages, paint rooms, and near oil burners. The foam type extinguisher, as indicated from the foregoing, is used on fires involving flammable liquids such as oil and grease. This extinguisher in outward appearance is similar to the water and soda-acid types, but does not have the tendency to spread the burning oil which the latter have. When the special chemical charges are mixed by inverting this extinguisher, the resulting reaction produces foam and also generates a pressure which forces the foam out of the hose. The principle of this type of extinguisher is the application to the fire of a smothering blanket of foam containing bubbles of carbon dioxide. In the Bell System they are normally not used on fires other than burning liquids and grease because of the damage caused to equipment by the foam which is rather difficult to remove.

For special cases where combustible contents indicate the need, such as basements containing supplies, or for warehouses and garages, automatic water sprinklers are used as supplementary protection. These are not provided in telephone equipment areas, since the other protection described is considered to be adequate.

Asbestos gloves for emergency use in extinguishing small fires in telephone equipment and for snuffing out small glowing embers after the flames have been smothered by the carbon dioxide, are furnished as well as portable tarpaulins for protecting telephone equipment against water damage.

Instruction and Inspection

UNDERLYING all these provisions is the practice of training the personnel in the use of the apparatus and procedures which includes, as a safety first measure, calling the municipal fire department immediately after discovery of a fire. Also, regular inspections, tests and maintenance of the apparatus in accordance with established practices are basic essential requirements. Fire drills are conducted periodically with the purpose of familiarizing the occupants with the exits, which are all plainly indicated and illuminated where necessary.

Cleanliness and orderliness are indispensable factors in the elimination of fire hazards and, aside from the efforts of the fire protection engineers to provide the physical means to this end, these virtues must be largely relied upon to attain the desired results. In telephone buildings continuous stress is laid on the quality of housekeeping, providing a proper place for everything and keeping it there. And particular pains are taken to keep the spaces clean, and closets and attics clear of combustible storage. This routine, born out of practiced habit, adds no small part to the System's justified feeling of confidence when it comes to safety and control against fire.

IT may happily be that none of the war fire hazards discussed earlier in these pages will turn out here to be real; but even so, it is hoped that the national interest and coöperation in fire protection work will continue after the crisis is over. There is plenty of urge for this without the fires of war. No better support need be offered than the dismal record of the country's fire losses, a large proportion resulting from endless repetition of simple, everyday acts of carelessness and thoughtlessness. The enormous fire losses in the United States compare unfavorably with the relatively small losses in European countries, notwithstanding the much larger normal complement of fire department personnel and equipment here. In this country, emphasis has been placed on facilities for extinguishing fires, while Europe has depended for protection more on personal habits of carefulness and on establishing, in each case, legal responsibility for their violation. On the other hand, in America there is greater industrial concentration in large units and more extensive use of combustible construction, especially in congested residential areas. It is in these homes and other small-unit properties that the major part of the loss of life and injury by fire occurs. It is in the saving of such life and property that much is still desired and hoped for in preaching the gospel of carefulness in relation to "playing with fire."

Victory over fire would be in the making if the present interest in this all-important effort could be maintained in the battle to free America from the stigma of being the world's worst reveler in fire waste.

TELEPHONE STATISTICS OF THE WORLD

This Annual Survey of Telephone Facilities Everywhere, Although Necessarily Estimated in Large Part, Again Affirms This Country's Leadership in Voice Communication

By KNUD FICK

UNITED STATES OF AMERICA *Average telephone development, on January 1, 1941 in:*	*Number of Telephones per 100 Pop.*
6 cities with more than 1,000,000 population	25.10
13 cities with 500,000 to 1,000,000 population	26.30
31 cities with 200,000 to 500,000 population	24.51
150 cities with 50,000 to 200,000 population	20.93
All communities with less than 50,000 population	11.87

The foregoing tabulation illustrates the penetration of telephone service into every type of community in this country, and shows the extent to which—in contrast to most foreign countries—the service is available not only in metropolitan centers but also throughout less densely populated areas.

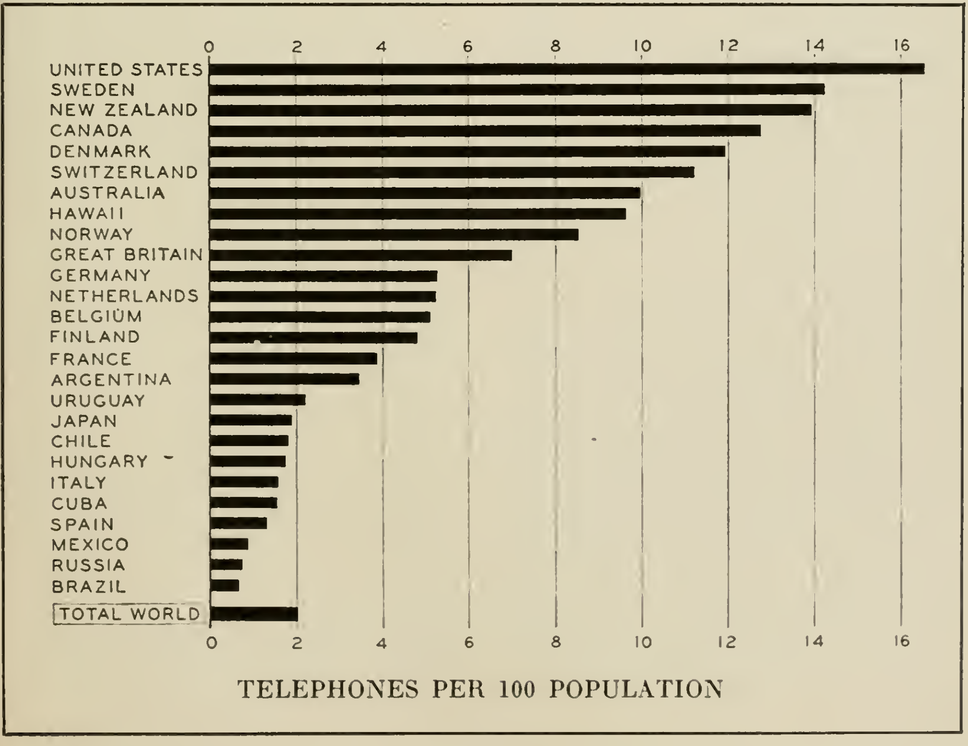
Thus the smaller towns and rural communities, each with less than 50,000 inhabitants, had on the average more than one telephone for every ten people—men, women and children. It is only when comparison is made with conditions in other countries that it is realized how extraordinary is such uniform availability of telephone service. In fact, this development of the smaller communities in the United States is equaled in only a few of the world's largest cities outside the United States.

These and other data have been compiled by the Chief Statistician's Division of the American Telephone and Telegraph Company in connection with its annual survey of the world's telephone facilities. Similar bulletins—the only compilation based upon a canvass of every telephone system in the world—have been published each year since 1912, interrupted only by the years of World War I. Issued as a pamphlet entitled "Telephone Statistics of the World," this year's compilation was gathered in the face of increasing difficulties, because of the lack of statistical information for many of the foreign countries involved in the global war, and is restricted to the latest available telephone statistics for the major countries of the world, as well as estimated totals for each continent and for the world as a whole, as of January 1, 1941. Estimates have been based on previous years' figures and on such additional information as has been available.

For this MAGAZINE, a table has been prepared showing telephone data for countries in the Western Hemisphere, for which more detailed data were available, and also a table of telephone data for certain cities.

At the beginning of 1941, the total number of telephones in the world as a whole was estimated at 44,189,669. Of these, virtually one-half—or 21,928,182—were in the United States and nearly one-third—or some 15,900,000—in Europe. The remaining one-sixth of the world's telephones was located in other countries in the Western Hemisphere and in the continents of Asia, Africa and Oceania. The United States, however, has only 6 per cent of the world's population of slightly over two billion people, and thus enjoys a vastly greater telephone density in relation to population than the rest of the world: 16.56 telephones for every 100 inhabitants of the United States, compared to 2.75 in Europe and an average of only 1.08 for the world outside the United States.

The indicated net gain in telephones throughout the world during the year 1940 was a little more than one and a half million telephones, or at the rate of 3.6 per cent, compared to 3.8 per cent during 1939 and 4.7 per cent dur-



TELEPHONE DEVELOPMENT OF THE WESTERN HEMISPHERE AS OF JANUARY 1, 1941

(PARTLY ESTIMATED)

Countries	Number of Telephones: Government Systems	Private Companies	Total	Per 100 Pop.	% Dial of Total Telephones
North America:					
United States	—	21,928,182	21,928,182	16.56	53.36%
Alaska	—	6,152	6,152	8.31	0.00%
Canada	222,580	1,238,458	1,461,038	12.78	52.50%
Central America—					
British Honduras	460	—	460	0.78	0.00%
Costa Rica	170	5,533	5,703	0.88	0.00%
Guatemala	2,835	826	3,661	0.12	58.18%
Honduras (June 30, 1941)	1,973	2,879	4,852	0.43	24.42%
Nicaragua	1,679	121	1,800	0.13	12.78%
Panama (incl. C. Z.)	3,721	11,001	14,722	2.18	27.17%
Salvador	4,411	—	4,411	0.25	0.00%
Mexico	3,000	175,726	178,726	0.89	67.64%
Newfoundland	—	14,300	14,300	4.70	0.00%
West Indies—					
Bahamas	1,914	—	1,914	2.95	100.00%
Barbados	—	2,446	2,446	1.29	93.95%
Bermuda	—	2,350	2,350	7.58	100.00%
Cuba	891	67,592	68,483	1.57	79.83%
Curaçao & Aruba	1,600	—	1,600	1.48	68.75%
Dominican Republic	160	3,103	3,263	0.19	63.53%
Guadeloupe	400	—	400	0.12	0.00%
Haiti (Sept. 30, 1940)	2,700	—	2,700	0.08	74.00%
Jamaica	508	6,105	6,613	0.54	88.66%
Leeward Islands	681	—	681	0.47	0.00%
Martinique	1,500	—	1,500	0.60	0.00%
Puerto Rico	531	17,456	17,987	0.95	0.00%
Trinidad (& Tobago)	73	7,164	7,237	1.52	26.96%
Virgin Islands	572	—	572	2.29	0.00%
Windward Islands	1,356	—	1,356	0.60	0.00%
Other Places in No. America	100	—	100	0.56	0.00%
Total North America	253,815	23,489,394	23,743,209	12.66	53.36%
South America:					
Argentina	—	460,857	460,857	3.46	72.01%
Bolivia	—	2,621	2,621	0.08	23.96%
Brazil	1,291	289,619	290,910	0.65	73.91%
Chile	—	90,943	90,943	1.81	66.62%
Colombia	9,000	33,233	42,233	0.46	23.68%
Ecuador	4,200	3,400	7,600	0.26	0.66%
Guianas—					
British	2,528	—	2,528	0.73	6.77%
French	170	—	170	0.46	0.00%
Netherlands	700	—	700	0.39	0.00%
Paraguay	—	3,800	3,800	0.39	87.10%
Peru	—	35,151	35,151	0.52	73.54%
Uruguay (Jan. 1, 1939)	34,810	11,846	46,656	2.20	71.69%
Venezuela	760	31,096	31,856	0.88	86.48%
Total South America (Estimated as of Jan. 1, 1941)	60,000	965,000	1,025,000	1.11	70.00%
Total Western Hemisphere	313,815	24,454,394	24,768,209	8.86	54.00%

ing 1938. Similar net gains for the United States were at the rate of 5.3 per cent during 1940, 4.4 per cent during 1939, and 2.6 per cent during 1938.

Close to 58 per cent of the total number of telephones in the world are connected to dial central offices. Nearly one-half of these dial telephones are in the United States.

The table on page 194, which was not included in the published bulletin, gives telephone statistics for individual countries in the Western Hemisphere, and cover a total of 24,768,209 telephones as of January 1, 1941, or 8.86 telephones per 100 population. With less than 13 per cent of the world's population and less than 9 per cent of its area, the Western Hemisphere thus has more than 56 per cent of the world's telephone facilities.

Outside the United States, the highest telephone development in the Western Hemisphere is that in Canada, with 1,461,038 telephones—all but 15 per cent of which are under private ownership. Canadian telephone development was equivalent to 12.78 telephones per 100 population. Other fairly large systems are located in Argentina, Chile and Mexico. Smaller systems with relatively high telephone development are to be found in Alaska, Bermuda, and Newfoundland, with 8.31, 7.58 and 4.70 telephones per 100 population, respectively.

In other parts of the world, the largest telephone systems are found, in the order named, in Germany, Great Britain, France, Japan and Russia—ranging from more than 4.2 million to about a million and a quarter telephones. In proportion to population, however, the best developed telephone systems are the Scandinavian, Swiss, Australian, Hawaiian, and New Zealand systems, all of which have in the neighborhood of one telephone for every ten people.

The table on pp. 196–197, showing the telephone development of representative cities in the United States compared with that of a number of foreign cities for which data were available as of January 1, 1941, while not included in the published bulletin, is shown here because of the significant data it reveals.

The largest urban telephone systems, as was to be expected, are those of New York and Chicago, with 1,713,544 and 1,032,902 telephones, respectively, at the beginning of 1941. The relative telephone density in cities and towns of the United States is well ahead of foreign developments. Thus, San Francisco on January 1, 1941, had a development of no less than 45.63 telephones for every 100 inhabitants. The only large foreign city to approach this high degree of telephone saturation was Stockholm, Sweden, whose 190,203 telephones on January 1, 1941, were equivalent to 41.46 per cent of its population.

During the year 1940, a total of 32½ billion telephone messages were exchanged in the United States, corresponding to 246.4 telephone conversations annually for every person in the country. The estimated average for the rest of the world is about 16 conversations per capita.

TELEPHONE DEVELOPMENT OF CITIES, JANUARY 1, 1941

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones Per 100 Population
ARGENTINA:			
Buenos Aires	3,450,000	290,955	8.43
Rosario	1,560,000	27,977	5.00
AUSTRALIA:			
Sydney	1,311,000	177,446	13.54
Melbourne	1,077,000	152,243	14.14
Brisbane	336,000	39,893	11.87
Adelaide	334,000	39,825	11.92
BAHAMAS:			
Nassau	20,000	1,914	9.57
BARBADOS:			
Bridgetown	71,000	2,057	2.90
BERMUDA:			
Hamilton	3,000	1,650	55.00
BOLIVIA:			
La Paz	200,000	1,218	0.61
BRAZIL:			
Rio de Janeiro	1,980,000	112,705	5.69
São Paulo	1,290,000	54,153	4.20
Bahia	400,000	6,734	1.68
BRITISH HONDURAS:			
Belize	23,000	337	1.47
CANADA:			
Montreal	1,105,000	192,540	17.42
Toronto	814,800	223,920	27.48
Winnipeg	305,000	52,275	17.14
Vancouver	295,000	80,469	27.28
Ottawa	225,000	44,679	19.86
Quebec	193,200	27,956	14.47
Hamilton	162,800	30,789	18.91
Windsor	118,500	17,585	14.84
Calgary	102,000	19,899	19.51
CHILE:			
Santiago	944,000	48,771	5.17
Valparaiso	216,000	8,322	3.85
Concepción	92,000	2,793	3.04
COLOMBIA:			
Bogotá	400,000	15,262	3.82
Barranquilla	247,000	4,361	1.77
PARAGUAY:			
Asunción	110,000	3,277	2.98
PERU:			
Lima	525,000	24,119	4.59
Callao	82,000	1,855	2.26
PHILIPPINE ISLANDS:			
Manila	790,000	26,881	3.40
Cebu	200,000	1,498	0.75
Iloilo	117,000	1,602	1.37
PORTUGAL:			
Lisbon	711,000	35,562	5.00
Oporto	288,000	12,233	4.25
PUERTO RICO:			
San Juan	175,000	10,376	5.93
Ponce	66,000	1,573	2.38
SPAIN:			
Barcelona	1,000,000	54,509	5.45
Madrid	953,000	70,398	7.39
Valencia	282,000	12,951	4.59
Sevilla	194,000	11,055	5.70
Bilbao	159,000	11,878	7.47
Málaga	152,000	4,289	2.82
Zaragoza	134,000	7,372	5.50
Granada	113,000	2,459	2.18
Cartagena	102,000	916	0.90
SWEDEN:			
Stockholm City	459,000	190,203	41.46
Göteborg	281,000	65,432	23.26
Malmö	155,000	30,975	19.92
Norrköping	71,000	12,691	17.92
Hälsingborg	62,000	10,925	17.53
SWITZERLAND:			
Zurich	330,000	75,633	22.92
Basel	167,000	39,867	23.87
Geneva	130,000	30,124	23.17
Bern	127,000	33,524	26.40
Lausanne	85,000	19,515	22.96

COSTA RICA:			
San José	70,000	3,442	4.92
CUBA:			
Havana	701,000	48,639	6.94
Santiago	108,000	1,741	1.61
DOMINICAN REPUBLIC:			
Ciudad Trujillo	80,000	1,394	1.74
ECUADOR:			
Guayaquil	160,000	2,800	1.75
Quito	150,000	3,340	2.23
EIRE: (3/31/41)			
Dublin	492,000	26,367	5.36
Cork	81,000	3,565	4.40
GUATEMALA:			
Quatemala City	180,000	2,130	1.18
GUIANA (BRITISH):			
Georgetown	70,000	2,117	3.02
HAWAII:			
Honolulu	180,000	28,893	16.05
HONDURAS: (6/30/41)			
Tegucigalpa	48,000	1,084	2.26
HAITI: (9/30/40)			
Port-au-Prince	115,000	1,976	1.72
JAMAICA:			
Kingston	148,000	3,575	2.42
MEXICO:			
Mexico City	1,465,000	97,839	6.68
Guadalajara	228,000	8,895	3.90
Monterey	181,000	10,306	5.69
Pueblo	137,000	5,928	4.33
NEWFOUNDLAND:			
St. John's	59,000	7,669	13.00
NEW ZEALAND: (3/31/41)			
Auckland	215,000	34,640	16.11
Wellington	158,000	34,133	21.60
Christchurch	136,000	18,930	13.92
NICARAGUA:			
Managua	120,000	890	0.74
PANAMA:			
Panama City	113,000	5,210	4.61
Colón	46,000	1,241	2.70
TRINIDAD:			
Port-of-Spain	92,000	4,606	5.01
UNION OF SOUTH AFRICA: (3/31/41)			
Johannesburg	607,000	63,881	10.52
Cape Town	386,000	35,740	9.26
Durban	284,000	21,886	7.71
Pretoria	147,000	16,109	10.96
Port Elizabeth	130,000	7,599	5.85
VENEZUELA:			
Caracas	315,000	23,042	7.32
Maracaibo	125,000	2,460	1.97
UNITED STATES: (See Note)			
New York	7,492,500	1,713,544	22.87
Chicago	3,410,000	1,032,902	30.29
Los Angeles	1,485,000	477,032	32.12
Cleveland	1,159,100	284,429	24.54
Total 6 Exchange Areas with over 1,000,000 Population	17,380,600	4,361,989	25.10
Milwaukee	756,700	170,606	22.55
Boston	713,800	196,191	27.49
Washington, D. C.	700,000	275,326	39.33
San Francisco	649,200	296,226	45.63
Minneapolis	546,500	165,006	30.19
Total 13 Exchange Areas with 500,000 to 1,000,000 Population	9,013,700	2,370,884	26.30
Seattle	427,200	137,526	32.19
Denver	325,000	112,256	34.54
Omaha	248,100	70,749	28.52
Hartford	244,400	71,820	29.39
Total 31 Exchange Areas with 200,000 to 500,000 Population	9,815,000	2,405,687	24.51
Total 150 Exchange Areas with 50,000 to 200,000 Population	15,171,800	3,175,168	20.93
Communities with more than 50,000 Population	51,381,100	12,313,728	23.97
Communities with less than 50,000 Population	81,018,900	9,614,272	11.87

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES

Countries	Date of Statistics	Number of Telephones: Government Systems	Number of Telephones: Private Companies	Number of Telephones: Total	Telephones per 100 Population
NORTH AMERICA:					
United States #	Jan. 1, 1941	—	21,928,182	21,928,182	16.56
Canada	"	222,580	1,238,458	1,461,038	12.78
Central America	"	15,249	20,360	35,609	0.41
Mexico	"	3,000*	175,726	178,726	0.89
West Indies—					
Cuba	"	891	67,592	68,483	1.57
Puerto Rico	"	531	17,456	17,987	0.95
Other Places in the West Indies	"	11,464	21,168	32,632	0.39
Other Places in North America	"	100	20,452	20,552	5.19
Total	"	253,815	23,489,394	23,743,209	12.66
SOUTH AMERICA:					
Argentina	Jan. 1, 1941	—	460,857	460,857	3.46
Bolivia	"	—	2,621	2,621	0.08
Brazil	"	1,291	289,619	290,910	0.65
Chile	"	—	90,943	90,943	1.81
Colombia	"	9,000*	33,233	42,233	0.46
Ecuador *	"	4,200	3,400	7,600	0.26
Paraguay	"	—	3,800	3,800	0.39
Peru	"	—	35,151	35,151	0.52
Uruguay	Jan. 1, 1939	34,810	11,846	46,656	2.20
Venezuela	Jan. 1, 1941	760	31,096	31,856	0.88
Other Places in South America	"	3,398	—	3,398	0.60
Total (Estimated as of Jan. 1, 1941)		60,000	965,000	1,025,000	1.11
EUROPE:					
Belgium	Jan. 1, 1940	428,752	—	428,752	5.11
Bulgaria	"	31,225	—	31,225	0.48
Denmark	"	17,813	441,944	459,757	11.95
Eire	Mar. 31, 1941	46,726	—	46,726	1.56
Finland	Jan. 1, 1940	8,837	177,736†	186,573	4.81
France	"	1,622,680	—	1,622,680	3.86
Germany (incl. Austria and Sudetenland)	June 30, 1939	4,226,504	—	4,226,504	5.28
Great Britain and No. Ireland	Mar. 31, 1941	3,348,000	—	3,348,000	7.00
Greece	Jan. 1, 1940	5,967	48,437	54,404	0.76

Hungary	Jan. 1, 1940	178,325	790	179,115	1.76
Italy	Jan. 1, 1941	—	685,815	685,815	1.58
Netherlands	Jan. 1, 1940	461,424	—	461,424	5.23
Norway	June 30, 1939	153,000*	97,000*	250,000	8.52
Portugal	Jan. 1, 1941	21,000*	54,803	75,803	0.98
Roumania	"	92,107	—	92,107	0.51
Russia ¶	Jan. 1, 1939	1,272,500	—	1,272,500	0.75
Spain	Jan. 1, 1941	—	336,448	336,448	1.31
Sweden	"	906,917	1,736	908,653	14.26
Switzerland	"	474,038	—	474,038	11.23
Yugoslavia	Jan. 1, 1940	72,000*	—	72,000	0.45
Other Places in Europe *	Jan. 1, 1941	550,000	130,000	680,000	1.20
Total (Estimated as of Jan. 1, 1941)		13,920,000	1,980,000	15,900,000	2.75
ASIA:					
British India	Mar. 31, 1939	31,878	51,500	83,378	0.02
China *	Jan. 1, 1941	40,000	120,000	160,000	0.04
Japan	Mar. 31, 1939	1,367,958	—	1,367,958	1.89
Other Places in Asia *	Jan. 1, 1941	220,000	108,000	328,000	0.16
Total (Estimated as of Jan. 1, 1941)		1,710,000	290,000	2,000,000	0.19
AFRICA:					
Egypt	Jan. 1, 1940	67,983	—	67,983	0.30
Union of South Africa	Mar. 31, 1941	232,885	—	232,885	2.21
Other Places in Africa *	Jan. 1, 1941	146,000	1,460	147,460	0.11
Total (Estimated as of Jan. 1, 1941)		450,000	1,460	451,460	0.27
OCEANIA:					
Australia	Jan. 1, 1941	704,868	—	704,868	9.97
Hawaii	"	—	41,568	41,568	9.64
Netherlands Indies	Jan. 1, 1940	48,321	4,492	52,813	0.08
New Zealand	Mar. 31, 1941	228,346	—	228,346	13.96
Philippine Islands	Jan. 1, 1941	2,504	31,419	33,923	0.20
Other Places in Oceania *	"	5,300	380	5,680	0.25
Total (Estimated as of Jan. 1, 1941)		992,000	78,000	1,070,000	1.06
TOTAL WORLD (Estimated as of Jan. 1, 1941)		17,385,815	26,803,854	44,189,669§	2.02

* Partly estimated. † January 1, 1939. # As of January 1, 1942, there were 23,521,000 telephones in the United States. ¶ U.S.S.R., including Siberia and Associated Republics.
§ Approximately 58% of the total number of telephones in the world are estimated to be automatic or "dial" telephones, including, on January 1, 1941, some 11,700,000 "dial" telephones in the United States.

FOR THE RECORD

IN THE ARMED SERVICES

Of the 175,000 male employees of the Bell System (including the Western Electric Company and the Bell Laboratories), more than 15,000 are in the nation's armed forces as this issue of the Magazine goes to press. In the General Departments of the A. T. and T. Company, of the 783 male employees the following are in the military services:

John R. Agren, Clerk, Comptroller's Dep't . Tech., 5th Grade, QM. Corps, U. S. Army
Joseph W. Ahearn, Clerk, Treasury Dep't . . . . . Sergeant, Coast Artillery, U. S. Army
Emre T. Altmann, Clerk, Comptroller's Dep't . Staff Sgt., Armored Force, U. S. Army
Lawrence R. Askling, Clerk, Information Dep't . . Private, Medical Corps, U. S. Army
Rand S. Bailey, Engineer, O. & E. Dep't . . . . Major, Engineer Corps, U. S. Army
William S. Bartley, Off. Mgr., Treas. Dep't . Lieut. Col., Ordnance Dep't, U. S. Army
Carroll O. Bickelhaupt, Vice Pres., Admin. M Dep't . . Col., Signal Corps, U. S. Army
Robert Bigelow, Type Stamper, Gen'l Serv. Bureau . . Private, Air Corps, U. S. Army
James D. Burns, Clerk, Comptroller's Dep't . . . . . 2d Lieut., Signal Corps, U. S. Army
Malcolm Burnside, Junior Statistician, Comptroller's Dep't . . . . . Ensign, U. S. Navy
Albert J. Carey, Engineer, O. & E. Dep't . . . . Captain, Air Corps, U. S. Army
William F. Bourbeau, Jr., Jr. Drafts., Gen'l Serv. Bur. . . Pvt., Eng. Corps, U. S. Army
John J. Christian, Clerk, Gen'l Serv. Bureau . . . . Private, Medical Corps, U. S. Army
William J. Clark, Clerk, Treasury Dep't . . . . . Aviation Cadet, Air Corps, U. S. Army
Loyd P. Cody, Jr., Junior Draftsman, Gen'l Serv. Bur. . . Private, U. S. Marine Corps
Eugene L. Cook, Accountant, Comptroller's Dep't . 1st Lieut., Signal Corps, U. S. Army
Robbins P. Crowell, Engineer, O. & E. Dep't . . . . Major, Air Corps, U. S. Army
Walter Danielsen, Junior Draftsman, Gen'l Serv. Bureau . . . . Private, U. S. Army
Harry Disston, Engineer, O. & E. Dep't . . . . Major, Cavalry, U. S. Army
Joseph V. Downs, Accountant, Comptroller's Dep't . . Capt., Signal Corps, U. S. Army
Thomas F. Fischer, Mot. Pict. Ass't, Inform. Dep't . . . Photog., 3d Class, U. S. Navy
William M. Freismuth, Trimmer, Gen'l Serv. Bur. . . Radioman, 2d Class, U. S. Navy
Willard M. Grimes, Ass't Statist., Treasury Dep't . . Capt., Signal Corps, U. S. Army
W. H. Harrison, Vice President, O. & E. Dep't . . . . Brigadier General, U. S. Army
Jack R. Harrow, Messenger, Gen'l Serv. Bureau . . . Air Cadet, Air Corps, U. S. Army
William Hodgkinson, Jr., Statist., Comptroller's Dep't . Capt., Signal Corps, U. S. Army
George Holmfelt, Junior Draftsman, Gen'l Serv. Bur. . . Seaman, 2d Class, U. S. Navy
Merritt H. Hursh, Advertising Ass't, Information Dep't . Capt., Infantry, U. S. Army
Francis A. Jahrling, Draftsman, Comptroller's Dep't . . . . Ensign, U. S. Navy
Delancey F.-J. Jones, Information Assistant, Information Dep't . . Ensign, U. S. Navy
Duncan G. Kilgour, Medical Officer, Personnel Relations Dep't
Lieutenant Commander, Medical Corps, U. S. Navy
Edward J. Knott, Messenger, Gen'l Serv. Bureau . . Private, Signal Corps, U. S. Army
Harold A. Koch, Junior Drafts., Gen'l Serv. Bur. . . Private, Signal Corps, U. S. Army
Edward C. Koenig, Messenger, Gen'l Serv. Bureau . . . Private, Air Corps, U. S. Army
John C. Latham, Writer, Information Dep't . . . . Lieutenant Commander, U. S. Navy
Edward A. Levins, Results Ass't, Treasury Dep't . . . Capt., Signal Corps, U. S. Army
Donald W. MacNeil, Clerk, Treasury Dep't . . 1st Lieut., Military Police, U. S. Army
Raymond P. Maguire, Supervisor, Treasury Dep't . . . . Private, U. S. Army

John T. McDermott, Clerk, Gen'l Serv. Bureau .... Private, Infantry, U. S. Army
James R. McGowan, Clerk, Comptroller's Dep't .. Cpl., Ordnance Dep't, U. S. Army
Martin J. McGuire, Jr., Clerk, Gen'l Serv. Bureau .... Sergeant, Infantry, U. S. Army
Perry Molstad, Engineer, O. & E. Dep't .... Captain, Signal Corps, U. S. Army
Walter W. Moran, Mot. Pict. Ass't, Inform. Dep't .... Photog., 3d Class, U. S. Navy
Justin O'Brien, Trimmer, Gen'l Serv. Bureau .... Private, Air Corps, U. S. Army
Conrad H. Pedersen, Supervisor, Treasury Dep't .. Lieut. Col., Infantry, U. S. Army
Allen F. Peirce, Engineer, O. & E. Dep't .... Lieutenant, Air Corps, U. S. Navy
George C. Ritter, Clerk, Comptroller's Dep't .... Sergeant, U. S. Army
Oliver C. Schlemmer, Staff Ass't, Pers. Rel. Dep't ... Capt., Signal Corps, U. S. Army
Charles T. Schrage, Engineer, O. & E. Dep't .... Lieutenant Commander, U. S. Navy
Frederick G. Scott, Clerk, Comptroller's Dep't .... Private, U. S. Army
Edwin A. Smith, Messenger, Treasury Dep't .... Corporal, Infantry, U. S. Army
Justin N. Spafford, Statist., Comptroller's Dep't . 1st Lieut., Signal Corps, U. S. Army
Thomas T. Stevenson, Statist., Compt. Dep't . Lieut. Col., Field Artillery, U. S. Army
Norman Stolz, Messenger, Information Dep't ...... Radioman, 2d Class, U. S. Navy
Allen G. Swede, Office Manager, O. & E. Dep't ..... Major, Signal Corps, U. S. Army
Robert R. Velie, Clerk, O. & E. Dep't .. First Lieutenant, Coast Artillery, U. S. Army
H. Wesley Webb, Engineer, O. & E. Dep't .... Captain, Air Corps, U. S. Army
James E. Wright, Clerk, Comptroller's Dep't .... Private, U. S. Marine Corps
Raymond A. Yerks, Senior Clerk, Treasury Dep't .... Private, U. S. Army

W. H. HARRISON MADE BRIGADIER GENERAL

Vice President William H. Harrison of the A. T. and T. Company, whose most recent government service has been as director of the production division of the War Production Board, became Brigadier General Harrison on June 26, and since July 1 has been in charge of the production activities of the Services of Supply of the Army.

General Harrison was nominated for promotion to his present rank by President Roosevelt within less than a week after he had entered the Army as a colonel. His new assignment reflects the policy of shifting production functions of the WPB (as distinguished from the work of other branches) into the Army and Navy. This shift, according to "Telecommunications Reports," Washington newsletter, "has been viewed for some time by the government leadership in Washington as the logical step in the war machinery, since the day-by-day production work is now wholly a task to be followed up by the armed services and WPB is becoming more and more concerned with the problems of materials and labor supply."

CONTRIBUTORS TO THIS ISSUE

Entering the Bell System as restaurant supervisor in charge of employees' dining service in the Philadelphia division of the Bell Telephone Company of Pennsylvania in 1916, Raymond A. Steelman was transferred to the A. T. and T. Company Department of Operation and Engineering in 1922. In the traffic employment section there, his work includes such matters as the recruiting and selection of telephone operators and their introduction to the business; working conditions, health, safety, employee informational activities, and employee out-of-hour courses. Since the war began, Mr. Steelman has been closely identified with traffic personnel problems springing from the nation's war efforts, notably those having to do with operation by the telephone companies of the private branch exchanges at Army establishments. He is the author of "The Development of Employees' Dining Service and Other Quarters," which was published in the Bell Telephone Quarterly of October, 1936.

A 1937 graduate of Wesleyan University, Alvin von Auw stayed on there to take his M.A. degree in 1938. After a year of editorial work in the magazine field, he joined the Western Electric Company's Public Relations Department in 1939, where since the first of this year he has been Information Supervisor. He has contributed numerous articles to trade and general publications on such subjects as broadcasting, aviation radio, marine radio, public address systems, and sound motion pictures. During recent months he has been editing a picture supplement, *Telephone Arsenal,* to Western Electric's six employee newspapers, and has been active in the preparation of the company's motion pictures. In the Magazine for August, 1941, appeared his "Western Electric: Telephone Arsenal."

Starting as a clerk in the office of the division traffic engineer of the Pacific Telephone and Telegraph Company in San Francisco in 1912, Mark R. Sullivan held a number of posts in the traffic department, including those of division traffic supervisor, general toll supervisor, and general traffic supervisor, until in 1928 he was appointed general traffic manager of the Northern California and Nevada area of the Pacific Company. In 1934 he was made vice president and general manager of that area; in 1938 his duties became company-wide when he was made chief of staff of the operating vice president's organization; and a year later he was elected vice president in charge of operations of the Pacific Company. On December 1, 1941, he was elected a vice president of the American Telephone and Telegraph Company. During the leave of absence of William H. Harrison, now Brigadier General in charge of production activities of the Army's Service of Supply, Mr. Sullivan is in charge of the A. T. & T. Co. Department of Operation and Engineering.

Shells and guns are not new to Irvin M. Cupitt, for he worked on these in a steel mill during his years in college. Immediately after being graduated from the University of Pennsylvania in 1912 as a Civil Engineer, he joined the engineering department of the Bell Telephone Company of Pennsylvania, where he worked on problems incident to the erection of central-office buildings, supervising the planning phases and also at times the actual construction work. In 1925 he was transferred to the Equipment and Building Engineer's group in the A. T. and T. Company, and since 1932 he has been the group head responsible for the consultation service to the Associated Companies with regard to building plans and equipment layout—which includes, of course, protection of buildings and equipment against fire.

Born in Denmark, Knud Fick was graduated in 1916 from Hellerup Gymnasium, near Copenhagen, with a degree corresponding to Bachelor of Arts, supplementing this two years later with the degree of Candidate of Philosophy from the University of Copenhagen. Following a number of years in the Foreign Office and other branches of the Danish Government, he joined the American Telephone and Telegraph Company in 1925. In the Chief Statistician's Division of the Comptroller's Department he has been in charge of statistics and economics relating to foreign telephone development. In 1932 he was sent to Madrid, Spain, and in 1938 to Cairo, Egypt, in connection with work for the International Telecommunication Conferences. The present is his eighth annual contribution to the Magazine and its predecessor on this topic.

BELL TELEPHONE MAGAZINE

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WAR ACTIVITIES OF THE BELL TELEPHONE SYSTEM

MORE AND MORE—WITH LESS AND LESS

BRIDGING BREAKS IN WIRE CIRCUITS BY RADIO TELEPHONE

THE AMERICAN TELEPHONE HISTORICAL LIBRARY: 20 YEARS OF SERVICE

FIRST AID TRAINING IN THE BELL SYSTEM

A. T. & T. STOCKHOLDERS IN TWO WARS

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE MAGAZINE

Continuing the Bell Telephone Quarterly

A Medium of Suggestion and a Record of Progress

"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."

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E STANDS FOR EXCELLENCE

The emblem of the joint Army-Navy award for high achievement in the production of war equipment, here being raised above the Bell Telephone Laboratories, flies also above all the Works of the Western Electric Company. See the article beginning on the opposite page

WAR ACTIVITIES OF THE BELL TELEPHONE SYSTEM

The Challenge to This Organization, and Its Accomplishments in Meeting Extraordinary Demands for Service, Are Told in Broad Outline by a Vice President of the Headquarters Company

By KEITH S. McHUGH

THE scope of the Bell System's nation-wide service is, even in peace, difficult to visualize in its entirety. In war, when practically every phase of the national effort to overthrow the Axis aggressors depends in some part on swift communication, both the extent and the importance of the System's contributions to the winning of the conflict are beyond summarizing. In the past two years, numerous articles in this MAGAZINE,* and in the employee publications of the Associated Companies, have described many aspects of the System's coöperation with the armed forces, with industry, and with the civilian population. Now, nearly a year after Pearl Harbor, it seems appropriate to review both the System's preparations for the national emergency and the steps which it has taken since war became no longer a threat but a fact. To the extent that it is possible in limited space, the following article rounds out the previous fragmentary parts of the whole picture.

THE EDITORS

HITLER'S legions invaded Poland at dawn on the morning of September 1, 1939, and set in motion forces felt around the world. The repercussions struck in far-off America; even then we feared that another great world war had begun.

To Bell System men and women the invasion brought a direct warning of what might lie ahead for them as telephone people if the United States should become involved in the war. Things began to happen immediately on our overseas radio telephone circuits—in fact, they began to happen a few days before September 1, when nearly twice the normal number of

* A list of these will be found at the end of this article.

calls were made to and from Europe. First France, then England clamped rigid censorship on our circuits, only Government calls being permitted. The volume of calls over the remaining circuits to Europe and to the rest of the world jumped instantly to new high levels. The increase in telephone calls within the United States likewise carried a warning. During the first week of September the Long Lines Department handled far more long distance calls than during any previous week of the year. All communities throughout the nation were affected; the intercity wires hummed with thousands of added calls.

Ever Ready for Emergencies

TELEPHONE men and women are not strangers to emergencies. Floods, fires, blizzards, earthquakes, hurricanes, affecting communities or larger areas, occur from time to time. When their effects are severe, the System must meet them in much the same way it might mobilize for war, because communications must be restored before substantial relief can be given.

Fortunately, the System's organization is such as to meet these emergencies with the least practical lost motion. In this respect its plan of organization is not unlike the Army's. The functions of the headquarters' staff of the American Telephone and Telegraph Company have many similarities with the work and operations of the general staff of our Army. Flanking this general staff at System headquarters are the Bell Telephone Laboratories' organization of scientists and engineers, and the great manufacturing and supply organization, the Western Electric Company. The latter maintains not only a manufacturing and purchasing group for the materials and supplies needed by Bell Telephone Companies but a large number of strategically located supply depots containing the things needed to meet current requirements and emergencies in the field.

The Associated Bell Telephone Companies and the Long Lines Department constitute the front-line troops and reserves, the fighting forces of the Bell System. Each Associated Company is complete in itself, having its own construction forces, its own repair and maintenance people, its own experienced operating forces, commercial and accounting people and engineers. These groups appear through all levels of each company: at the general office, the division, the district, and are repeated again to the extent required in thousands of cities and towns throughout the country.

THE shock troops' efforts are aided immeasurably during times of disaster by the fact that many years ago tools, telephones, switchboards, cables, and working practices were standardized throughout the System. Thus, when a disaster occurs and it is necessary to mobilize Bell people from one area to help elsewhere in that company or in other Bell companies, the repairman does not meet new and unfamiliar kinds of apparatus and equipment, nor does the traffic operator meet with new methods of operation; each is at once at home with the instrumentalities and practices; each can devote his or her full effort to

CABLES UNDER THE POTOMAC

Six of the 12 telephone cables recently laid between Washington, D. C., and the new War Department office building across the river are here being unreeled from a barge at one time

meeting the emergency without confusion or delay.

A CASE in point is the great hurricane which struck New England and parts of New Jersey and New York in September, 1938. This disaster affected hundreds of communities, and was perhaps the most terrible thing of its kind to happen in New England within the memory of living man. From a telephone standpoint it meant some 600,000 telephones out of service; about 500 communities completely isolated from communication with the rest of the world; thousands of miles of toll wire damaged or destroyed; central office buildings flooded; transportation at a standstill.

The forces of the New England, Southern New England, and New York Telephone Companies, New Jersey Bell Telephone Company, and Long Lines went into action at full speed, but the damage was so enormous as to be far beyond the capabilities of the able men and women of these companies to repair it quickly. Within forty-eight hours, crews from other Bell Companies along the Atlantic seaboard, in the middle west, and as far west as Omaha, Nebraska, were in motion. Trainloads of men, fully equipped with trucks, tools, and emergency supplies were en route to the affected areas; crews from nearby Bell companies were rolling over the highways with their own trucks and equipment. More than twenty-three hundred men with six hundred vehicles moved into the stricken areas of New England to help the more than seven thousand men of the New England and Southern New England Companies. They stayed there for weeks, working from dawn to dusk, and longer, until the job was done.

Telephone operators were flown in to Boston to do their bit. The Western Electric Company worked around the clock to supply the enormous quantities of materials required to make repairs.

The Warning Recognized

WITH such a background, and with the possibility of a war which might involve the United States, it was to be expected that the sudden increase in telephone calls in September, 1939, led Bell System people to begin at once to get ready to meet a grave emergency. When war is not immediately upon you and hope tries insidiously to triumph over experience, getting ready for war is first dependent on a state of mind. Because "business as usual" is a part of the make-up of all of us in peaceful times, it is a difficult habit to abandon quickly when war is only threatened. We all remember the long lull and apparent stalemate when the German and French armies faced each other across the no-man's-land between the Maginot Line and the West Wall. Not until May 10 of the following year (1940) did the German forces invade Belgium, the Netherlands, and Luxemburg. But, fortunately, it was the practical experience of handling the toll calls associated with the outbreak of war in Europe which made Bell System people war conscious.

On May 28 and 29, 1940, two events of great importance occurred: King Leopold of the Belgians surrendered his army unconditionally to the Germans, and the President of the United States approved the regulations governing the functioning of the Advisory Commission to the re-established Council of National Defense. The latter action meant that the United States intended to move ahead under full steam to prepare for possible future difficulties.

It seemed to us in the Bell System that the action of the President called for specific action on our part. Six days later—curiously enough, that fateful fourth of June on which the evacuation of Dunkirk was completed—I began, at the suggestion of President Walter S. Gifford of the

FOR THE WORLD'S LARGEST PRIVATE BRANCH SWITCHBOARD

This is the Information section of the P.B.X. in the War Department office building in Arlington County, Va. That conveys some idea of how large is the main switchboard, parts of which may be seen in the upper corners of this picture

Laboratories and made by the Western Electric Company and now by other manufacturers also, are but one of the items of communication equipment for the armed forces to which Western Electric is devoting the greater part of its manufacturing capacity

U. S. ARMY AIR CORPS PHOTO

American Telephone and Telegraph Company, a series of discussions in Washington with high officials of the Government departments and agencies most concerned in preparing for defense or war. These included General George C. Marshall, Chief of Staff of the Army, his deputy chief, and most of the assistant chiefs of staff and the heads of many of the Army services and branches; Admiral H. R. Stark, Chief of Naval Operations, and other leading officers of the Navy; Hon. Robert H. Hinckley, Chairman of the Civil Aeronautics Authority; members of the Advisory Commission to the Council of National Defense; and Chairman Fly and other members of the Federal Communications Commission. I carried a message to each from Mr. Gifford—that the armed services and other Government agencies could count on the Bell System, its people and its resources, to do its full part in preparing for the defense of our country, or, if war came, in the winning of it. I asked each for suggestions as to how the System could be most useful.

These purposes have dominated the thinking of Bell System people since that time.

For many years during peace-time all of the units of the System had designated appropriate administrative officials as principal service representatives with the regional area and shore establishments of the Army, Navy, Marine Corps, and Coast Guard, and with their headquarters organizations in Washington. These positions were reviewed immediately by the presidents of all the Associated Companies and by executives of the A. T. and T. Company. The offices themselves were strengthened and experienced executives were chosen to head them so as best to meet the expanding service requirements of the military. The Washington service representative of the companies strengthened his office and put it on a basis of 24-hour service. A permanent war office was established at A. T. & T. headquarters in New York, manned and equipped for instant communication and action around the clock of every day. The watchword was, "Know what communication service the Army and Navy need as soon as they know it, and get it for them instantly."

Before the war began in Europe, much had been done in coöperation with the Army, Navy, and Coast Guard that has since proved of great value in the war effort. Practical working arrangements for telephone service at Army, Navy, and Coast Guard establishments in peace and war had been adopted; plans for special service facilities for various types of establishments had been made; the Western Electric Company had worked out general plans with the Army for the manufacture of wire and radio communication equipment for war use; the Bell Laboratories had carried on continuously certain important development and research work in the communication field which has proved to be of great value to our fighting forces; a practical working plan for spotting and reporting hostile aircraft had been developed in coöperation with the Signal Corps and tried out in maneuvers; and a seasoned plan of meeting disasters and emergencies was in general operation. It is of interest that these aircraft warning plans, modified by the experience of the British, are substantially those being used throughout the United States at the present time.

With the summer of 1940 the Bell System began to function in high gear in preparing for war.

Some time earlier, a painstaking review had been made of the experiences of the System in World War I. The lessons learned from that war were most helpful in planning to meet some of the things which have already happened in this war. They included experience as to loss of personnel, provision of telephone plant, the security of plant and service (i.e., protection against sabotage and espionage), unusual army and navy communication requirements, abnormal traffic volumes, and other related matters. These earlier experiences formed the setting for conferences of operating executives of all Associated Companies called together to make careful plans to meet the problems certain to arise if war came.

While many of the actions agreed upon and precautions taken as a result of these meetings cannot be discussed here, it can be said that the plans covered a broad survey of the steps to be taken as to the safety of buildings and their essential central office equipment, of cable vaults and outside plant, of protection against fire and other damage, of the security of vital calls, of emergency methods of handling local and long distance traffic in the event of bomb or other damage, of plans to meet the work of saboteurs, and of plans to meet possible future shortages in man-power or in woman-power.

Experience in Britain

By the time this work was under way, it seemed clear that we ought to have the benefit of British experience in England, since the British had been at war for some months and had had practical experience with many of the problems which we were considering. This information was obtained through several different sources: in part through close relations with the British Post Office officials, the result of many years of business association in the operation of transatlantic telephone service, and in part from reports of certain United States Army missions which had been in England.

The System was extremely fortunate, moreover, in having this information supplemented by a long and carefully prepared report made by a high ranking reserve officer of the Signal Corps who was also an experienced telephone executive. He went to England at the request of the Chief Signal Officer of the Army and took with him a long list of questions relating to damage, protection of plant, security of messages, war-time experience of

LONG DISTANCE CIRCUITS ARE CARRYING HEAVY LOADS

War calls are speeding through this toll switchboard in a resort center which has largely been taken over by the Army

working forces, construction, maintenance and operating under war conditions, and other related matters which had been prepared by experts of the American Company. He was given all pertinent British experience on all points and, upon his return, his report was made available by the Army and formed the basis for an immediate check of the plans agreed upon and under way throughout the System.

Today, while all plans for the protection and operation of the System in war emergencies have not been entirely completed, and in a sense never will be completed because of continuous improvements resulting from experience, the System feels confident that it can meet emergencies imposed upon it with the same spirit and, we hope, with the same results that we would expect from our armed forces on their far-flung battle fronts.

Construction Problems

As mentioned earlier, carefully prepared plans had been made with the Army and Navy for telephone service at military establishments long before 1940. It was fortunate that this had been done, because of the speed with which the military functioned in building camps, cantonments, airports and flying schools, and the speed with which our Government and private industry functioned in building plants to make the munitions of war. The number of military establishments and Government ordnance plants at which the Bell System is already furnishing or will shortly provide new and enlarged service is about 2,500. This number does not include any privately owned manufacturing plants. While some of these establishments are not large, some of them are as big as good-sized cities.

The story of the miracles of construction performed by the System's operating companies and the Long Lines Department in connection with these projects for the military would make a good thick book.

Many of the establishments were located far from places where we had any telephone plant at all; many others in rural areas, where existing plant was hopelessly inadequate to serve the new purpose. For military reasons, the proposed location of a new camp or munitions plant was frequently kept secret until the contractor was ready to move initial equipment onto the site. This meant in most cases that some telephone service had to be provided for the contractor on very short notice.

As the project neared completion, men, tools, and equipment began to move in, usually on a large scale. The telephone company had to have its main construction work finished prior to any large-scale occupancy of the new establishment. This often meant the manufacture and installation of a large private branch exchange with distributing plant and station equipment to serve the reservation. It meant frequently the building of a cable route sometimes many miles in length to reach the serving central office. It meant sometimes complete new buildings and central office equipment at an existing or new serving point. Near Camp Edwards on Cape Cod, for example, a new central office building with 6,400 square feet of floor space and containing 45 positions of central office equipment had to be built especially for this purpose.

Further, since army camp traffic often includes a high proportion of toll calls, it usually involves building many toll circuits from the central office to other points and reinforcing the associated long distance routes so that the messages from the camp can be carried out into the general telephone toll network of the System.

One such telephone project cost six and a half million dollars. Within four days after it was first discussed, the telephone company's engineers had prepared a preliminary statement of the material and equipment required. Service was begun within from one-third to one-half the normal time for engineering and construction. The project involved continuous work by about 1,000 people, on the average, during this construction period.

An interesting recent project of this class is the new switchboard provided by the Chesapeake and Potomac Telephone Company for the War Department. This main board with an associated satellite board, both providing integral parts of the War Department's headquarters service, cost three million dollars, is now equipped for 15,000 telephones and, although a dial system, requires 300 operators to serve it. This is as large an installation as would be required for a city the size of Albuquerque, N. M. or Pittsfield, Mass. The main switchboard is larger than that at any single local central office in the Bell System.

Bell System people are proud of the fact that there have been no de-

MODERN METHODS FOR FOOD AND FOR COMMUNICATION
The transcontinental cable is plowed into the fertile soil of the western plains as a farmer prepares his crop close to the cable right-of-way. His tractor could pull no such heavy equipment as the deep-cutting plow partly shown at the right of the picture

lays of consequence in any of the 2,500 Army and Navy projects of this character.

Long Distance Wires Are Loaded

NOT all of the System's high speed telephone construction work has been made on or near military establishments and private plants engaged in the war effort. As the war production effort expanded throughout the country, through the drive of the War and Navy Departments and the War Production Board, the demand for long distance service increased enormously. During the two years beginning June, 1940, the System has handled over its longer toll routes added calls amounting to nearly 10 years' peace-time growth. The demand is still increasing.

Between June, 1940, and the end of 1942, over three million miles of toll circuits will have been added, involving the manufacture of thousands of miles of toll cable and the installation of carrier systems over many routes. Despite these large increases in toll facilities to serve the war-time needs of the nation, the added plant has been less than would normally be provided to keep pace with the growing demands for this service, since we have been unable to obtain, because of war necessities, the required quantities of critical materials—particularly copper.

A single incident in connection with this provision of long distance facilities may be of interest as evidence of the war-mindedness of the System. Late in 1939, it was clear that some additional circuits would have to be provided to meet the expected growth in our transcontinental service.

Four open-wire pole lines were in

existence west of Chicago: one via Minneapolis to Seattle and Portland, one through the central part of the country, and two through the southwestern states. The simplest, initially least expensive, and fastest way of providing the additional circuits required would have been by stringing some additional wire and providing the necessary carrier equipment on one or more of these routes.

A BOLD alternative was to make the heavy investment in a cable immediately. I well remember the meeting in which the final decision was made. All of the major considerations had been discussed in some detail; it was concluded to go ahead immediately with buried cables through the central part of the western United States, despite the large extra initial cost of such a program. The controlling consideration for that decision was the possibility of a war with Japan. Field surveys and engineering work on detailed plans were begun at once.

Meanwhile, on an open wire line on the southern transcontinental route, additional wire and carrier systems were constructed in order to provide more circuits to California with the least possible delay. Fortunately, these circuits were ready for service several months before Pearl Harbor.

The transcontinental cable is now practically all in place, and is in use as far west as Salt Lake City. Circuits through to the west coast will be in service shortly after the close of this year. The cost will be about $25,000,000, and the construction will make possible a telephone call over an all-cable route from coast to coast for the first time in history. While no claim is made for prophetic vision by the executives responsible, nevertheless, they foresaw that should real trouble come with Japan, not only would the volume of long distance calls between the west and east coasts require a large number of additional circuits, but the service itself ought to be made as invulnerable as possible by the provision of the new buried cable.

The System's war activities during the fall of 1940 and through 1941 until the fateful seventh of December increased steadily in number, magnitude and complexity.

The War Communications Board

IN September, 1940, President Roosevelt created the Defense Communications Board, consisting of Mr. James Lawrence Fly (Chairman of the Federal Communications Commission) as chairman, Major General Joseph O. Mauborgne (Chief Signal Officer of the Army), Admiral Leigh Noyes (Director of Naval Communications), Mr. Breckinridge Long (Assistant Secretary of State), and Mr. Herbert E. Gaston (Assistant Secretary of the Treasury). The present members of the Board are Mr. Fly, Major General Dawson Olmstead, Captain Carl F. Holden, Mr. Long, and Mr. Gaston. The Board's name has been changed to the Board of War Communications.

The Board was charged by the President with the responsibility of determining, coördinating, and preparing plans for the national defense, including the needs of the armed forces, of other Government agencies,

PHOTO BY 161ST SIGNAL PHOTO CO.

Serving the Army

These Bell System operators are some of the hundreds who are now handling calls at many Army cantonment switchboards and other locations, at the request of the War Department

of industry, and of other civilian activities for communication facilities of all kinds. These plans were to include the allocation of such facilities as might be required to meet the needs of the armed forces, the measures of control, and the principles under which such control should be exercised so that non-military communications would meet defense requirements.

It organized promptly, and created three general committees: an Industry Advisory Committee, a Labor Advisory Committee, and a Law Committee; and 12 technical committees, each to deal with a separate phase of communications. The work of the technical committees was organized and directed by an all-Government committee called the Coördinating Committee. Mr. Gifford was made chairman of the Industry Advisory Committee, and representatives of the Bell System are on five of the technical committees, one being chairman of the Telephone Committee.

Chairman Fly of the Board of War Communications, in an address before the National Federation of Telephone Workers, in Baltimore in June, 1942, noting that "our tremendous war economy . . . would be paralyzed were this great nerve center of communications ever to suffer impairment," mentioned that the Board had given attention to a wide range of war communication requirements, including the need for uninterrupted service, for secrecy, and for safety of communications. He also spoke of the Board's concern for the adequacy of man-power in the communication field. The Bell System has coöperated actively at all times with the Board and believes that the work which the

Board is doing has been of the greatest value in coördinating the communications requirements of the nation and of preparing for emergencies which might arise.

Conservation of Materials

Reference has been made above to the fact that scarcity of materials has made it impossible to provide adequate facilities for all service needs. The work of the System in lessening the impact of these shortages by conservation of and substitution for critical materials of war is a fascinating story.

The Bell Laboratories and the Western Electric Company have for many years made systematic studies of the application of new or different materials to telephone equipment and of the world sources of such materials. It was quite natural, therefore, that in the fall of 1939, after the declaration of war between Great Britain and Germany, consideration was given immediately to the replacement of those critical materials coming from far parts of the world where the sources or supply routes might be affected by the war. Among these materials were tin and rubber. Of both, the System used large quantities: tin particularly in solder, rubber for insulation and in thousands of parts throughout our apparatus. When it became apparent that numerous additional material shortages would develop, a formal Committee on Substitutes and Conservation was established within the Bell System, consisting of appropriate representatives of the American Company, the Bell Laboratories, and the Western Electric Company. As additional items have been added to the critical list, plans thus made have been put in operation for their conservation and substitution.

There is not space here to go into this long story, except to say that the best technical and engineering brains and ability of the System have been devoted to the maximum savings of these things critical in the war effort. Only a few illustrations need be given to show the results. The System had been using 1,000 tons of aluminum annually; it now uses 70 tons. It had been using 7,500 tons of zinc; it now uses 1,000 tons. It had been using 1,900 long tons of rubber; it now uses 200 long tons. It had been using 980 long tons of tin; it now uses 130 long tons.

Similar illustrations could be made by the score, but these will suffice. The limitation orders of the WPB were, of course, important factors in this work; but we know from the week-to-week work of our own people that in most instances they anticipated the extraordinary war needs for materials and possible action of the Government, and took many of the necessary steps in advance of the Government's conservation orders.

Despite every effort to conserve materials, the war-time demands of the nation for new communication facilities have required a very large construction program during the last two years. It is of interest that in metropolitan Washington, D. C., the Chesapeake and Potomac Telephone Company has added more new plant in the last twelve months, largely to meet the expanding needs of the Government,

ARMY MEN GET BELL SYSTEM PLANT TRAINING

The three groups of Signal Corps men shown here with their Associated Company instructors (in "civvies") are learning about inside wiring, station equipment, and central office line circuits. Plans have been completed for a continuous training program at the rate of about 5,000 Signal Corps men a year

than existed in the city at the close of World War I.

For the Bell System as a whole, the total gross construction in 1940 was $380,000,000, in 1941 $520,000,000, and in 1942 will be about $460,000,000. This enormous program has required large amounts of new capital, a continuously heavy manufacturing and construction job, and large installation and construction forces.

THE many problems involved in obtaining the materials needed for construction of telephone plant have called for continuous close relations first with the National Defense Advisory Commission, later with the Priorities Division of the Office of Production Management, and subsequently with the Communications Branch of the War Production Board. Since substantially all of the manufactured equipment and supplies to meet the requirements of the Associated Companies are produced or purchased by the Western Electric Company, the physical and factual problems both for Bell System people and for officials of the War Production Board have been much simpler than they would have been had these problems been related separately to each of the Associated Companies and the Long Lines Department and to a number of manufacturers. Nevertheless, because of the relatively large demands for nation-wide telephone service, the work of continuous coordination of these essential requirements with the nation's other wartime needs for materials has been substantial and continuous. From the outset the engineering organizations of the American Company and the Associated Companies and the

SERVICE FOR SERVICE MEN

Pleasant surroundings and helpful attendants on or near Army posts are part of the System's effort to make it easy for soldiers to place their calls

manufacturing department of the Western Electric Company have considered this one of their most important and pressing problems.

The War Comes First

THE policy of the System from the beginning as to these needed materials has been very simple: The war needs of the nation must come first; the needs of the nation for additional communication facilities must be subordinated to the fundamental purpose of winning the war—excepting as it is clear to the authorities in Washington that certain of these communications requirements are substantially equal in importance to the needs for munitions of war. The telephone companies have been and are determined to give the best telephone service possible with whatever materials the Government feels should be utilized for communication purposes.

In pursuance of this policy, the nation's needs for additional communication facilities to serve new Army camps and munitions plants, and to handle the flood of long distance calls occasioned by the war production efforts of industry, have been checked continuously with officials of the War Production Board and to a considerable extent with the interested representatives of the Board of War Communications, the Army, the Navy, the Joint Army and Navy Munitions Board, and the Federal Communications Commission. All of these Government organizations have given careful and painstaking attention to the communication needs of the country and of the armed forces. They have been keenly aware of the essential nature of such communications and at the same time have been fully alive to the necessity of balancing these requirements against other vital material requirements for other war purposes.

Pearl Harbor—and After

THE attack on Pearl Harbor had the force of an explosion within the System. From the first news I had that bleak Sunday afternoon until the small hours of the next morning, I was on the telephone almost continuously. Mr. Gifford and hundreds of executives and administrative officials of the System had similar experiences. The Government—especially Army and Navy officials—discussed with us many urgent features of our operations.

Local and long distance traffic on the West Coast jumped tremendously. The toll traffic all over the country, particularly over the transcontinental routes and into and out of Washington, soared to new and all-time highs. The army of telephone workers had only to know that they were needed. Telephone operators rushed to central offices to man the switchboards. Plant forces jumped into action. The Bell System was in the war!

FOR SAILORS TOO

Shore leave, or its equivalent at a training station, gets off to a good start when calls may be made from an attended station such as this

The first call I received that Sunday afternoon was a request that all calls in and out of FBI offices throughout the United States be given precedence. That message was flashed immediately by our headquarters to all of the operating units of the Bell System, in order that the fastest possible service might be given to this important agency of the Government. Advance plans made it possible for Navy censors to move in on overseas circuits within a few hours.

In the city of Washington and elsewhere, major feats were performed in meeting the emergency. In the toll operating room in Washington stood some 30 positions of toll switchboard on which the wiring had been only partially completed. Plant forces of the Western Electric Company and of the Chesapeake and Potomac Company put these boards into operation within eighteen hours. Emergency plans for the fastest possible handling of vital calls from high officers of the Army, Navy, and other Government departments were put in effect immediately. Extra positions of special equipment were installed in the Washington toll office wherever there was space. While the demands on the several telephone companies differed, each one bent every effort to the job. The urgent war calls had to go through.

Increasing Responsibilities

SINCE Pearl Harbor, the volume, number, and complexity of System war activities has steadily increased. Only a few illustrations can be given.

The War Department at many locations throughout the United States had operated its own switchboards, partly with soldiers and partly with civil service employees. The telephone companies were asked to take over a large number of telephone systems at these camps and other establishments in a hurry and to maintain the systems and operate them. Studies were made at each location on a rush basis, and today the System is handling the service at 150 Army camps and establishments requiring over 2,000 telephone employees for operation and maintenance of the systems.

THE Signal Corps, to expedite its own training program, wanted assistance through use of Bell System technical schools, in training soldiers to become installers, splicers, repairmen, and teletypewriter maintenance men. Hundreds have already been trained and plans have been completed for continuous training at a rate of about 5,000 per year.

Experts of the Bell Telephone Laboratories are conducting a continuous school for Army and Navy men in the operation and maintenance of certain new radio protective equipment and other complex electrical equipment essential to mechanized warfare.

The overseas radio stations of the System are proving of great value to the Government. Not only have they provided continuous means of communication between the United States and its representatives in far distant lands but, at the request of the Government, arrangements have been completed to convert some of them to special communication purposes for the War Department and other branches of the Government.

ACME NEWSPHOTO

A Filter Board of the Army's Aircraft Warning System

Developed in co-operation with the Signal Corps before the outbreak of war, and modified by the experience of the British, the system is in operation day and night throughout the country. "Flash" calls from volunteer aircraft observers reach these women, also volunteers, in an average of about 30 seconds

Before and since Pearl Harbor the engineers and scientists of the System have been continuously at work in developing new communication facilities and services of especial interest and necessity to the armed forces. In addition, the Bell Laboratories is engaged, for the Army and Navy, in the development of new tools of warfare involving communication techniques. Most of this work is secret and cannot be discussed until after the war; but it can be said that all available resources of the Bell Telephone Laboratories are now devoted to these and related purposes.

The Western Electric Company likewise is now devoting almost all of its manufacturing effort to war work, building vast quantities of intricate radio and wire communication equipment for the armed services. Radio equipment built by Western is being widely used in ships, tanks, and aircraft of the United Nations. Western's organization has more than doubled, and further increases will probably be made by the end of the year.

Thousands of miles of private line circuits, some with special forms of operation and equipment, have been provided for the armed services, the Civil Aeronautics Authority, and other departments of the Government.

Service for Soldiers, Sailors, and Civilian Defense

SPECIAL attention has been given, also, to the soldiers' and sailors' needs for telephone services at camps and shore establishments. Thousands of public telephones were installed at locations convenient for their use, special mobile equipments were provided to make telephones easily available to soldiers at remote points, and in many of the larger camps cheerful telephone operators appeared and stayed on the scene to help the soldier or sailor make his calls. At each of the larger military establishments the Associated Company has appointed a permanent resident manager, who sees to it that facilities are available for the use of the military forces and that the service is rendered with maximum efficiency and in the most pleasing manner.

Paralleling the communication work for the operation of the armed forces themselves, there has come a large program of meeting the communication requirements for the civilian defense—both for the Army aircraft warning service and for local Civilian Defense organizations. When the War Department and the Office of Civilian Defense wanted assistance in the laying out of filter and information centers for air raid warning purposes and in the development of special communication facilities to meet the requirements of local, county, and state defense agencies, we were in a position to provide designs and, shortly, equipment embodying the best of the experience abroad and the best brains of our scientists and engineers. Every effort is made to furnish the maximum speed of service for these purposes. As a result of this coördinated effort, thousands of operators are able to handle Army "flash" calls at a current average speed of about 30 seconds from the time the aircraft observer or spotter lifts the receiver until the call is answered at the Army filter center.

Each Associated Company throughout the country organized small groups of specialists to handle these matters with the representatives of the local, state, and Federal Governments. No attempt has been made to compile a composite picture in detail of the communication facilities which have been provided for these purposes, but in the aggregate they run into thousands of items of equipment and many hundred major installations throughout the country.

IT would not be appropriate for me to attempt any description of the fine war job which has been done and is being done by independent telephone companies throughout the country. I can only pay tribute to them here and leave it to some one in their own group to tell their story. The war has emphasized the essential unity of all telephone people, Bell System and Independent. Their purpose is victory; it is being sought with utmost determination and with untiring effort. From the outset it has been the continuous view and practice of both groups that any mutual telephone problems involving the war effort must

FOR SERVICE AWAY FROM HOME

These Long Distance operators, about to entrain for a distant city, have volunteered for temporary transfer to Bell System companies whose switchboards are loaded with war calls. Similar transfers have been made among a number of Associated Companies recently

be straightened out within the industry and that nothing must interfere with the communication requirements of our armed forces or of the nation's producers of ships, guns, tanks and planes.

Bell System Men and Women

No story of the System's war activities would be complete without some reference to the part its people are playing in the war. Up to November 15, about 29,000 men from the System have gone into the armed services. Some of these men were called to active duty as members of the Army or Navy Reserves to which they had belonged before the emergency. Many more have gone in via the normal routes of the Selective Service or regular enlistment.

About 2,000 have volunteered for special service in the Signal Corps. Many of these are older men of considerable experience, often in administrative or supervisory positions, who have volunteered at the request of the Signal Corps to become commissioned officers or technicians in construction, maintenance, and operating units of the service, where their special knowledge and training can be of the greatest possible value. In this particular branch of the services, it is expected that, by the end of 1942, some 4,000 highly skilled craftsmen and men in responsible supervisory positions throughout the System will have volunteered for duty.

It is known now that Bell System men in the uniform of our country are already in service in such far-off places as England, Egypt, India, Hawaii, the South Seas, and Australia. In World War I some 25,000 Bell System people were in the services. Already, more than that number are in the armed forces of this war; and if it continues, it now seems certain that many more will see active military service.

Besides those in direct military service, a number of Bell System executives, engineers, and scientists have been spending full time or part time as civilians in important Government posts on direct war work. These include work with the Army and Navy, the War Production Board, the Office of Price Administration, the National Defense Research Committee, and other agencies.

If the leaders of our Army and Navy were asked as to the occupation for women which they considered most important in order that the armed services could perform their full function in the best interests of the nation, I imagine that "telephone operator" would appear near the top of the list of every one of them. If they knew the telephone business intimately, they might well say "telephone girls," to include all the 225,000 women of the Bell System—operators and others in many different types of work.

The army of telephone operators and girls in other departments of the Bell System have a proud tradition of service behind them. They have performed in accordance with that tradition since things began to hum in 1940, and particularly since Pearl Harbor. Traffic volumes, notably long distance, have been increasing enormously—at some war-busy places by leaps and bounds. Surges in the number of calls come frequently without warning. The living creed of these girls—in small country towns, in large cities, and in all operating work—is, "The Message Must Get Through." Many, eager to serve where they are most needed, have volunteered for work away from their homes. Many others are serving at attended public telephones that have been provided at and near military camps and training stations to make the telephone service more convenient and more pleasing. All are ready to work around the clock, on Sundays and on holidays. This year the System will hire 75,000 women for telephone operating alone.

Those of us who are not in the military service total more than 400,000 Bell System men and women—working on the home front. Besides our telephone work, we are doing our part by buying War Bonds at the rate of $75,000,000 per year. Ours is a very active home front, because we are daily handling calls and meeting the telephone requirements of the Army and the Navy, of the great war production factories, and of the day-to-day needs of our citizens. We provide means of warning, should the enemy invade our skies. We serve those who guard us against danger from without and against emergency and disaster from within. Whether on the home front or with the armed services, the part of each and every Bell System man and woman is a glorious part.

We serve the nation in peace and in war.

The following is a chronological listing of articles already published in the BELL TELEPHONE MAGAZINE which discuss or have a bearing on the Bell System's part in national defense and its contributions to the war effort:

"A War Game Test of Telephone Service," January, 1939.

"Another War Game Test of Bell System Services," July, 1940.

"The Bell System's Part in National Defense," October, 1940.

"The Bell System and National Defense," February, 1941.

"Engines for Defense," May, 1941.

"Western Electric: Telephone Arsenal," August, 1941.

"An Operating Company's Part in National Defense," November, 1941.

"Providing Substitutes for 'Critical' Telephone Materials," November, 1941.

"The Present Situation and the Present Outlook," November, 1941.

"Engineering the Transcontinental Telephone Cable," November, 1941.

"We Shall Justify Their Faith," February, 1942.

"Telephone Lines and Air Defense," February, 1942.

"The Mobilization of Science in National Defense," February, 1942.

"The Role of the Telephone in the Civilian Defense Organization," June, 1942.

"War-Time in the Traffic Departments," August, 1942.

"Doing a Bigger Job—With Less," August, 1942.

"The Organization of Large-Scale Engineering Work," August, 1942.

"Protecting the Service against Fire," August, 1942.

MORE AND MORE—WITH LESS AND LESS

To Handle More Telephone Calls Than Ever, Over Facilities Taxed Nearly to the Limit, Is a Challenge Which the Soldiers of the Switchboard Are Meeting in Traditional Fashion

By HAROLD M. PRESCOTT

This brief statement was originally written for publication in the employee magazines of the System's Associated Companies, and was submitted to their editors for use without the name of the author—who is Traffic Engineer of the A. T. and T. Company. It so vividly epitomizes both the problems which war-time conditions impose on the Traffic Departments and the spirit with which they are being met that it is reprinted here as supplementary to "War-Time in the Traffic Departments," which appeared in the MAGAZINE *for last August.*

THE EDITORS

"AH, ME," said the Experienced Operator, "remember the 1930's? Those were the days of service *with*."

She couldn't have said it better. Service with plenty of switchboards and plenty of circuits. Operators and equipment ready and waiting to handle every call. Long distance calls put up in a matter of seconds to points far and near. That was service *with*.

Each year, too, brought forth new developments that simplified the operator's work and improved the handling of calls. Service approached technical perfection. Of equal importance, it became increasingly friendly and pleasant. To telephone users, our desire to serve was more apparent than ever before.

AND then came War. Our country's defense activity, starting in 1940, shifted into high in the next few months. Long distance traffic jumped more than a third in 1941. In many places calls doubled and trebled, and on some routes they at times increased seven- and eight-fold. Traffic records were knocked galley-west. You operators who came on the job in 1941—you set a record, too, for you were the largest "class" ever to join the Bell System in a single year. And you went right to work, side by side with others more experienced, to handle more calls from more telephones than were ever handled before.

But that was only the beginning.

Today we must put through even more calls, and more of those calls are important. Though millions of miles of new circuits have been added, still the plant has filled up and in many places overflowed. We know, too, that the limit of plant expansion has been pretty nearly reached, because the critical materials required can no longer be obtained: Uncle Sam needs them for bullets and weapons. From an easy service situation a few years ago, we have moved into a period when we must give service *without* the facilities we would like to have.

All of you at the switchboards—older and younger together—know how great your opportunities are to serve your country in the telephone army of the nation. You wear no uniforms and carry no rifles, but you are *soldiers of service,* and your positions are battlefront positions. For you weave the messages that speed the building of the tools of war—messages that coördinate the training and movement of soldiers and sailors—messages that knit the chain of aircraft warning and civilian defense—messages that help the man who fights to keep in touch with loved ones at home.

The job to date has been marvelously well done. Can you—we—all of us—keep up the good work? Can we continue, in time of war, to give the courteous, accurate "service with a smile" that won fame in time of peace? We think we can—we *know* we can; this will be our contribution to winning the war.

The task ahead will not be easy. Until victory is won, we will not have the facilities we need. But this is certain: all the experience, all the ingenuity of Bell System people, who have given and will continue to give this nation the best telephone service in the world, will be brought into play to make the best possible use of the things we do have.

Traffic men and women are on the alert. They are looking ahead, eager and determined that telephone service will not only remain good, but that under the circumstances it will be remarkably good. Facing squarely all the problems of service *without,* we're still going to give service *with—with everything we've got!*

BRIDGING BREAKS IN WIRE CIRCUITS BY RADIO TELEPHONE

More Than a Hundred Emergency Sets, Strategically Located Over The Country, Are Available to Restore Temporary Service Quickly While Permanent Repairs Are Completed

By AUSTIN BAILEY

In September, 1933, when a hurricane centering between Palm Beach and Fort Pierce, Florida, damaged the wire telephone system, radio telephone stations at New York and Miami normally employed for overseas services were used for about a day and a half to provide an alternate traffic route into the storm area while repairs to the wire circuits were being completed.

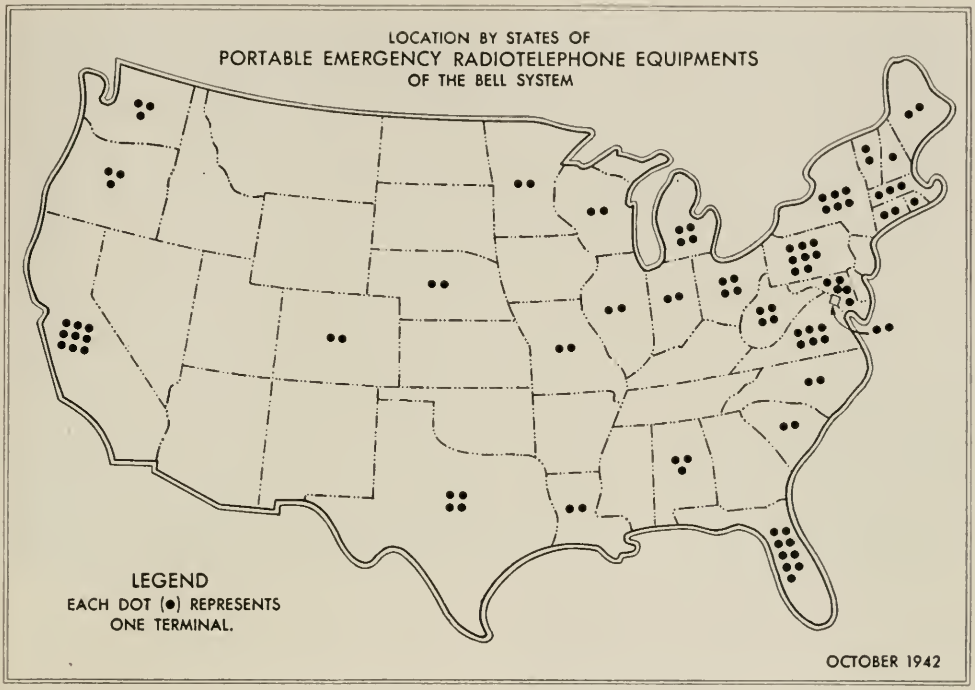
After the New England hurricane of September, 1938, an established radio telephone circuit in the Boston-Provincetown group provided for a time the only connection with all of Cape Cod as well as with the islands of Martha's Vineyard and Nantucket.

On the Pacific Coast, the coastal harbor radio telephone stations at Seattle, San Francisco, and Los Angeles have, in emergencies growing out of flood and storm, been employed for point-to-point emergency service.

It is seldom that established radio telephone stations normally used in other services happen to be so located that they are of value at the time of an emergency. These instances illustrate, however, how telephone transmission by radio can be used to provide alternate routes to hurdle temporary gaps in wire circuits, caused by nature or by accident, if suitable radio terminals are available on both sides of the damaged telephone wire plant.

If wire circuits are damaged in an area where such established radio terminals do not exist, and where alternate wire routes are inadequate or may also have been destroyed, other types of radio equipment, plus a good deal of electrical knowledge and ingenuity, have been called on to save the day while damaged lines are being repaired. On several occasions, available radio equipment built for ship, airplane, and police use has been installed on short notice and operated to give some communication during an emergency.

When a tropical hurricane in September, 1935, almost completely destroyed 35 miles of telephone line along the Florida East Coast Railway across the Florida Keys, voice communication with Key West and with Havana, Cuba, which is reached over a submarine cable from Key West,



was restored by employing airplane-type radio equipment. Stations were established at Tavernir and Big Pine Key to bridge the over-water gap by radio telephone, and the service was continued in operation for four months, such was the extent of the disaster and the inaccessibility of the right-of-way where the railroad had been.

AFTER the New England hurricane of September, 1938, radio telephone transmitting and receiving sets, with gasoline-driven generators for providing the necessary power supply, were rushed to Boston by air express.

Two ultra-high-frequency radio telephone sets of the type employed in small police stations were the first to arrive in Boston, and these were immediately sent to span a river where the floods had washed away a river crossing. Since they were not arranged for connection to the wire lines, those wishing to talk came to the location of the equipment to send their messages.

Two other sets were special assemblies of ship equipments which came from Florida, where they had been held in readiness for similar hurricane emergencies. These were employed between Gardner, Mass., and Keene, N. H., and made a part of a Boston-Keene circuit.

Of the central offices isolated by this great disaster, fourteen per cent were first reconnected to the general telephone network over circuits which employed in part a radio telephone link. In the days following the storm, over 5,000 messages were completed, many of an urgent emergency nature,

AFTER THE NEW ENGLAND HURRICANE OF 1938

Under the tent is one of a pair of ship radio telephone equipments, brought by air from Florida, which temporarily reconnected New Hampshire to the Bell System long distance network

through the use of radio telephone circuits.

TELEPHONE lines are built to withstand all but the most abnormal conditions, ninety-five per cent of them are in aerial or underground cable, and the provision of alternate routes in all but sparsely settled areas is a service objective. Sometimes the elements do conspire, none the less, to put circuits out of service, and to isolate groups of people, telephonically speaking—as the foregoing incidents have illustrated. They, and others, illustrate, also, the value of radio telephone equipment for emergency and temporary use. It was a natural consequence, therefore, that as part of the Bell System's constant effort to safeguard the service, the Bell Telephone Laboratories should design units of radio telephone equipment specifically engineered to meet emergency situations of that kind: to bridge temporary gaps in wire lines quickly and until the breaks can be repaired. The Western Electric Company began manufacture of these special radio telephone sets in 1938.

Harnessing Radio Circuits

TO the uninitiated, it would seem to be a simple matter to employ radio as a link in a wire telephone network system, but there are numerous engineering problems involved which make such use of radio rather complicated. Let us briefly consider some of them.

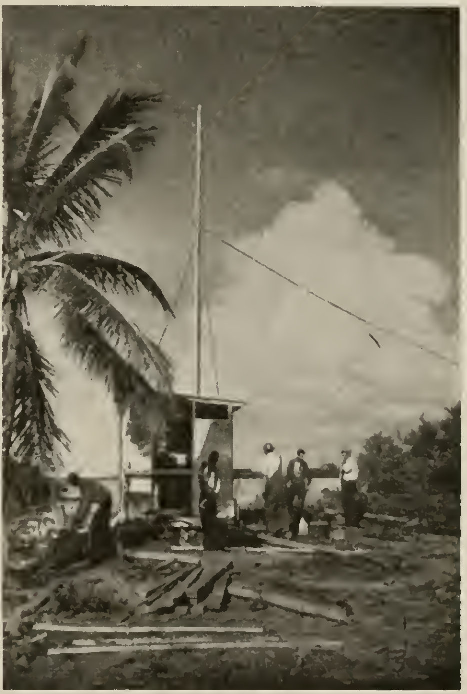
The broadcasting kind of radio telephone transmission is basically quite simple; but, as everyone knows, it carries a one-way message only. The performer must speak into a particular microphone, and the "reply" is received in the form of "fan mail" or by other systems of communication.

In the police type of two-way radio system, there are really two broadcasting systems, working in opposite directions, and separate and complete from microphone to loud-speaker.

The next step in the interconnection of two-wire telephone lines with a radio link is represented by the coastal harbor systems, where the ship end of the connection still has separate microphone-plus-radio-transmitter and radio-receiver-plus-loudspeaker circuits. However, the coastal station requires terminal equipment to connect between the radio circuit, which at any instant may be either transmit-

IMPROVISED RADIO TELEPHONE STATIONS

Right: Installing emergency radio telephone equipment at Tavernir, Fla., which bridged the gap to Key West and Cuba after a hurricane while permanent repairs to the line were completed. Below: On the banks of the Columbia River. Complete transmitting and receiving apparatus is installed in both tents, establishing two working circuits across the river



ting or receiving, and the two-wire line, which can always be used in either direction.

The final step in the development of this series is the connection of two-wire telephone circuits at both ends of the radio link. This is best represented by the overseas radio telephone circuits. Overseas terminal arrangements are necessarily complicated, expensive, and bulky. On the other hand, while emergency radio telephone equipments for application in a wire network system need to connect at each end to two-wire circuits, the terminal arrangements must be simple, inexpensive, and readily portable.

That was the general problem—or series of problems—which was posed for the System's scientists, engineers, designers, and equipment manufacturers. It probably is of interest to see just how this interconnection with wire lines at both ends was finally engineered for Bell System portable emergency radio telephone equipments.

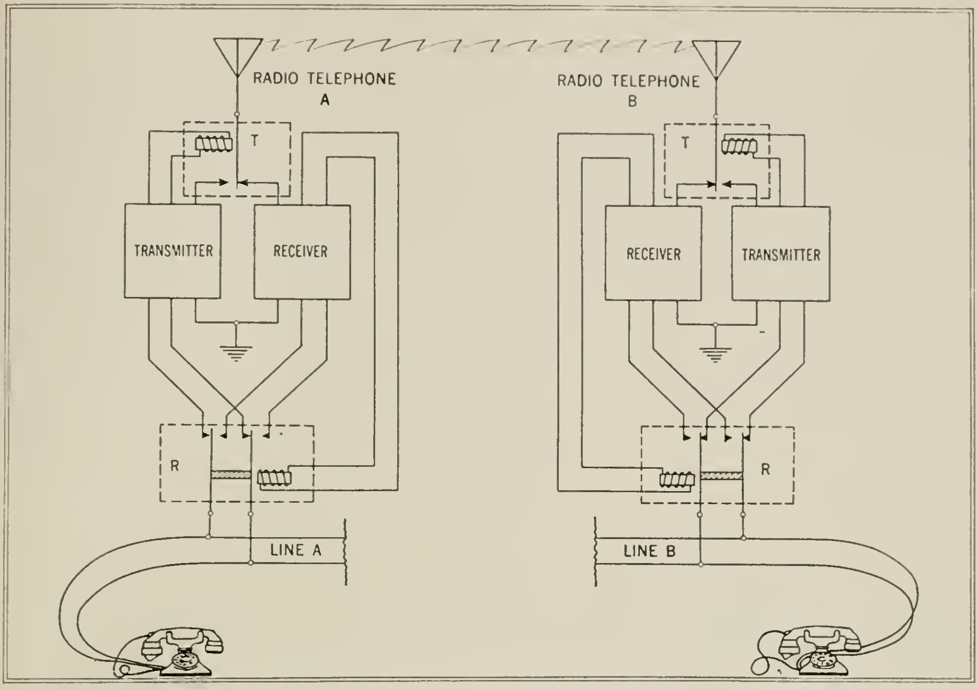
How the Units Work

IN the diagram on page 233, two radio telephone terminals are schematically indicated in use to bridge a gap between Line A and Line B. Suppose the subscriber on Line A begins a conversation. The speech currents from his telephone instrument are connected through relay R to the radio transmitter. Inside the "A" radio transmitter, a part of these speech currents is taken off in a branch circuit and made to produce current which turns on the radio transmitter and which by also operating relay T connects the radio transmitter to the antenna. A speech-modulated radio wave of characteristics similar to that sent out by a standard broadcasting station is then transmitted by radio.

When this wave reaches the "B" radio terminal antenna, it goes directly into the radio receiver through relay T. In the "B" radio receiver, a part of the amplified received signal is employed to produce current to operate relay R. This relay connects the radio receiver to the two-wire line and thereby clears the path for the speech currents to travel on to the subscriber on Line B.

When the Line A subscriber stops talking, both relay T of the "A" equipment and relay R of the "B" equipment return to normal, and the way is made ready for the Line B subscriber to reply. In the reverse direction, the operation is similar except that relay T of the "B" equipment and relay R of the "A" equipment are this time caused to operate by the talker connected with Line B. Repetition of these operations of the relays occurs with the to-and-fro nature of the conversation.

During periods of no conversation, both radio transmitters are "off the air" and the system at both ends stands ready to accept an incoming radio signal. On the line side of each radio terminal, the equipment likewise stands ready to respond to speech currents from a subscriber's telephone. In order to operate successfully a telephone circuit with reversal of its direction of transmission under the control of speech currents, the relays must operate fast enough to prevent any important loss of the initial syllables spoken. At the same



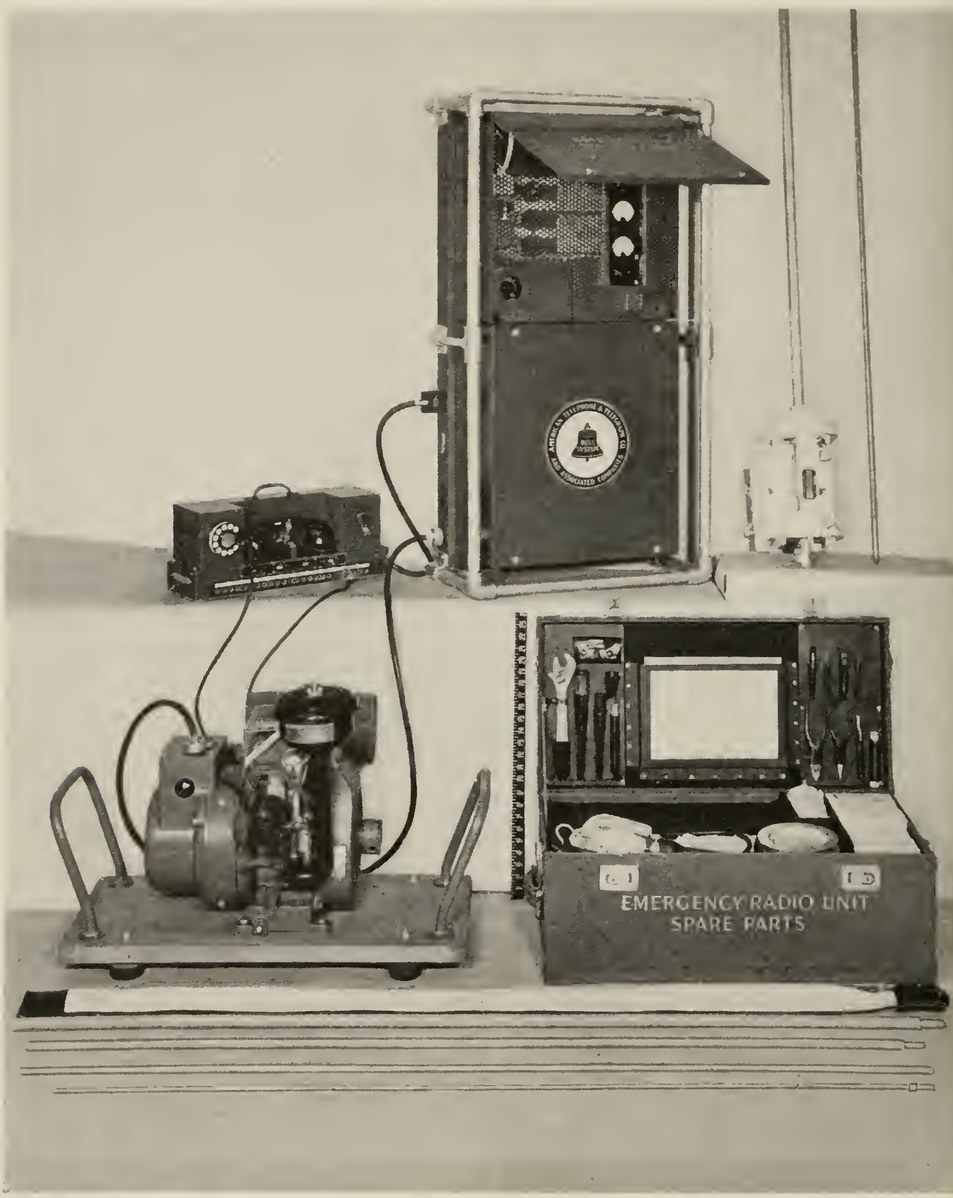
Simplified Diagram of the Operation of the Present Emergency Radio Telephone Equipments

A non-technical description of how they work is given on the opposite page

time, experience has shown that the relays must be slow in releasing, to prevent chopping up sentences between words. One penalty that an arrangement of this kind places on the free flow of conversation, then, is that each speaker must be courteous enough to listen to the other without interruption until he has finished a sentence. In fact, if one speaker should try to interrupt the other, his attempt will meet with failure because the emergency radio terminal will prevent it.

The questions might well be asked, "Why all these relays? Why not just connect the radio transmitter and receiver to the wire lines and go ahead and talk?" There is, of course, a definite—though somewhat technical—reason.

If both radio transmitter and radio receiver were connected together, then obviously everything that came out of the radio receiver would go into the radio transmitter and be sent back as an echo to the other end of the line. Furthermore, if the other radio terminal was similarly arranged, this echo would come back again behind the original word and continue to chase itself around this closed loop until it became dissipated. If the radio system amplified the signals, the circuit not only would sound hollow, like shouting into a rain barrel, but it actually would build up into a howl



Components of an Emergency Radio Telephone Unit

The parts and their functions are described on the opposite page and prevent any further conversation. The relays effectively prevent such conditions by making the radio link a "one way at a time" circuit. In fact, the arrangement does more than this, since only one antenna is required for the radio equipment at each terminal and but a single radio channel is needed for both terminals.

The Component Parts

SOME of the essential electrical parts of the Bell System's emergency radio telephone equipments have been suggested by the discussion of the diagram. In the photograph on page 234, the radio unit is shown near the top center. The framework, with a hand rail to furnish a substantial base and facilitate its transportation, mounts at the top the radio transmitter, and in the lower half is the radio receiver. The dust-cover door of the radio transmitter is open, as it would be during actual operation.

To the left of the radio unit, and connected to it by a plug-in cord, is the control unit with an ordinary telephone hand set. When the equipment is in use, the wire lines are connected to this control unit. The control unit provides the radio operator with means for signaling or ringing, as well as for talking on the wire lines and over the radio circuit. The spare parts trunk, in which the control unit is kept during transportation, also carries a miscellaneous assortment of tools, vacuum tubes, antenna system materials, and testing equipment.

In the foreground of the photograph are parts of a demountable antenna rod and its canvas carrying case. When assembled for use, this antenna rod is 25 feet in height. For transmission over quite short distances it can be supported in a base insulator unit, as shown at the right of the radio unit. For transmission over longer distances this 25-foot antenna rod is supported on an extension pole, to make an antenna some 50 feet tall.

The remaining unit in the photograph is a gasoline-driven generator capable of providing all the power supply necessary to operate the radio terminal, including some auxiliary equipment which may be needed. The radio unit may be operated from commercial power supply whenever it is conveniently available. However, the same unusual occurrences which temporarily disrupt telephone service may likewise be destructive to electrical power networks. For this reason, as well as to increase the speed of getting emergency radio telephone equipment into operation, a power supply is provided with every unit.

THE output of the radio transmitter in operation is 50 watts. The emergency frequency assigned by the Federal Communications Commission for this kind of service is 2,726 kilocycles. The equipment is so constructed that operation at any frequency in the range between 2,000 and 3,000 kilocycles is possible by changing the quartz crystal elements which control the frequency and making minor tuning adjustments. The power required from the supply source to operate the complete equipment is about the same as is needed to operate an electric flat iron. Such facts as these are of interest, but are only incidental to the primary purpose of the entire radio terminal.

The total weight of all the units

represented in the photograph is less than 500 pounds, and no single unit weighs more than 180 pounds. The approximate size of the individual unit may easily be judged from the 2-foot ruler included in the photograph. Where emergency conditions exist following major disasters such as hurricanes, sleet storms, floods, fires, and similar occurrences, there are good reasons to have the equipment as light in weight and as convenient to handle as is compatible with reliable operation. Of course, any such complicated equipment contains some parts, such as the glass vacuum tubes, electrical meters, and quartz crystals, which are fragile. A certain amount of care in handling is, therefore, necessary. If two men can load or unload the equipment conveniently, the hazard of rough handling is considerably decreased.

Transportation by Trailer

Sometimes it is necessary to employ airplanes, railroad cars, or boats to get an emergency radio telephone into a location where it can be used. However, experience has shown that motor vehicle transportation is possible in most cases. A special radio telephone trailer has therefore been made available for transporting the equipment to the location where it is needed, and with as little delay as possible.

In designing this trailer, arrange-

Present-day Operation

This is one of the pair of emergency units which maintained service across the Hudson River after a drifting vessel had severed submarine telephone cables

A TRAILER ON THE JOB

Note the tarpaulin used as an awning, and the antenna mounted on the body for service over a relatively short distance

ments were made to employ it not only for storing and transporting the equipment but to serve as operating quarters when on location. Because the equipment is placed in the trailer in such a way that it may be put into immediate operation once it reaches the scene, much time can be saved which otherwise would be used in looking for proper shelter for the operators and equipment before setting up for service. However, the necessity to use other means of transportation on occasion has not been overlooked, and the equipment is so installed that it can be removed readily from the trailer when necessary.

THE photographs on this and the next two pages show the trailer as it is employed to complete the radio telephone terminal for use during emergencies. Ample space for the comfortable operation of the radio equipment is provided in the front half of the trailer, where the radio and associated control equipment have been installed. The rear half, separated from the front half by a gas-tight partition, houses the gasoline-driven generator unit. It likewise provides space for storage of miscellaneous items of equipment and supplies needed under such conditions. The antenna materials, ropes, tarpaulins, wire, water jug, oil supply, shovel, axe, saw, jacks and similar things are kept in the back compartment, where they are convenient to reach when an installation in the field is undertaken.

On hot days when the sun beats down, shade is provided by a tarpaulin supported above the roof of the trailer. It is really surprising what a difference this makes in the temperature inside. When it rains or

The Equipment in Service
There is ample room for the operator inside the trailer

snows, the tarpaulin is pulled over on one side of the trailer to provide shelter in front of the door. Both windows have screens to keep out insects when the windows are open for ventilation. In winter, the front compartment can be heated by an aerial tent heater for which space has been provided.

Weight of the trailer and equipment is under 2,000 pounds, so that it can be towed, under all but exceptional conditions, by a passenger car or half-ton chassis equipped with a towing hitch. This too is a valuable characteristic, because during emergencies there is need for the heavier maintenance and repair vehicles for use in restoration of wire lines. Moreover, with a small trailer the maneuverability is such that it can be taken into open fields or pastures off the road, which facilitates setting up the radio antenna system.

Units Are Widely Dispersed

In an emergency, the first consideration is to get radio telephone equipment to a location where it can be employed effectively. With a few equipments held at widely separated points, it might require much time to get them into operation. The alternative is to have a sufficient number of emergency radio telephone equipments in readiness at strategic locations to be able to reach any vulnerable point in a few hours at most. With this ultimate goal in view, the Bell System has consistently proceeded in recent years, on the basis of experience already obtained, to locate a gradually increasing number of emergency radio telephone terminals at strategic points throughout the country.

In some instances these points of departure for the equipments are altered on a seasonal basis. For example, during the hurricane season more equipments may be held in readiness along the Atlantic and Gulf Coast areas, while during the winter months these same equipments have new locations in the sleet belt. As spring comes on, they may again be moved into areas which are occasionally subject to floods. In this way the strategic points move about and fewer equipments may be made to do the work that otherwise would require many more. The map on page 229 shows the distribution of equipments by states throughout the country on October 1, 1942. This distribution will doubtless vary somewhat from month to month.

THE REAR COMPARTMENT
In this separate section of the trailer are the power supply, wire, and miscellaneous tools and equipment

The number of radio telephone equipments now in service, which is over a hundred, is somewhat greater than during 1941 and almost double the number in use in 1940. Under existing conditions, when communication facilities are loaded with business vital to the war and so large a part of the messages handled are essential, there is an even greater need for added protection to service. Provided materials can be obtained, the number of equipments in use next year will be still further increased.

How They Serve in Emergencies

DURING 1940 there were sixteen cases in which emergency radio telephone equipments were employed for restoring service. Causes included a number of sleet storms in the middle west, a mild hurricane in South Carolina, and a forest fire on Cape Cod. The next year there were about two dozen cases of restoration which used emergency radio telephone equipment. In almost all of these cases, radio provided the only means of communication for periods varying from an hour or so to as long as 13 days in the case of a submarine cable across the mouth of the Columbia River which failed in August, 1941.

In addition to the uses of emergency radio telephone equipment following such disasters as are caused by winds, floods, sleet, explosions, and fires, these radio telephone terminals have a day-to-day use in emergencies. A number of examples could be cited, but two may be of interest as illustrative of the kind of thing for which these terminals have been employed.

An oil barge caught in an ice flow in the Hudson River in March, 1941, dragged anchor and severed two submarine cables. A pair of radio telephone terminals was brought into service and in about four days handled over two hundred messages, while repairs to the cables were being made.

Telephone lines from the Pacific Telephone and Telegraph Company connect with the telephone lines in Yosemite National Park near El Portal. During the winter season, there are very severe storms in this vicinity, often followed by landslides and floods in the narrow pass through which the telephone lines enter the park. Experience had shown that, even with the heroic efforts of telephone men and forest rangers to maintain the lines, there were some days each winter when service with the park was disrupted. In order to care for these occasions, emergency radio telephone equipment has been set up in the park and near Merced, California, ready for almost immediate use. There are quite a number of people whose duties require them to live in the park throughout the entire year; and to serve them in emergencies this radio telephone circuit has repeatedly proved its worth, and no extensive isolation has occurred since it was placed in readiness.

Now, as never before in the history of the Bell System, the maintenance of communication is vital to our national well being. The wheels of industry are geared to a new tempo of production for war, to roll out unceasingly the tanks, planes, ships and guns needed by the United Nations. The coördination of this vast productive effort depends in no small part upon telephone service. While it is the duty of everyone to keep the lines open for essential conversations, it is the job of the telephone companies to maintain those lines. Not only does war production depend upon communications for coördination, but to a considerable degree the telephone service supplements the domestic communication services of the military and provides circuits for civilian defense. Radio telephone terminals for emergency use are more important than ever, because in emergencies they will restore vital communication circuits which cannot be re-established so expeditiously by any other means.

THE AMERICAN TELEPHONE HISTORICAL LIBRARY: 20 YEARS OF SERVICE

In Its Collections of Documents and Records Are Preserved Much Of the History of the Development of the Service and the Origins Of the Spirit Which Animates Its Men and Women

By ROBERTSON T. BARRETT

The American Telephone Historical Library, maintained at the headquarters of the American Telephone and Telegraph Company, 195 Broadway, New York, was twenty years old on October 7, 1942. Had there been an anniversary celebration, it would have been affected by the exigencies imposed by war, for many of the most significant records and relics which normally have a place there, in a large room on the twenty-sixth floor, are now absent.

They are emigrés. Soon after bombs fell on Pearl Harbor, and it became apparent that they might some day fall on New York, the staff of the Historical Library went over the items which make up the various collections and selected the more important ones for shipment to a point outside the city for safe-keeping. All of these documents which have been removed are irreplaceable, and some of them are priceless in the traditions that are written between their lines. And they are missed—as persons are missed when removed from the accustomed places where they have lived their daily lives.

In a sense, it is not difficult to think of each of these documents as having a personality of its own. So much does the written word partake of the character of him who pens it, or with whose life and works it is associated, that it becomes a projection of his own self, a reflection of his spirit. A letter thus becomes a living thing, a hastily scribbled note has a soul, a proclamation or some other public document becomes a personage, re-enacting the great events of which the man who signed it was a part.

True, photostatic reproductions have been substituted for these documents which have been taken from the glass cases of the Historical Library, or removed, with their frames, from its walls. But the art of the photographer and its allied arts of photo-engraving and printing cannot reproduce the personality inherent in original documents. There are thousands of pictures of Magna Charta, but only the original parchments to which King John reluctantly set hand and seal breathe the real drama of what happened at Runnymede on a

A Corner of the Historical Library

Although many of the most significant records have been removed "for the duration," much that is of general interest, as well as of value for research, remains. The desk in the foreground was used for many years by Theodore N. Vail

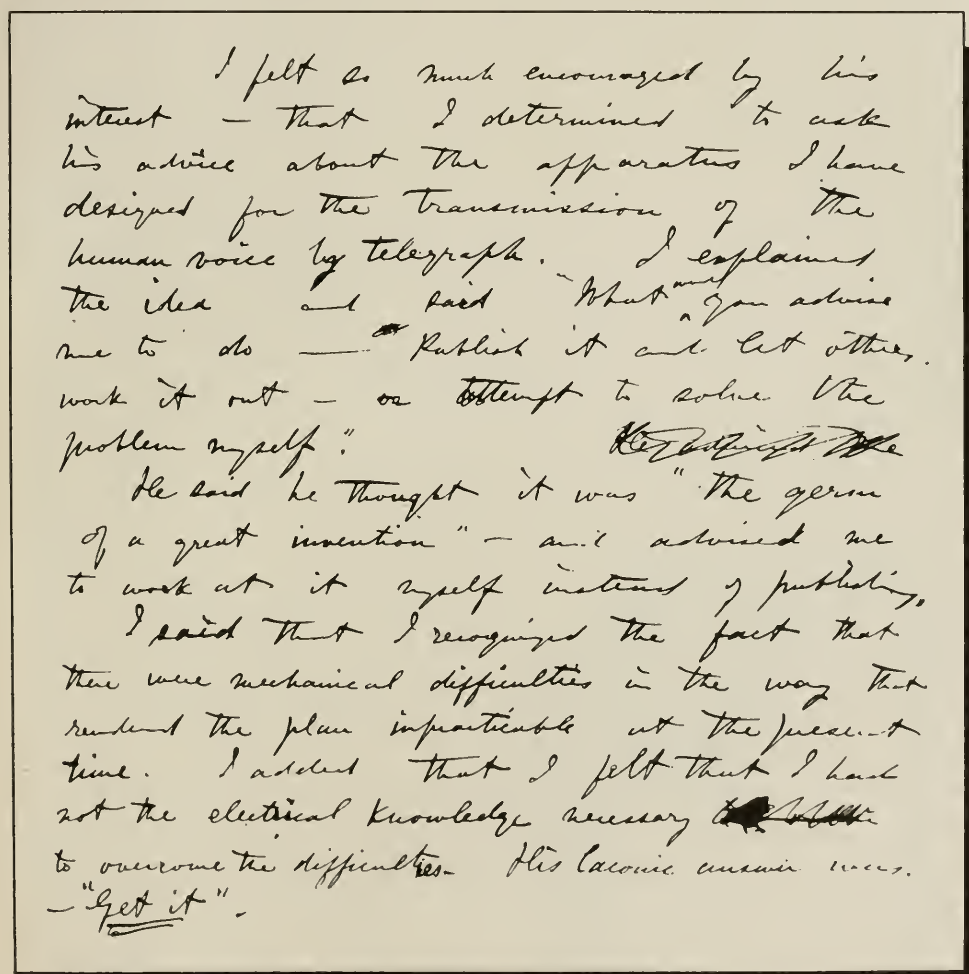
momentous June day in 1215. Reproductions of the Declaration of Independence there are almost without number, but the original alone, with John Hancock's bold signature heading the list of signers, breathes the real spirit that brought a nation to birth.

Documents Which Live

And so it is with some, if not all, of these documents that form the telephone's historical pattern, and that have helped to make the Historical Library what it is—an intimate, revealing place in which, if one is willing to do so, one may rub elbows with the men and women who have moved across the telephone scene. The black-bound notebook in which, under date of March 10, 1876, is recorded the first full sentence of speech transmitted by telephone: "Mr. Watson, come here; I want you!"—that is not just a book; it is the methodical, painstaking, devoted Thomas A. Watson, himself. The Bell Patent is not merely a public document, tied with a ribbon and officially sealed—it is Alexander Graham Bell, thrilling with renewed hope and courage as this patent was allowed to him, on his twenty-ninth birthday. The letters of Theodore N. Vail come alive as one reads them, and stride across the stage of one's imagination in the form of the virile, forthright, far-seeing man of affairs that he was, even in his younger years, and that he remained throughout his career.

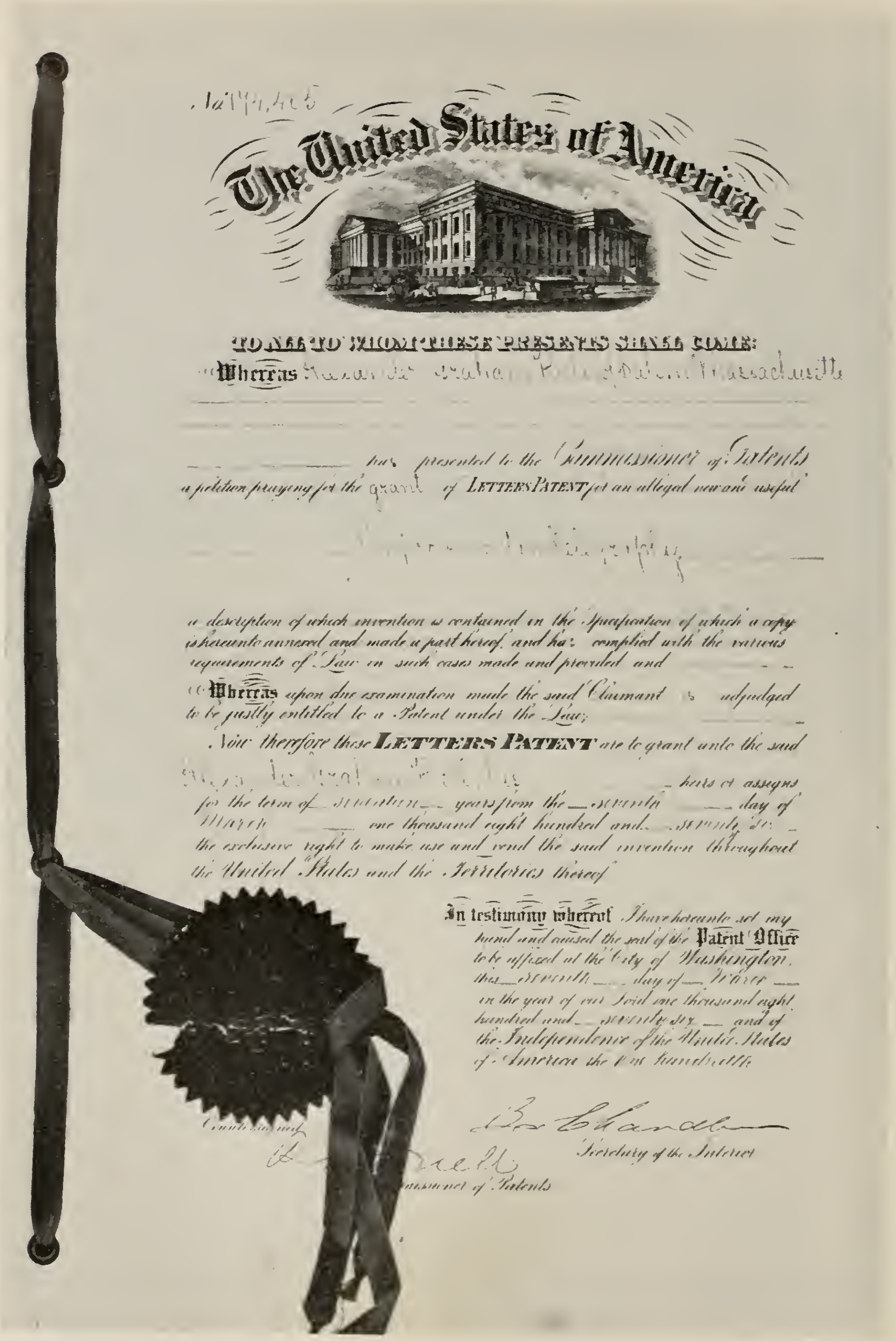
Nor are all of the items in the Historical Library of interest or importance because the names with which they are associated are as well known as those of Bell, Watson, or Vail. Some of them tell the simple, unspectacular stories of linemen, cable-splicers, operators or others who, each in his own way, have played parts in the creation of the telephone service of today and have impressed their own personalities upon it.

It is by no means strange that the American Telephone Historical Library, made up as it is of many thousands of individual items about telephone people, or contributed by telephone people, each reflecting a personality, has a personality of its own that is, as it were, a compound or amalgam of all of these individual personalities. It, too, as well as the multitude of separate documents which make it up, is a living thing, reflecting—or doing its best to reflect—the aims and purposes and accom-


I felt so much encouraged by his interest — that I determined to ask his advice about the apparatus I have designed for the transmission of the human voice by telegraph. I explained the idea and said "What would you advise me to do — publish it and let others work it out — or attempt to solve the problem myself."
He said he thought it was "the germ of a great invention" — and advised me to work at it myself instead of publishing.
I said that I recognized the fact that there were mechanical difficulties in the way that rendered the plan impracticable at the present time. I added that I felt that I had not the electrical knowledge necessary to overcome the difficulties. His laconic answer was. — "Get it".

"THE GERM OF A GREAT INVENTION"

In a letter to his parents in Canada in 1875, reproduced in part above, young Bell relates how Joseph Henry, the famous scientist, encouraged him to acquire the electrical knowledge necessary to carry on the experiments which resulted in the invention of the telephone



The United States of America

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas Alexander Graham Bell of Boston Massachusetts

has presented to the Commissioner of Patents a petition praying for the grant of LETTERS PATENT for an alleged new and useful

Improvement in Telegraphy

a description of which invention is contained in the Specification of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of Law in such cases made and provided, and

Whereas upon due examination made the said Claimant is adjudged to be justly entitled to a Patent under the Law;

Now therefore these LETTERS PATENT are to grant unto the said Alexander Graham Bell heirs or assigns for the term of seventeen years from the seventh day of March one thousand eight hundred and seventy six the exclusive right to make, use and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this seventh day of March in the year of our Lord one thousand eight hundred and seventy six and of the Independence of the United States of America the One hundredth.

Z. Chandler
Secretary of the Interior

Countersigned,
Commissioner of Patents

"Improvement in Telegraphy"

This is the basic telephone patent, which was granted to the young inventor on his twenty-ninth birthday, and formally issued four days later plishments of all the men and women who, from the beginning, have helped in any way, little or large, in the making of the history that is here preserved.

It seems almost needless to add that, if the Historical Library has a personality, as the writer likes to believe that it has, this personality reflects that of those who brought this collection of memorabilia into being and who, throughout the past twenty years, have had a hand in helping it to become what it now is. Behind the collection that makes up the American Telephone Historical Library there is and always has been a very specific and concrete purpose; a philosophy that has been at once deep-laid and well defined.

That purpose and that philosophy have been directed toward making what has been here collected a useful instrumentality of service. Every document here preserved has been kept on the basis of its possible usefulness as a means of helping to tell truthfully the romantic story of the development of the telephone. Which is not to say that all items are of equal importance. Some have been momentous in their implications, far-reaching in the results which they have helped to achieve. Some are seemingly trivial, and serve only to throw additional light on the men and women who have made telephone history, or upon the innumerable little incidents or episodes which, taken together with the greater events, have gone into the making of the telephone service of today.

In its main essentials, this purpose was from the beginning what it is today: to preserve and perpetuate the documentary evidence of telephone history; to place the more striking and important of these pieces of evidence on display, where they may be of interest to those of the telephone-using public who see them, and of inspiration to telephone men and women; to make these and other documents available, under proper restrictions, for the use of students of telephone history, whether from the ranks of telephone people or outside them; and to provide facilities for those who wish to do so to see the story of telephone development, not merely as a series of unrelated events, nor as a mingled crowd of people whom the passage of time has robbed of personality, but as a continuous process in which the telephone men and women of today participate equally with others of earlier generations who were as human as they are.

A Philosophy of Service

But while the main purpose of what is now called the American Telephone Historical Library was doubtless clearly defined in the minds of those who created it, the philosophy that lies behind what is there done was not brought into being, as Minerva was said to be, full grown. Like all worth-while philosophies, it has been the product of evolution, increasing in scope as experience has expanded its horizons. In order to trace the steps in this evolution, it will perhaps be helpful to review the history of the Historical Library itself.

What is now the American Telephone Historical Library began officially on October 7, 1922, when H.

B. Thayer, then President of the American Telephone and Telegraph Company, appointed William Chauncy Langdon to the newly created position of Historical Librarian—of a non-existent library. Such library as there was did not even have that name, as will presently appear. At first, the space assigned to the new appointee—a small room, bearing the number 2611–C, which still designates the Historical Library, but occupying only about half the area now devoted to it—contained only a desk, some chairs, a few filing cabinets. But it had about it an atmosphere surcharged with enthusiasm.

Early Interest in the Project

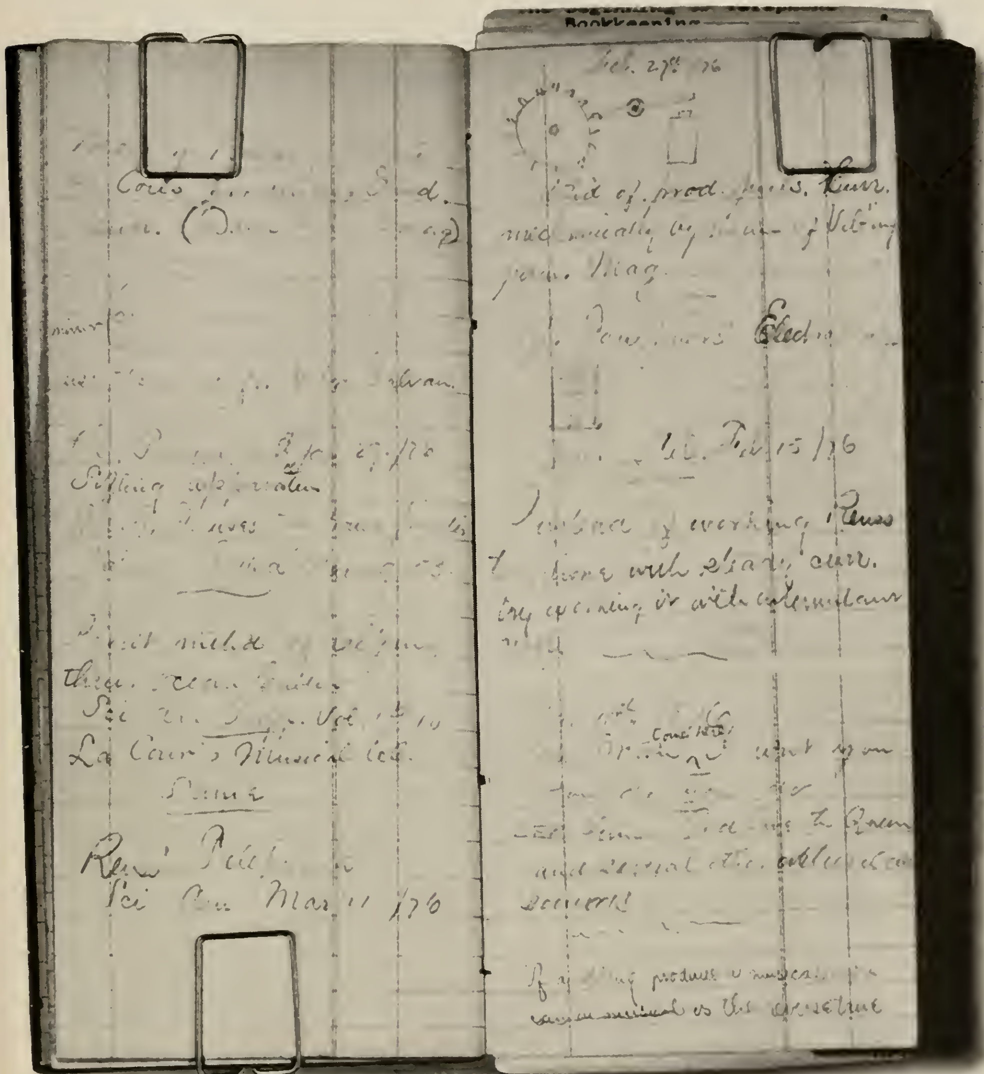
IMPETUS had been given to this enthusiasm by the very real and personal interest shown in the project, from the time it was suggested, on the part of Mr. Thayer. His own career as a telephone man had begun in 1881, when he became a shipping clerk in the Western Electric Company, at Chicago, and it was doubtless in part because of his association with the events of early telephone history that this interest continued not only while he was President, but to the end of his life. But enthusiasm for the historical aspects of telephone development is not necessarily related to the date upon which one's telephone career began, as is evident from the fact that, as Mr. Thayer's successor, President Walter S. Gifford has also taken a personal interest in the work of the Historical Library, and has donated to it not a few interesting and important items.

It is appropriate to say that, but for a personal regard for the success of what the Historical Library was intended to accomplish, on the part of some of the men who have played important roles in the making of telephone history, no real measure of such success could have been achieved.

Among those who, in addition to Mr. Thayer, early coöperated in the building up of the Library, both through their personal interest and inspiration and by making valuable donations to it, were Mrs. Gilbert Grosvenor and Mrs. David F. Fairchild, daughters of Alexander Graham Bell and granddaughters of Gardiner G. Hubbard, one of his two principal business advisors; the family of Thomas Sanders, who provided much of the financial support that enabled Bell to carry on his telephone experiments; Thomas A. Watson, his mechanical assistant in the early days of his struggle to bring his invention to success; Thomas D. Lockwood, for many years an authority on telephone patent matters and other phases of telephone history; John J. Carty, who began his telephone career as a boy operator in Boston in 1879 and rose to a position of world-wide recognition as a leader in the field of telephone engineering, and many others.

ALTHOUGH Mr. Langdon had himself selected the title of Historical Librarian,* as against that of "Historian," to which consideration had been given, the one-room domain over which he presided was not called a library. It was known as the Ameri-

* Mr. Langdon retired in 1936, and was succeeded as Historical Librarian by the present writer.



THOMAS A. WATSON'S NOTEBOOK

In it Bell's young assistant kept a methodical record of their progress. On the lower right page is noted verbatim the first complete sentence of speech ever transmitted electrically

can Telephone Historical Collection,* and this name was retained until it was changed in 1933 to the American Telephone Historical Library. The original name was perhaps more significant than might appear on casual consideration. The first and most important task of the librarian was obviously that of a collector.

* See "The American Telephone Historical Collection," BELL TELEPHONE QUARTERLY, January, 1924; "The Growth of the Historical Collection," QUARTERLY, April, 1925.

Kensington
March 25th 1878

To the Capitalists of the
Electric Telephone Company

Gentlemen,

It has been suggested that at this our first
Meeting I should lay before you a few ideas
Concerning the future of The Electric Telephone together
with any suggestions that occur to me in regard to
the best mode of introducing the instrument to the
public.

The Telephone may be briefly described as an
electrical Contrivance for reproducing in distant places
the tones and articulations of a speakers voice so that
Conversation can be carried on by word of mouth
between persons in different rooms, in different streets
or in different Towns.

At the present time we have a perfect net-
work of gas pipes and water pipes throughout our large
Cities. We have main pipes laid under the streets
Communicating by side pipes with the various dwellings
enabling the inmates to draw their supplies of gas and
water from a Common source.

In a similar manner it is Conceivable that Cables
of Telephonic wires could be laid under-ground or suspended
over head Communicating by branch wires with private
dwellings Counting houses shops manufactories &c &c
uniting them through the main Cable with a
Central office where the wires could be Connected
together as desired establishing direct Communication
between any two places in the City. Such a plan
as this though impracticable at the present moment
will, I firmly believe, be the outcome of the introduction
of the Telephone to the public. Not only so but I
believe that in the future wires will unite the
head offices of Telephone Companies in different cities
and a man in one part of the Country may
Communicate by word of mouth with another in a distant place

Introducing the Telephone in England

These are extracts from a prospectus which Bell presented to British capitalists in 1878. In the lower section is found his prophetic statement of the service which the telephone could render to mankind

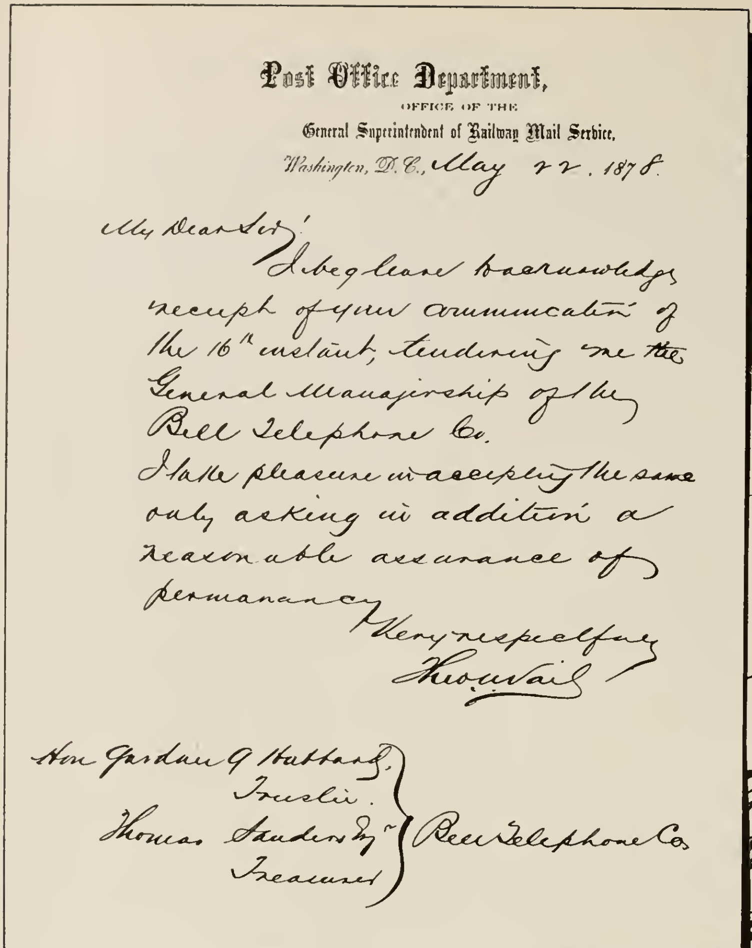
For this function Mr. Langdon was admirably fitted. He was a collector by instinct, and—so far as the collection of historical data was concerned—a collector with a purpose. Already well grounded in telephone history by reason of his activities as a writer on the staff of the Information Department of the American Telephone and Telegraph Company, he knew what would, and what would not, be of value to the collection he was to build up, from the standpoint of its purposes as already outlined.

He had what amounted to a reverence for the great documents of telephone history: the Bell Patents; the mortgage made by the mother of Enos M. Barton in order that her son might purchase an interest in what later became the Western Electric Company; Watson's notebook, in which he recorded the first transmission of a full sentence of speech, on March 10, 1876; the first telephone advertisement, probably penned by Hubbard; and some of the more intimate letters or memoranda of the great figures of the telephone's early days. But he knew also, as any man with an historical instinct must know, that many seemingly trivial incidents, in which the actors were plain, ordinary people, had a part in the making of telephone history. And he therefore set himself to collect the reminiscences of such people, as well as those whose names were better known—all to the end that, by fitting these bits of history together, like the pieces of a mosaic, the student of the telephone's past might see it in proper perspective and in its entirety.

The custodian of the newly created American Telephone Historical Collection had, too, what might be called an inspired acquisitiveness—coupled with no little ability as a follower of faint trails. Once on the track of an item he wanted for the Historical Collection, he was never content to rest until he had traced out its whereabouts and—sometimes after adroit persuasion—obtained the consent of its owner to donate it for permanent preservation among the memorabilia of the telephone. And he had a deep-seated prejudice against throwing away anything, once acquired, until it had been thoroughly demonstrated to be of no historical or practical worth. The value of this instinct for preserving the seemingly unimportant is now demonstrated almost daily, when some document, filed in the Historical Library years ago, is called upon to settle some obscure or mooted point in telephone history—sometimes in matters in which the point in question is of vital moment.

Valuable Papers Rescued

The records show that the Historical Library came into existence because two other men had developed and made use of this same penchant for collecting and preserving information that, in later years, proved to be of historical importance. Back in 1883, Thomas D. Lockwood had the foresight to perceive that it was then, or sometime would be, valuable to collect information as to the beginnings of the telephone business in various parts of the country. He painstakingly gathered such reports for twenty-three American cities. For years, these reports reposed in the archives of the American Telephone



Post Office Department,
OFFICE OF THE
General Superintendent of Railway Mail Service,
Washington, D.C., May 22. 1878.

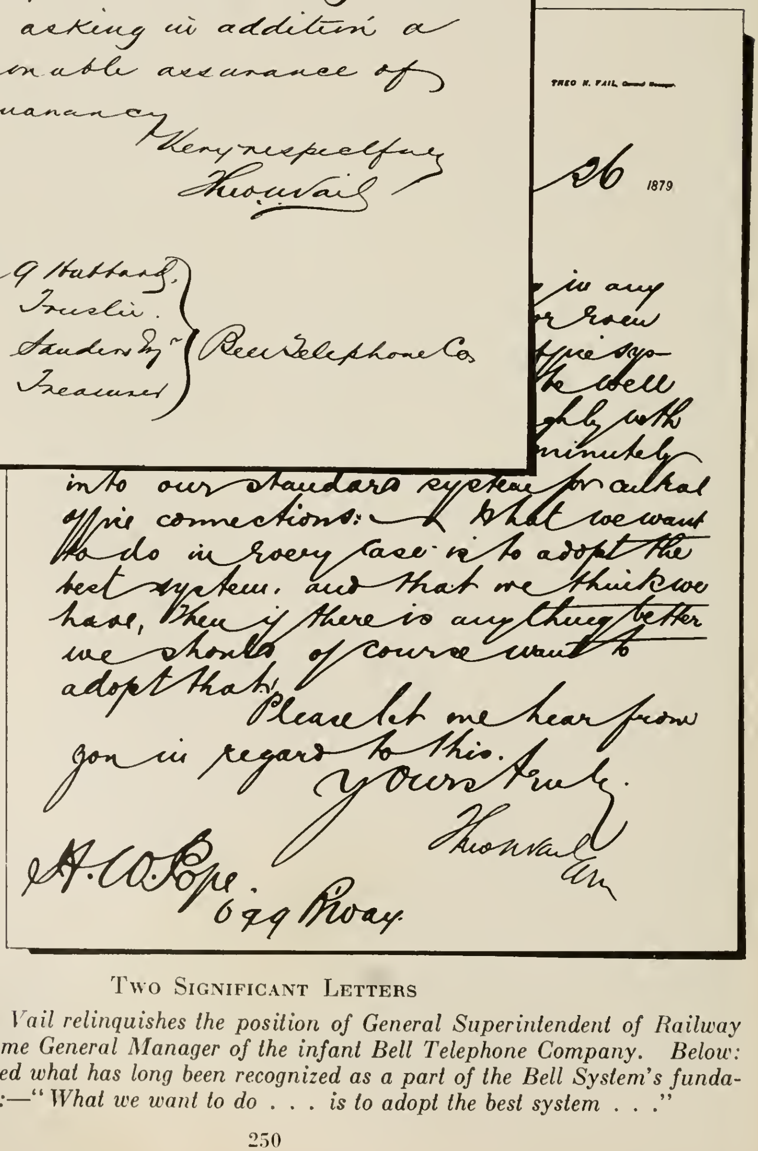
My Dear Sir!

I beg leave to acknowledge receipt of your communication of the 16th instant, tendering me the General Managership of the Bell Telephone Co.

I take pleasure in accepting the same only asking in addition a reasonable assurance of permanancy

Very respectfully
Theo N Vail

Hon Gardiner G Hubbard, Trustee.
Thomas Sanders Esq. Treasurer
Bell Telephone Co.



THEO. N. VAIL, General Manager.

26 1879

in any
or room
office sys-
the Bell
ghly with
minutely
into our standard system for central office connections: & what we want to do in every case is to adopt the best system, and that we think we have, then if there is anything better we should of course want to adopt that.

Please let me hear from you in regard to this.

Yours truly
Theo N Vail

A. W. Pope.
629 B'way.

TWO SIGNIFICANT LETTERS

Above: Theodore N. Vail relinquishes the position of General Superintendent of Railway Mail Service to become General Manager of the infant Bell Telephone Company. Below: In 1879 he enunciated what has long been recognized as a part of the Bell System's fundamental policy:—"What we want to do . . . is to adopt the best system . . ."

and Telegraph Company in Boston. When a general weeding-out process was undergone preparatory to moving the headquarters of the Company to New York in 1907, these old reports seemed, to some of those who were doing the weeding, to be of no particular value.

But they were rescued from the limbo of lost things by J. A. Gately, later for many years chief clerk of the Patent Department, who personally brought them to New York, and kept them in his desk. One day he showed them to Mr. Langdon, who in turn brought them to the attention of James D. Ellsworth, then head of the Information Department. Finally, they were shown to Mr. Thayer, who soon after made the decision that led to the establishment of what is now the Historical Library.

This was by no means the first step taken by the Bell System in the direction of the perpetuation of its history and traditions. As early as 1912, John J. Carty, who had become Chief Engineer of the American Telephone and Telegraph Company, took action which led to the establishment of the Bell System Historical Museum,* at 463 West Street, New York. Under the able direction of Wilton L. Richards, and later of William C. F. Farnell, a remarkably complete collection of telephone equipment has been assembled and is now on display. From a piece of the original wire over which Bell spoke the first sentence transmitted by telephone, and replicas of his early instruments, down to the latest developments in apparatus design, the physical aspects of telephone history are here displayed in case after case of exhibits that are not only of interest but of inspiration.

Mr. Thayer must have seen, however, that instruments and other mechanical devices do not and cannot tell the complete story of telephone development—that as romance and drama, that story is only half told unless it includes that which reflects policies, principles, and human personalities. It was, then, to supplement what had already been attempted in establishing the Bell System Historical Museum that authority was given for beginning what has since grown into the American Telephone Historical Library.

To the papers which Mr. Lockwood had originally collected and which Mr. Gately had preserved throughout the years, more were added as the purpose of the Historical Collection was brought to the attention of others who had pioneered in telephone development, or in some cases, of their relatives after their death. The business of collecting material went on without interruption, is still going on, and will continue to go on as long as telephone men and women keep on doing things that make telephone history.

What the Library Contains

The Historical Library now contains some 25,000 items. Space does not permit the inclusion in this article of anything that even approximates a list of the types of documents that make up the various groups. But it may be well to indicate in broad terms the nature of these records.

* See "The Bell System Historical Museum," Bell Telephone Quarterly, July and October, 1936.

The Telephone.

The proprietors of the Telephone, the invention of Alexander Graham Bell, for which patents have been issued by the United States and Great Britain, are now prepared to furnish Telephones for the transmission of articulate speech through instruments not more than twenty miles apart. Conversation can be easily carried on after slight practice and with the occasional repetition of a word or sentence. On first listening to the Telephone, though the sound is perfectly audible, the articulation seems to be indistinct; but after a few trials the ear becomes accustomed to the peculiar sound and finds little difficulty in understanding the words.

THE FIRST TELEPHONE ADVERTISEMENT

The "proprietors" make modest claims for Bell's invention which contrast with its accomplishments in later years

In addition to original documents which are of obvious importance, such as the Bell Patents and the records of the many bitterly contested suits that grew out of them, there are found original letters of Bell, Hubbard, Sanders, and Watson, together with the latter's notebooks, kept not only when he was assisting with the experiments which led to the invention of the telephone, but during the period when he was, in effect, the entire "Engineering Department" of the telephone company, and went about the country advising the licensees who were starting telephone exchanges as to how they might meet their technical problems.

THERE are collections of early telephone directories from the larger cities of the United States, and some from smaller towns, all of which afford, by contrast, striking proof of the rapidity with which the telephone business has grown in popularity and use during its relatively short existence. There are scrap-books filled with contemporary clippings saved by those who played large or small parts in bringing about this remarkable growth.

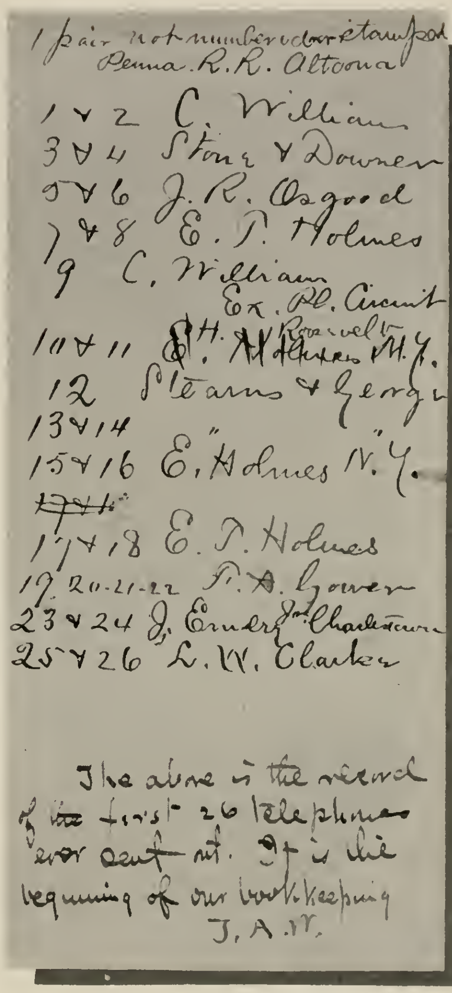
There are two postal cards, of no apparent importance until it is realized that they are the reports of the first day's work done on the New York-Philadelphia line—the real beginning of the creation of today's nation-wide network of long distance telephone facilities. There are photographs and newspaper clippings that tell of great emergencies, like the blizzard of 1888, the San Francisco earthquake and fire, and the great floods which have swept the valleys of the Ohio, the Mississippi, the Connecticut and other rivers.

There are comprehensive records of the part which telephone men and women played in the first World War, together with a letter to Mr. Vail from Postmaster General A. S. Burleson, expressing the latter's appreciation for the coöperation received during the war years "in the interest not alone of this important service as a whole, but of the government of your country as well."

There are awards, certificates, or medals bestowed upon Bell and other individuals in recognition of their contributions to progress in the scientific field. There are similar awards to Bell System organizations, many of them issued in connection with expositions at which exhibits of telephone equipment held important places.

Finally, there are the personal reminiscences of many of the men and women who have helped to make telephone history. Written with no attempt at literary perfection, these are the simple stories of plain people, telling in their own words what they saw and what they did when the telephone was young. Not a few of them were based on notes taken by Mr. Langdon's secretary as he sat and talked informally with visitors whose memories of pioneer days are here recorded. It is of interest to note that Thomas A. Watson's remarkably interesting book, "Exploring Life," grew out of a manuscript prepared by him, originally intended only for preservation in the Historical Library.

And so it goes, from documents momentous in their importance at the time they were penned, and still of the highest significance, to scraps of paper on which some casual memorandum was made at a time when it did not seem to be of particular historical interest. Taken together, these items which make up the Historical Library afford—for those who care to study them thoughtfully—a means of re-creating the story of the


1 pair not numbered or stamped Penna. R.R. Altoona
1 & 2 C. Williams
3 & 4 Stone & Downer
5 & 6 J. R. Osgood
7 & 8 E. T. Holmes
9 C. Williams
Ex. Pl. Circuit
10 & 11
12 Stearns & George
13 & 14 " "
15 & 16 E. Holmes N.Y.
17 & 18 E. T. Holmes
19 20-21-22 F. A. Gower
23 & 24 J. Emery Jr. Charlestown
25 & 26 L. W. Clarke

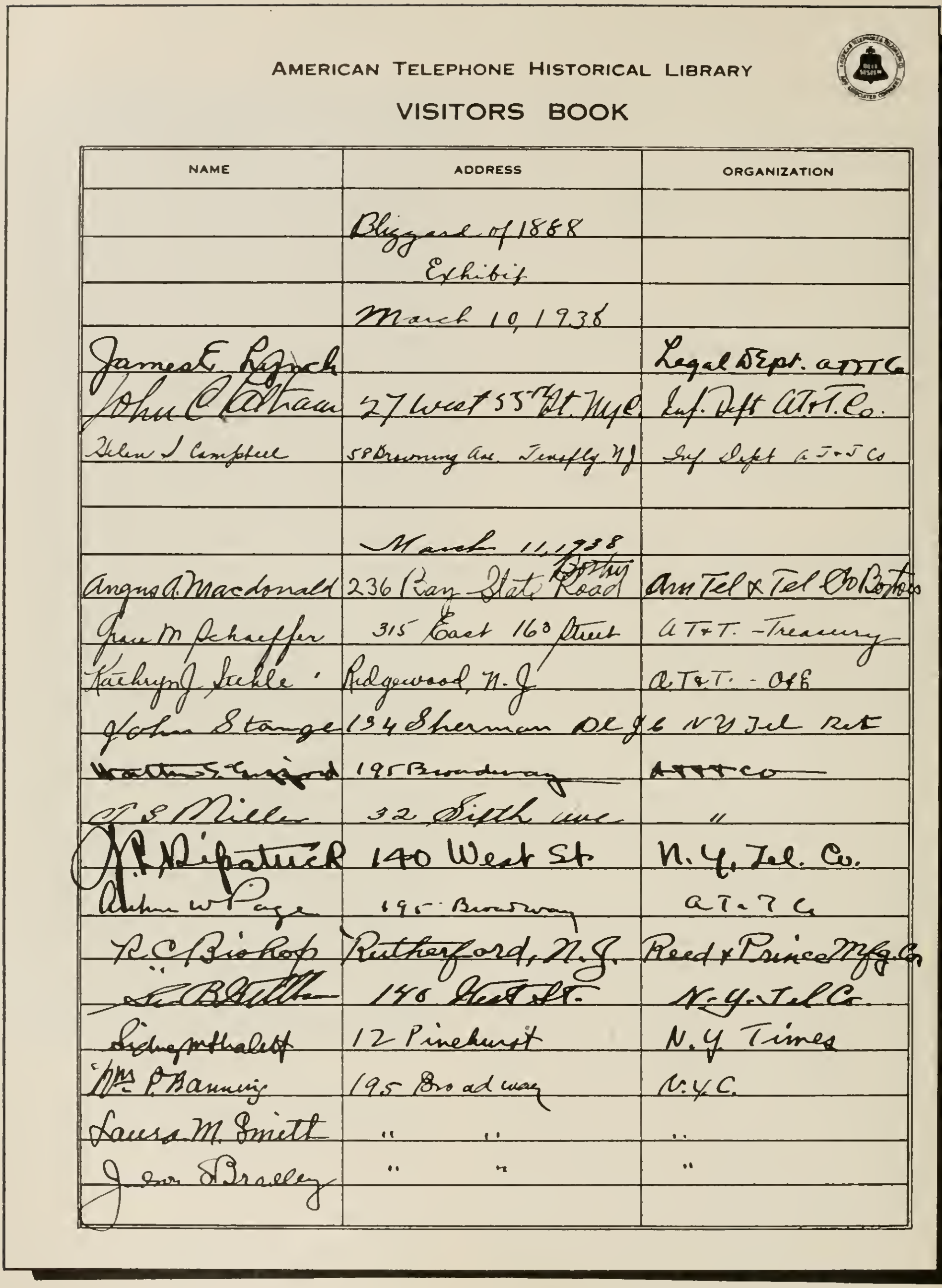
The above is the record of the first 26 telephones ever sent out. It is the beginning of our bookkeeping
J. A. W.

BOOKKEEPING BEGINS
The note below this list of telephones bears the initials of Thomas A. Watson

telephone from its very beginning to the present.

Other Historical Functions

BUT long before the name of the American Telephone Historical Collection was abandoned, it had become apparent that the function of merely collecting historical documents and other data was by no means the



AMERICAN TELEPHONE HISTORICAL LIBRARY

VISITORS BOOK

NAME	ADDRESS	ORGANIZATION
	Blizzard of 1888	
	Exhibit	
	March 10, 1938	
James E. Lynch		Legal Dept. AT&T Co
John C. Calhoun	27 West 55th St. NYC	Inf. Dept AT&T Co.
Helen S. Campbell	58 Browning Ave. Tenafly N.J.	Inf. Dept AT&T Co
	March 11, 1938	
Angus A. Macdonald	236 Bay State Road Boston	Am Tel & Tel Co Boston
Grace M. Schaeffer	315 East 160 Street	AT&T. - Treasury
Kathryn J. Sahle	Ridgewood, N.J.	AT&T. - O&E
John Stange	134 Sherman Pl. J.C.	N.Y. Tel Ret
Walter S. Gifford	195 Broadway	AT&T Co
T. S. Miller	32 Sixth Ave	"
J. P. Kilpatrick	140 West St	N.Y. Tel. Co.
Arthur W. Page	195 Broadway	AT&T Co
R. C. Bishop	Rutherford, N.J.	Reed & Prince Mfg. Co.
[illegible]	140 West St.	N.Y. Tel Co.
Sidney M. Hallett	12 Pinehurst	N.Y. Times
Wm. P. Banning	195 Broadway	N.Y.C.
Laura M. Smith	" "	"
J. Geo. Bradley	" "	"

A PAGE FROM THE VISITORS BOOK

On the occasion of an exhibition observing the fiftieth anniversary of the "Blizzard of '88," the first to sign under the date of March 11 was Angus A. Macdonald, who patrolled the New York-Boston lines on snowshoes outside of Boston during that storm, and subsequently posed for the well known painting, "The Spirit of Service." Third name below his is that of John Stange, who similarly maintained the service near New York. Other names familiar to Bell System people appear on the same page only one that was here to be performed. Although Mr. Langdon had modestly eschewed the application to him of the title of Historian, there was hardly a day in which he was not called upon to act as such—to collate, as well as to collect, historical data; to evaluate them as to their accuracy; to see them in their proper relationship to each other; to interpret them in terms of their bearing on the telephone service of the present and the future.

THIS function of interpretation has become one of increasing importance. Year by year it has become more and more apparent that the documents which the Historical Library contains are not chiefly important as individual records, but as facilities by which, guided by the Library staff, a student who cares to do so may correlate all these bits of history in such a way as to make clear to later generations of telephone people and telephone users just how a nation-wide telephone service has come into being.

Such interpretation has been made the more necessary by the passage of time and all that it involved. Practically all of the men and women who played parts in telephone development in its earlier days have retired from the service; many have died. New actors have taken their place upon the stage. Employees—most of them young men and women—join the telephone family by thousands each year. And most of them have had little or no opportunity of learning, in advance of their employment, anything about the beginnings from which has come the great public service in which they are engaged.

Many opportunities for such interpretation present themselves to the members of the Historical Library staff in the course of a year. Visitors at the Library are given individual attention, and the more significant exhibits are explained in as much detail as may seem desirable, this depending largely upon the direction in which the interests of the listener appear to lie. Incidentally, a register of visitors, which has been kept since the Historical Library was opened, contains the names of people from many lands, not a few of whom hold distinguished places in the fields of science, inventions, the arts, and public affairs. Most of those who spend some little time in the Library, whether they are telephone people or otherwise, leave with a word of appreciation, and not a few confess to having learned a lot that they had not known about telephone development.

Answering Inquiries

PERHAPS more important is the steady flow of inquiries that reaches the Historical Librarian. These range from relatively simple questions on the part of public school pupils who are preparing "projects" to those of candidates for post-graduate degrees who are writing theses. One letter or telephone call may ask only that a name and address be checked in an old telephone directory; another may require hours and even days of research before a satisfactory answer is found.

Authors of novels or short stories call to find out whether it would have been possible, in 1897, let us say, for the hero at Detroit to call the heroine, at Jacksonville, Florida, on the long distance telephone, usually requesting, in addition, the necessary details as to whether he was likely to talk over a wall telephone, and whether he had to "turn the crank" to get the operator. Supplying material for and subsequently checking of magazine articles and scripts for radio sketches and moving pictures touching on the history of the telephone is another matter of routine that requires a considerable part of the time of the Library staff.

Not infrequently the material sought has a most direct and important bearing not only on telephone history, but on the telephone business of the present day. Within recent months, for example, a matter was before one of the government commissions in Washington in which it was highly desirable to establish what the early policy of the Bell System was as to a commercial practice now widely followed. Search elsewhere having failed to provide sufficient evidence, the files of the Historial Library were examined, and after considerable handling of old letter books, the desired evidence was found in a memorandum dictated by Theodore N. Vail more than sixty years ago.

With telephone development, as with everything else that is not static and lifeless, the past and the present are inextricably mixed and merged. One cannot understand the telephone service of today—and, indeed, one cannot contribute to the full his share of the provision of that service—without knowing something of the planting of the acorns from which this great oak has grown.

Unsung Heroes of History

But telephone history consists not alone of the words and deeds of the great figures who in their time have occupied the center of the stage. It has been written—as it is being written today—by thousands of men and women who in unspectacular and almost obscure ways have contributed toward the quality of the service in their own day, and to its improvement for all time.

Not all of the boy operators who were associates of John J. Carty in Boston when he began his telephone career rose to the position of large responsibilities which he achieved. But even the least of them made his own impress upon the overall growth and betterment of telephone service. Not every woman operator has "glorified her calling by sacrificing her own life, that others might live," as did Sally Rooke, when flood waters swept down on her little central office in Folsom, New Mexico, in 1908. But every woman who has done her work at the switchboard or elsewhere to the best of her ability has contributed something to the story of the telephone.

Not every lineman has guarded essential communication lines on snowshoes, as did Angus MacDonald during the blizzard of 1888, and won lasting fame as the original model of the best known of telephone pictures —"The Spirit of Service." But every lineman makes history when, in that same spirit, he does as well as he can what it is his to do. History is the sum of a multitude of acts like these. And because such acts are being done, day in and day out, in the telephone service today, the history of that service is a living, dynamic thing that never grows too old to be of interest and of inspiration.

One who has made even a feeble attempt at the interpretation of telephone history—who has made any effort at all at the job of trying to see telephone history in its broader aspects—would be struck with a sentence or two in a recent article by Roy F. Nichols on "Confusions in Historical Thinking." * This writer points out:

> ". . . The kind of interpretation of past events does not depend so much upon research as upon the way in which the historian interprets present events, views the world around him, and judges the character and motives of those with whom he comes in contact. . . . In other words, one is no better historian than he is citizen of the world."

Perhaps one does not need to qualify as a "citizen of the world" in order to take a somewhat similar view of telephone history, or to write about it—or to play his part in the making of the telephone history of today. It may not be necessary for him to reflect that the telephone is now world-wide in its reach, and that what he thinks or writes or does may have far-felt effects. But certainly he cannot well fail to think as clearly as he can upon the relationship between the telephone's past, its present, and its future—to see the telephone service of today in what might be called time-perspective. Whatever is his to do will be done the better if he will pause to reflect that, the minute it has been done, it becomes a part of telephone history, and thereby reaches far into the past—and even farther into the future.

The provision of such a time-perspective is, as the writer views it, the purpose of the American Telephone Historical Library. Its philosophy, built up by a process of evolution extending over a period of twenty years, is a simple one—that all that has been is a dynamic part of what is, or is to be. Touched by this philosophy, even the driest and dustiest of documents comes to life, and takes its place in the provision of telephone service in these troublous days when communication plays so important a part in preserving America and the American way of life.

* Journal of Social Philosophy and Jurisprudence, Vol. VII, No. 4, July, 1942, page 334.

FIRST AID TRAINING IN THE BELL SYSTEM

More Thousands of Employees than Ever Are Taking It and Are Teaching It, and a Recent Joint Agreement with the American Red Cross Assures Up-to-date Methods and Procedures

By ERLE S. MINER

PLAYING their regular positions on the "Bell System team of 400,000" to win this war, telephone men and women have also shown their eagerness to buy bonds, to conserve rubber, to "get in the scrap," to take every step by means of which the home front can contribute to victory. And since Pearl Harbor, increased thousands of them have taken first aid training.

These new "first aiders" come from all departments and from all levels of the organization. Because of their training, they are now prepared to serve more effectively as air raid wardens, nurses' aids, auxiliary firemen and policemen, and in other civilian defense activities. Many of them, further, are competent to instruct Red Cross classes in their respective communities—and are so doing.

This sharp acceleration in Bell System first aid activity is significant. During recent years, about 7,000 employees have qualified for first aid certificates annually. In the seven-month period following our entry into the war, *more than 16,000 employees* completed their training. More than a third of all the employees in the System, it is estimated, have now had first aid instruction. What is more, there are in the System approximately 2,500 qualified first aid instructors.

Not least among the benefits of first aid instruction is the fact that in telephone buildings throughout the System there now are trained rescue squads, ready to assist in evacuating designated areas—including transportation to shelter if enemy attack should necessitate evacuation of certain offices—in rendering necessary first aid, and in giving care thereafter. Because of long experience in first aid work, the Associated Companies were able in short order to plan for the care and protection of their own people who are the guardians of the Bell System's communication service of a nation at war.

Nor is it a negligible accomplishment that most of the thousands of Bell System men who are now in the armed forces have had first aid training.

It is apparent that the Bell System

is rapidly becoming an army of "first aiders," ready for duty in an emergency.

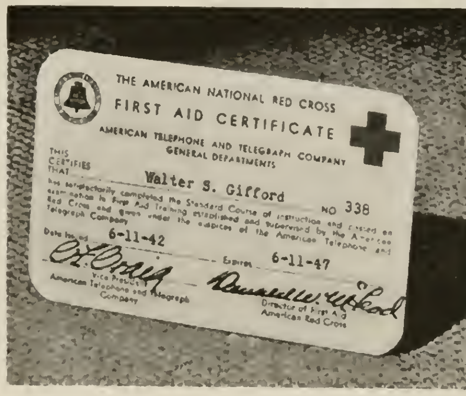
The activity is not new to the System, however. Actually, it was first introduced 30 years ago with the assistance and coöperation of the American Red Cross, primarily as an accident prevention measure in the plant departments of some of the Associated Companies of the System; and during three decades hundreds of telephone men and women have demonstrated their ability to lessen suffering and to render practical assistance in case of accident or sudden illness before the services of a physician could be obtained.

In those 30 years the importance of first aid training in the Bell System has increased, and the close and continuing coöperation between the System and the Red Cross has been exemplified by many developments and improvements incorporated in the training program.

A New Look at First Aid

The extent of first aid training within the Associated Companies has varied somewhat from year to year, largely in ratio with the number of new employees entering the business. During the depression of the early 'thirties, when few were being employed, there was less than usual activity. More recently there has been a definite revival of interest, not only in training new employees but in providing review courses for those who had received their instruction some years before.

This renewed activity raised a number of questions which during 1940 made it desirable to take a broad look



"From All Levels of the Organization"

This is a first aid certificate issued jointly by a Bell System company and the American Red Cross

at first aid in the light of past experiences, particularly as to what plans should be made for a continuing program. It was evident that procedures based upon such a review should lead toward greater uniformity in first aid training in the Bell System, and with it an increase in the effectiveness of all its benefits.

One point to receive particular consideration was the development of a working arrangement, in effect a joint agreement, with the American Red Cross, to which all the Associated Companies might subscribe. Some of them had been operating under Red Cross agreements executed during the early 1920's, and others had not. The new joint agreement, which is made possible by virtue of the medical supervision provided within the Bell System and the long standing relationships maintained with the Red Cross, was ratified during the latter part of 1940 after consultation between the Red Cross and all of the Associated Companies.

Special Edition

This standard Red Cross instruction text has a special cover and a foreword addressed to Bell System employees

The agreement covers first aid instruction and certification procedures which meet the standards and carry the endorsement of the American Red Cross, and provides for training and certifying Bell System first aid instructors and for means to keep both instructors and regular "first aiders" up-to-date in the latest first aid methods.

In order to place the new joint agreement in operation, representatives of the Red Cross and the Associated Companies met in a series of four joint regional conferences, held during September and October of 1941 in Princeton, New Jersey; Roanoke, Virginia; Chicago, Illinois; and San Francisco, California.

One purpose of these conferences was to give representatives of the Red Cross and the Bell System, who are jointly to administer the first aid agreement, opportunity to familiarize themselves with the methods for doing so. Another important purpose was to train and qualify a number of telephone company representatives who had been selected for supervising instructors. In all, 185 telephone company men, including general plant employment supervisors and safety supervisors and 55 Red Cross representatives, from the entire United States, attended the four meetings.

In addition to covering the terms of the joint agreement and training the Associated Company supervising instructors, the meetings enabled the representatives of the Red Cross and the Bell System companies to become acquainted, so that during the years to come they may all have an understanding of the joint problems involved. The conferences were invaluable in enabling the telephone company representatives to place the new agreement in operation in their respective companies.

Some Results of the Joint Agreement

The blue-covered Bell System "First Aid and Health" textbook, which was issued in 1927, had become considerably out-of-date. The Red Cross is in a position to revise its first aid text periodically to include improvements in first aid procedures as they are developed, and it has been adopted for Bell System use. Moreover, the adoption of the Red Cross textbook makes it unnecessary for the hundreds of telephone company instructors who also teach first aid classes organized by local Red Cross chapters to refer to one textbook for teaching telephone company classes and to another text for non-employee classes.

The Red Cross textbook used for telephone company first aid instruction is bound with a special cover, and contains a "foreword for Bell System employees" co-signed by Mr. Harold F. Enlows, Director of First Aid and Life Saving Service of the American Red Cross, and by Dr. C. H. Watson, Medical Director of the American Telephone and Telegraph Company.

Thus the Red Cross textbook is being used as the basis for all Bell System first aid training, and the joint agreement provides that each employee pursuing the course shall have a copy. In classes composed wholly of Bell System employees, however, this text may be supplemented by additional information covering procedures and techniques that experience has proved to be particularly applicable to the needs of the Bell System.

The Red Cross standard course is the basic course regularly offered to telephone employees. Twenty hours of training are required—with whatever reasonable additional time may be necessary in the judgment of the instructor. For effective teaching, classes are limited to not more than 20 students. Upon successful completion of the standard course, joint Red Cross-Telephone Company first aid certificates are issued.

The advanced course is a ten-hour course providing additional study and practice beyond the standard course. It includes, in addition to a review of the knowledge of first aid acquired in the standard course, a number of practical problems designed to develop further the first aider's skill. Enrollment in the advanced course requires previous qualification in the standard course and, upon its successful completion, advanced course certificates are issued jointly by the American Red Cross and the telephone companies. This course was not provided for in the previous arrangements with the Red Cross.

Another significant change with respect to the certificates of proficiency in first aid concerns the length of time during which the certificates are valid. Under the former procedure, certificates were issued to each employee-graduate of the standard first aid training course, but these certificates carried no expiration date. Now, all standard course certificates expire at the end of a designated period. Then the employee may enroll in the advanced course, and upon completing it may receive the advanced course certificate—which places him in good standing for another similar period. He may then again take the advanced course, and so on for subsequent periods. In this way the individual employee's knowledge of first aid, and his skill in administering it, will be given a definite continuity.

It is generally recognized that the success of any training program depends largely upon the abilities and sincerity of the instructors. They must not only possess the necessary knowledge and skill, but they must also know how to teach and have the necessary equipment for proceeding with the instruction. Since most of the telephone company first aid instructors teach only a limited number of classes each year, it seemed particularly important to include in the joint agreement procedures for assur-

Spotlight on Equipment

Here are three sizes of Bell System first aid kits: the tools which help the telephone first aider to apply his knowledge and skill

WOMEN EMPLOYEES SHOW THEIR PROFICIENCY
These first aid students represent various departments of an operating company. Two instructors train a group of this size

ing that the corps of Bell System first aid instructors are properly selected, thoroughly trained as instructors, given "refresher" work, and kept currently up-to-date on the latest first aid practices and teaching methods.

In order to be eligible to attend the instructor training course, candidates must have completed the standard and advanced courses. Upon the successful completion of the Instructor's course, joint Red Cross-Telephone Company instructor certificates are issued and are good for one year. The appointment of instructors is on an annual basis, renewable upon approval by the Red Cross provided the instructor has taught at least one class under his previous year's appointment and has satisfactorily availed himself of any review work to which he may be assigned. The emphasis in this review work is upon such matters as new procedures, text clarification, class organization, teaching problems and methods, et cetera.

The American Red Cross has also developed an instructor's outline, and its use by Bell System instructors helps to insure uniformity of instruction, and also relieves the companies of preparing and maintaining their own outlines.

WITH the approval of the Red Cross and as provided for in the joint agreement, the Associated Companies have generally selected one or more supervising instructors. They are chosen from among the active instructors, and have a background of thorough Red Cross first aid training and outstanding first aid teaching experience. Their function is to assist in all the problems of administering the training program within their organizations, so that high standards of first aid training will be maintained.

These supervising instructors include several women, who assist in administering the training among the women employees in departments other than the plant. Arrangements have been made for a staff representative of the American Red Cross to meet at least once a year with the supervising instructors, to discuss current needs of the training program and improvements in first aid practices.

Special Bell System Developments and Activities

Bell System first aid kits, containing standard materials, are tools which help the telephone first aider to apply his knowledge and skill. Three sizes of kits are provided. The large size is kept at convenient locations in central offices, storerooms, and in a suitable place on large telephone trucks. The medium sized kit is usually carried on smaller trucks and kept at locations where only one or two may need it. The small kit is designed for the pocket or tool bag where the larger kits cannot be conveniently carried. Operators' rest rooms are also provided with medicine cabinets containing a selected list of first aid supplies and necessary instructions.

Telephone first aid classes stress the importance of replacing as soon as possible each item taken from the kit,

They Will Instruct Others

Upon completing the Instructors' course, this group will be prepared to give first aid training to fellow employees

Plant First Aiders
These men are taking the basic course

of keeping the materials sterile, and of avoiding the possibilities of infection in case of wounds.

As a means of helping to make first aid a part of the regular plant job, a considerable portion of the first aid textbook has been condensed for inclusion in the Bell System Practices—which are the instructions for constructing and maintaining the telephone plant. This condensed information is provided in handbook size for outside plant forces and in larger size for central office plant forces. In this way the first aid text in condensed form is available on the job for review purposes by individual employees, as well as by foremen for training in the fundamentals of first aid new men who haven't yet had an opportunity to take the standard first aid course.

In addition to this condensed version of the textbook, other closely related information of special significance to outside plant forces and engineers is provided in several sections of the Bell System Practices handbook. These sections concern, for example, the rescue of employees from manholes, from poles, and from "live" circuits. While occupational accidents occur infrequently in the Bell System, the information has been provided and telephone employees are trained in what to do so that they will know how if they should ever be present during such an emergency.

Many of the Associated Companies have conducted first aid contests as part of their training program. During recent years, such contests have usually been confined to district and division competitions. They are also held in some of the companies as a part of evening programs following safety dinners or at similar gatherings. In some cases, the members of the competing first aid teams are selected immediately before the contest by drawing names from a hat. In this way stimulus is given to having the entire personnel proficient in first aid knowledge and skill.

During the past year, first aid was dramatized in an unusual and effective way in one company. In darkened recreation rooms, employees sat tense and alert as huge black bombers raced across the motion-picture screen and bomb-struck buildings dissolved into rubble before their very eyes. As the thunder of warfare diminished and the pictures faded from the screen, curtains parted to reveal the demolished interior of a home. Prone on the floor with the debris lay two victims of the air raid, their clothing torn and stained by "blood" from the make-up kit. Onto the scene of chaos came three first aiders. Then, to a microphone description, they turned efficiently to the assistance of the shocked and bleeding victims. The importance and impressiveness of the demonstration was indicated by a number of favorable comments in the press.

Posters have been used from time to time to call attention to the importance of first aid training and to announce that classes are to be conducted. Articles accompanied by pictures of first aid classes appearing in company magazines or Safety Bulletins have also increased the interest in first aid in the Companies.

Most of the companies have furnished their employees with printed first aid sheets listing the usual types of home accidents and the first aid care that should be applied. They can be gummed to the inside of the door of bathroom medicine cabinet or any convenient surface.

The Bell System companies are making extensive use of first aid motion pictures in classroom work as well as for showing to employee groups assembled upon different occasions. One that has been used by most of the telephone companies is the sound picture titled "Before the Doctor Comes," prepared by the American Red Cross. First aid subjects covered in this picture include control of bleeding, care of shock, artificial respiration, traction splinting, care for burns, and transportation of victims.

For years hundreds of Bell System plant men who have been teaching telephone company classes have also volunteered their time and energy to promote first aid by teaching classes in their local communities. During the past year, Civilian Defense organizations have called for a large number of volunteer workers, especially for those qualified as instructors. To assist in meeting this demand, Bell System companies have accelerated their first aid training programs so that more instructors would be available to volunteer their services to local Red Cross Chapters under whose direction and supervision they would teach first aid classes. Representatives of Civilian Defense groups, churches, schools, boy and girl scouts, police and fire departments are among those who have attended first aid classes taught by telephone company men.

Instructors' Course

Practice makes these people perfect in artificial respiration and other techniques which they will soon be teaching to other telephone workers

Bell System Men and Women Make Practical Use of Their Training

Many Bell System women are first aid instructors, and thousands more hold joint American Red Cross-Bell System certificates. They, as well as the men, are practical first aiders too, as typified by the following cases which are selected from those that have occurred during recent months.

An elderly woman fell off a bicycle and severed the artery above the temple when her head hit the curb. A telephone operator who had taken first aid some three months before and was in a nearby house was told of the accident. Investigating, she saw two men trying to place the woman in a car while another was attempting to give her a drink of water. The operator found that the arterial bleeding was bad and suspected a skull fracture—which later proved correct. She checked the bleeding and then got one of the men to hold the pressure point. She telephoned for an ambulance, secured a bandage, and treated the victim for shock and skull fracture. The physician in charge at the hospital highly commended the first aid work performed, which is generally believed to have saved the woman's life.

A telephone woman was involved in an automobile accident and suffered a severed artery in her scalp. While her companion walked four and one-half miles over a little-traveled road at night for assistance and transportation, she exerted pressure to stop the flow of blood. Thanks to her courage and to efficient application of first aid to her own injury, she saved her own life.

The extent to which Bell System women have engaged in first aid training is also exemplified by the performance of girls' teams in competition with men's teams. This year, for the first time, girls' teams in one of the companies entered competition in a number of districts. A girl's first aid team solved difficult first aid problems perfectly in three minutes' faster time than their competing rivals, consisting of five men's teams—and won the contest!

Other recent incidents indicate the first aid proficiency of Bell System men.

A telephone man arriving at a coal mine for maintenance work saw men running toward the mine opening, and sensed that an accident had happened. Taking his first aid kit from the truck, he ran to the head of the mine shaft.

Training Citizens
Above: Ten Associated Company plant men gave their time to instruct this class of school teachers and community leaders. Right: A town's air raid wardens learned first aid from Bell System men

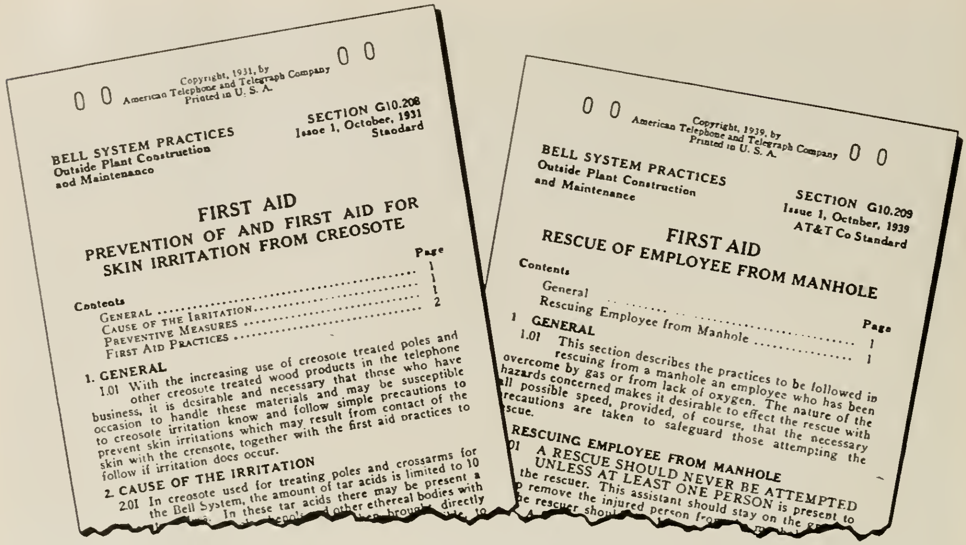
STAGED REALISM

This was the problem posed for one company's first aiders. As they went to work on the "victims," a play-by-play account of the steps they took was given the audience by loud-speaker

Then for three-quarters of an hour he faithfully administered artificial respiration to a miner with no tangible results, and was becoming exhausted, when suddenly the victim moaned. Ten minutes later, when a doctor arrived, the miner was breathing with some degree of regularity. Knowledge of first aid methods acquired as a telephone employee, and prompt and sustained action, had saved a life.

The twin sons of a telephone employee were playing on the floor at home when one of the boys accidentally swallowed a metal ball. Strangling, he ran toward his father with out-stretched hands, gasping for breath. The father picked the child up by the feet and shook him, but this treatment was unsuccessful. He then pried the child's mouth open and stuck his finger down the throat, found the string attached to the ball, and gently and quickly pulled the ball out. This telephone man had finished his first aid training the night before, and firmly believes the training he received enabled him to keep a cool head and to know what to do to save his child's life.

A soldier, in an automobile accident, was thrown against the windshield, and sustained severe cuts on his head and face. A telephone man, obeying the first rule of first aid by giving precedence to the most serious injury as he had been taught in the first aid class three months before, applied pressure to the large artery in the soldier's neck to stop the profuse



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BELL SYSTEM PRACTICES
Outside Plant Construction and Maintenance

SECTION G10.208
Issue 1, October, 1931
Standard

FIRST AID

PREVENTION OF AND FIRST AID FOR SKIN IRRITATION FROM CREOSOTE

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First Aid Practices	2

1. GENERAL

1.01 With the increasing use of creosote treated poles and other creosote treated wood products in the telephone business, it is desirable and necessary that those who have occasion to handle these materials and may be susceptible to creosote irritation know and follow simple precautions to prevent skin irritations which may result from contact of the skin with the creosote, together with the first aid practices to follow if irritation does occur.

2. CAUSE OF THE IRRITATION

2.01 In creosote used for treating poles and crossarms for the Bell System, the amount of tar acids is limited to 10 ... In these tar acids there may be present a ... other ethereal bodies with ... directly ...

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BELL SYSTEM PRACTICES
Outside Plant Construction and Maintenance

SECTION G10.209
Issue 1, October, 1939
AT&T Co Standard

FIRST AID

RESCUE OF EMPLOYEE FROM MANHOLE

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1 GENERAL

1.01 This section describes the practices to be followed in rescuing from a manhole an employee who has been overcome by gas or from lack of oxygen. The nature of the hazards concerned makes it desirable to effect the rescue with all possible speed, provided, of course, that the necessary precautions are taken to safeguard those attempting the rescue.

RESCUING EMPLOYEE FROM MANHOLE

.01 A RESCUE SHOULD NEVER BE ATTEMPTED UNLESS AT LEAST ONE PERSON IS PRESENT to ... the rescuer. This assistant should stay on the ... remove the injured person ...

For the Outside Plant Forces

Supplementary first aid information relating to certain types of work is included in the pocket volumes of Bell System construction and maintenance practices

arterial bleeding. The pressure on the artery was maintained sufficiently to control the bleeding on the ride to the hospital which took about 25 minutes. The surgeon who expertly repaired the injuries said that the soldier could have died from loss of blood in a very short time if the bleeding had not been controlled properly.

These cases are but a few of those that have occurred during comparatively recent months when telephone men and women have expertly applied their first aid knowledge and skill and relieved the suffering and saved the lives of members of their families, fellow workers, and others who have been the victims of accidents.

These telephone first aiders, both men and women, on their regular jobs are scattered all over the country. Bell System plant men, in particular, may be found on the streets and highways, in homes and offices, installing and repairing telephones or placing and rearranging poles, wire, and cables. They travel on trucks and smaller cars wherever the highways of the nation reach. Almost daily since the introduction of first aid training in the Bell System, news accounts have described some act of first aid by telephone people. Recognition of some of the important outstanding cases of this character may be found in the records of the President's Awards of the National Safety Council and in the records of the awards of the American Red Cross, as well as in those of the Bell System Vail Medal Awards.

In addition to preparing telephone people to take active roles in Civilian Defense and other home front activi-

THE WINNERS
This girls' team defeated five men's teams by solving perfectly and in the shortest time difficult first aid problems presented at a district contest

ties, first aid also plays a part in preventing wastage of human and material resources of the nation through accidents on the job, off the job, and at home.

The reason that accidents occur less frequently among persons trained in first aid is that these people have been impressed with the necessity of taking constructive steps to avoid accidents.* Those trained in first aid tend to be more alert in observing conditions and circumstances possessing accident possibilities, and thus are more likely to look one step ahead before acting. Through their knowledge and skill they promptly take proper care of all injuries and therefore prevent more serious consequences. Hence a thorough knowledge of first aid has proved to be a benefit to the individual, to his family, to his fellow workers, and to the community at large during times of peace and times of war.

* See "Safety in the Bell Telephone Companies," BELL TELEPHONE QUARTERLY, October, 1939.

First Aid is a Continuing Activity in the Bell System

No one can say how many additional telephone men and women will become first aiders during the next few years, but the number is sure to be large. The joint American Red Cross-Telephone Company agreement provides a sound basis for a continuing Bell System program. It is designed to train and to keep trained every telephone employee so that he or she may give the immediate and temporary care required in case of accident or sudden illness. A telephone first aider is able to put his knowledge and skill to work, whenever the occasion arises, confident that he is backed by the "know how" of large organization and practical experience on a national scale.

It is essential that first aid training in the Bell System be maintained at a high level. To meet these high standards, the instructors must continue to be conscientious about their work, know first aid and have developed a

First Aid and Safety Go Hand in Hand

Employees trained in first aid are doubly conscious of the need for working safely. This safety creed has been adopted by and is prominently displayed throughout the Bell System

high degree of skill in its application, and know how to train others. Bell System instructors meet these requirements; and the American Red Cross, the American Telephone and Telegraph Company, and the Associated Companies have a great appreciation of the loyal and devoted service rendered by the many instructors who, year after year, contribute their time and enthusiasm to inculcating the knowledge of first aid among the men and women of the Bell System and, perhaps no less importantly, among the public.

First aid knowledge may be considered a valuable personal tool; for the wish to lessen suffering, when combined with the ability to do so, results in a keen satisfaction which is its own reward. Now, with our nation at war, all first aiders realize that through their training they are able to help conserve manpower and check the interruption in war production caused by accidents while at work and when off the job. This is a definite, personal contribution to defense. First aid training repays each individual many times for the relatively few hours required to obtain the training.

A. T. & T. STOCKHOLDERS IN TWO WARS

An Increase in Owners from 59,415 to More Than 640,000 Between 1914 and 1942 Has Been a Vital Factor in Enabling the Bell System to Serve the Nation in Peace and War

By CLINTON S. VAN CISE

At the end of 1914, shortly after World War I broke out in Europe, the stock of the American Telephone and Telegraph Company was held by 59,415 stockholders. The growth which has occurred in ownership of the stock since that time has been a vital accompaniment to the growth in the Bell System. Today there are in each of three states, New York, Massachusetts, and Pennsylvania, more A. T. & T. stockholders than there were in the entire country in 1914, and with a current roster of more than 640,000 holders the total stock list is now almost eleven times larger.

Under the restrictions and rationing which are now being imposed on every hand, it is easy to forget the extent to which things changed in the years from 1914 through 1941. In that period, however, an astonishing development took place in our mode of living. The automobile completely emerged from the luxury class, air travel became routine, our movies acquired sound, and listening to the radio developed into a national pastime. In 1914 the completion of the transcontinental telephone line between New York and San Francisco represented a triumph of Bell System engineering. Today there is more telephone talk between New York and San Francisco than there was then between New York and Cleveland.

The factor of population growth, from 99,000,000 in 1914 to 134,000,000 in 1941, would alone have involved a 35 per cent increase in the nation's production and service equipment to maintain our scale of living. In actuality, however, the increase in the nation's capital assets was far outstripping population growth until we were overtaken by the most prolonged depression in our history; so that, even with this interruption, we were enjoying at the onset of the present war a scale of living which could only have been created and served by a marked expansion in corporate enterprise under our peculiarly American formula.

It is obvious that, as our standard of living rose, the telephone would become a greater factor in our business and social life, provided costs could be kept within reason by development of the art. Whereas in 1914 there was one telephone for every ten persons in the United States, there was one telephone for every six persons at the end of 1941. And even before the stimulus of the war emergency, these telephones were in use more of the time. Daily telephone conversations over Bell System wires, which averaged 23,000,000 in 1914, rose to 84,000,000 in 1941, and the total investment in telephone plant to render this service increased more than five fold. To finance this growth in telephone plant, investors added to the capital account of the Bell System from 1914 through 1941:

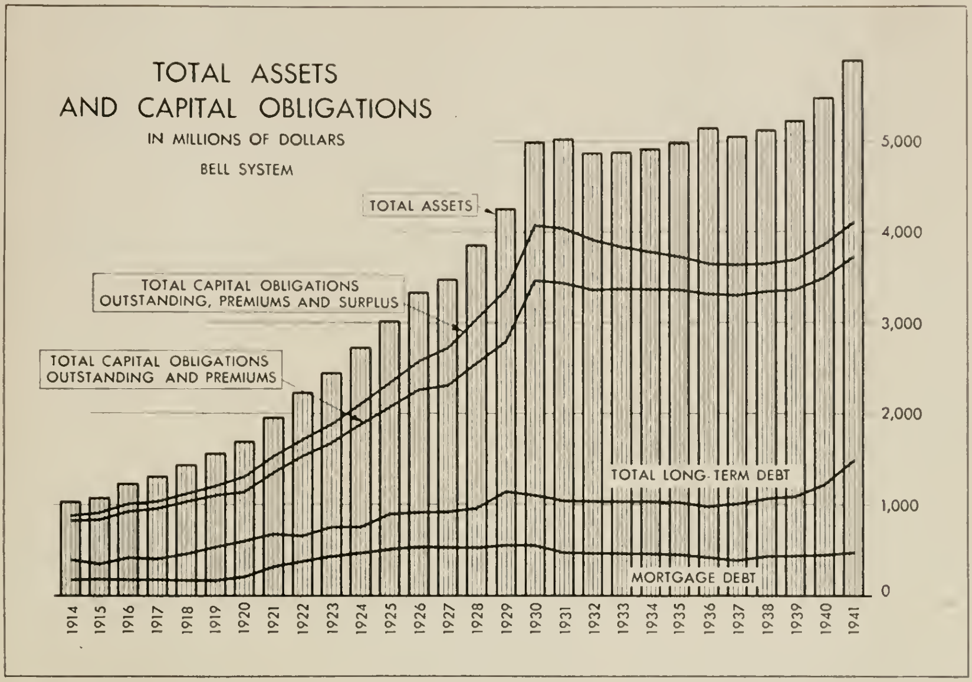
Through purchase of A. T. & T. stock	$1,770,000,000
Through purchase of stock of subsidiary companies	55,000,000
Through purchase of Bell System bonds and notes	1,081,000,000
Total	$2,906,000,000

These millions of dollars are counters of work and materials that have gone into constructing the Bell System, but they are also much more. They represent the day-by-day savings which have been put directly into the business by people throughout the country and in all walks of life: the corner druggist, the school teacher, men in shop and field, clerks and stenographers, housewives in tens of thousands. They also represent the bits of capital which thrifty people have put into savings accounts, life insurance policies and old age annuities, and which in part have found their way into the Bell System through purchases of its bonds by savings banks and life insurance companies. Too small in themselves to accomplish much, such bits of capital have aggregated enough in total to be a vital factor in financing the great industries of the nation which look to the public for their capital needs.

At the end of 1914 there were in the United States perhaps 1,000,000 holders of common stock. Among these, the owners of A. T. & T. stock, numbering more than 59,000, composed the second largest group. By the close of World War I, however, the owners of A. T. & T. stock had increased to 112,000 outnumbering other stockholder groups, and ever since they have exceeded in number the stockholders of any other American company.

Although owners of A. T. & T. stock now exceed 640,000 in number, almost eleven times the total in 1914, the essential character of the ownership is much the same. At that earlier date, the stock was already widely held, and such changes in distribution as have since taken place have only served to broaden this ownership. Then, as now, no single stockholder or small group owned a controlling interest or even a large proportion of the shares, and no individual owned as much as one per cent of the total. The holdings of owners of 100 shares or more have declined since 1914 from 69 per cent to 49 per cent of total; shares in the hands of foreign holders have decreased from 4 per cent to 2 per cent of total; and shares held in brokers' names have dropped from 5 per cent to 1½ per cent of total.

Numerically, ownership of the stock by women has shown the greatest

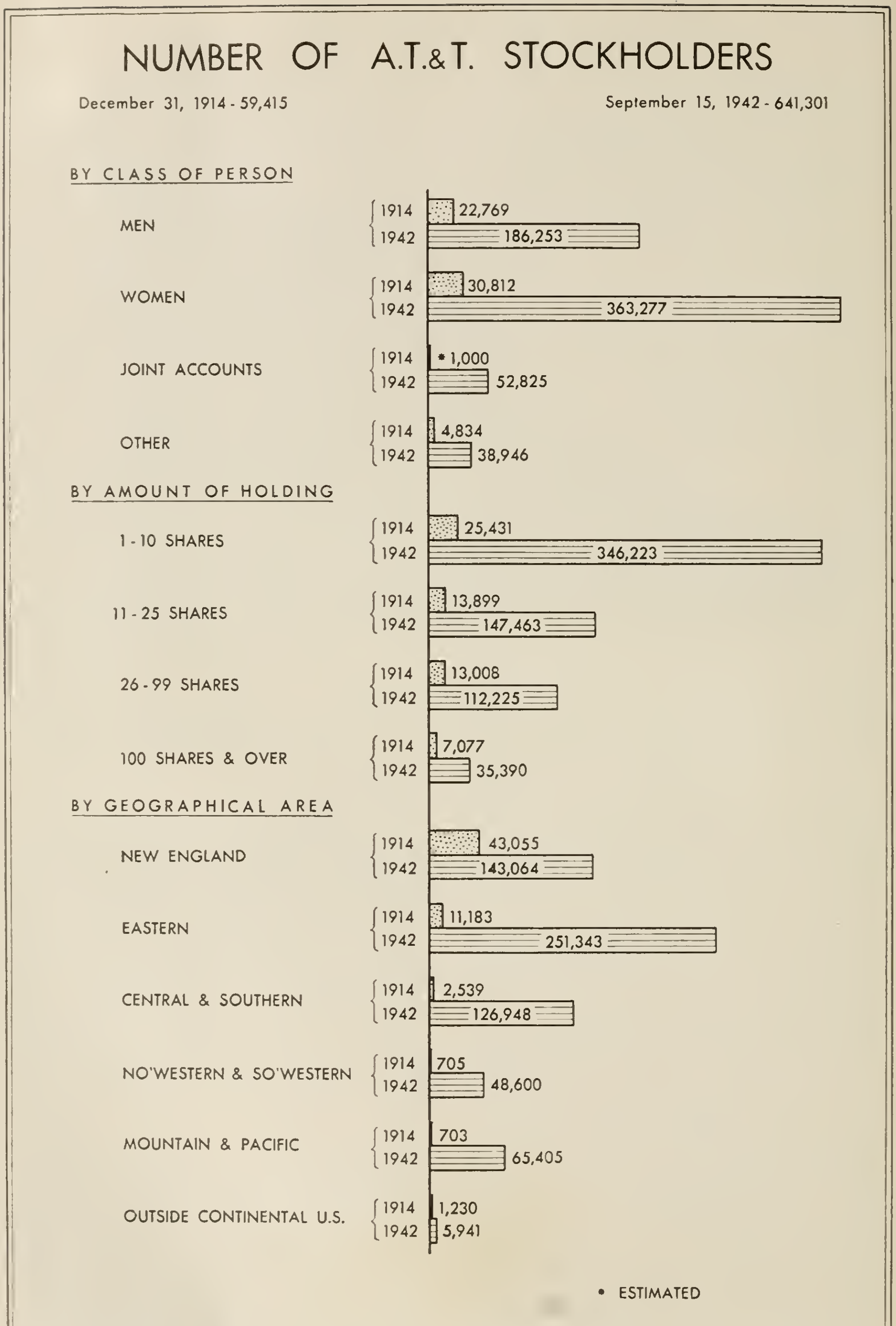


Growth of the Bell System over the years indicates the increasing value of telephone service to the nation.

increase. Approximately 363,000 women are today registered shareholders of the company, as compared with approximately 30,800 at the end of 1914, and they now own 43 per cent of the stock. A type of investment holding which has become increasingly popular in recent years is the joint account of two owners with right of survivorship. More than 50,000 joint holdings are now registered on the stock books of the Company. Approximately 186,000 men are registered shareholders today, as compared with approximately 22,700 at the end of 1914, and they now own directly 28 per cent of the stock. About 62,000 owners are Bell System employees.

A less numerous but still important group are the trustees who hold A. T. & T. stock. There are, in all, 32,000 trust accounts on the books, with a registered ownership of $190,000,000 par value of the stock, representing in themselves a sizable stock list. Institutions, corporations, and private firms compose the remaining 6,800 registered owners. In this group there are many religious organizations, schools, colleges, hospitals, and similar eleemosynary institutions.

GEOGRAPHICALLY and in the size of individual holdings, the ownership of the stock is in general accord with the investment wealth of the country—although there is still a somewhat higher ratio of ownership in New England, where the telephone was invented and originally financed. In each of six states there now live

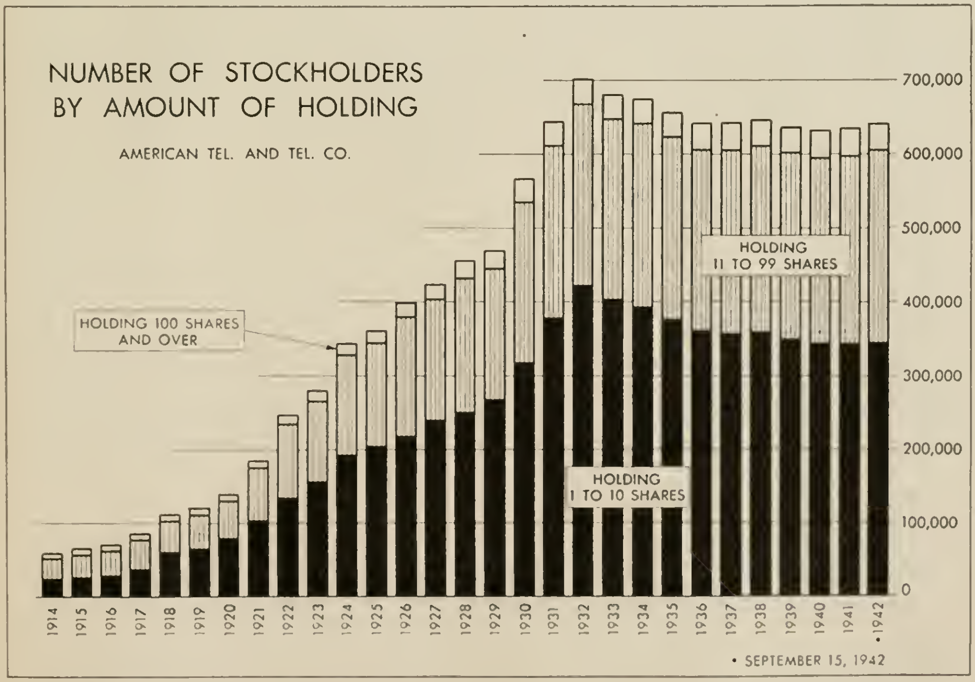


About 71% of A. T. & T. stock is held by men and women, 5% in joint accounts, 22% in the names of trustees, insurance companies, corporations, private firms, etc., and less than 2% in the names of brokers.

40,000 or more owners of A. T. & T. stock; in each of seventeen states there are between 5,000 and 40,000 owners; and in no state are there less than 400 owners. A large representation of stockholders, of course, reside in the bigger cities of the country, but they are numerous in the smaller communities also. For example, a study made some years ago of the ownership of the stock in Pennsylvania revealed that A. T. & T. stockholders resided in three-fourths of its cities and towns of more than 1,000 inhabitants.

While it may be stated statistically that the average holding per stockholder is 29 shares, representing roughly $3,900 in equity book value, on the other hand approximately 493,000 stockholders actually have holdings of 25 shares or less each, and 207,000 have holdings of five shares or less each. Holders of 100 shares or more each, who own 49 per cent of the total stock, number 35,000. In this group are some 825 holders of 1,000 shares or more each, owning 15 per cent of the stock, but a majority of these are banks and brokers, investment trusts, insurance companies, and other fiduciaries who hold the stock for the beneficial interest of a great many others. It is estimated, for example, that banks and brokers hold the stock for more than 10,000 customers, investment trusts for more than 135,000 investment trust certificate holders, and life insurance companies for more than 3,000,000 policyholders.

The composition of the stock list by the length of time shareholders have retained their ownership interest



Average holdings per stockholder are now 29 shares as compared with 56 shares in 1914.

is indicative of the usual intention of shareholders to invest their money for the long run. Of the present holders, approximately 340,000 have owned the stock for more than ten years and another 120,000 for more than five years. It is estimated that 12,000 stockholders, or 20 per cent of the total owning stock back in 1914, still have A. T. & T. shares registered in their names. This represents an average reduction of 3 per cent per year in the number of such stockholders for the period from 1914 through 1941.

WHILE the A. T. and T. Company may be the most widely owned enterprise in the country, many others are owned on a similar scale in relation to their size. There are now in excess of 20 corporations with more than 100,000 stockholders each, and for industry as a whole the grand total of common stockholders is estimated to be between eight and nine million. This number represents a substantial but by no means a stratified segment of the population, for it includes all classes of people who have shared the incentive to save and invest. A generous proportion of them, to be sure, are women, and a large number are doubtless elderly people. And with the country at war, there must be many thousands in our fighting forces.

The great broadening of stock ownership which occurred in the years between World War I and World War II has been by no means the least important among the social developments in this country. Nowhere else has there been so widespread a source of the venture money of people who believe in their country's future and want the risk and profit of ownership. This habit of investment by great numbers has been an evidence of our high standard of living, but, more than that, it has played a vital part in the production which made that high standard possible.

FOR THE RECORD

IN THE ARMED SERVICES

Some 29,000 male employees of the Bell System are in the nation's armed forces as this issue of the Magazine goes to press. A number of women employees are now in the auxiliary services. Since the publication of the last list, of 59 names, in the August issue, the following 30 members of the General Departments of the A. T. & T. Company have gone into the military services:

Charles R. Abels, Messenger, Information Dep't	Private, U. S. Army
Charles H. Albin, Clerk, Information Dep't	Aviation Cadet, U. S. Army
William S. Baker, Jr., Trimmer, Gen'l Serv. Bureau	Private, U. S. Marine Corps
Clefton R. Beck, Jr., Senior Clerk, Comptroller's Dep't	Apprentice Seaman, U. S. Navy
Hilda T. Berry, Clerk, O. & E. Dep't	Auxiliary, Women's Army Aux. Corps, U. S. Army
Erich G. Brunngraber, Jr. Statistician, Comptroller's Dep't	Private, U. S. Army
William L. Cronk, Messenger, Information Dep't	Private, U. S. Marine Corps
Henry G. Dudley, Physician, Pers. Rel. Dep't	Lieut. (j.g.), Medical Corps, U. S. Navy
Donald A. Field, Jr. Statistician, Comptroller's Dep't	Lieut. (j.g.), U. S. Navy
Hugh Gillespie, Jr. Draftsman, Gen'l Serv. Bureau	Private, Air Corps, U. S. Army
Kenneth W. Haemer, Jr. Statistician, Comptroller's Dep't	1st Lieut., S.O.S., U. S. Army
Allan C. Johnson, Engineer, O. & E. Dep't	Captain, Engineer Corps, U. S. Army
Willard W. Kelsey, Accountant, Comptroller's Dep't	Private, U. S. Army
Edmund C. Lehr, Clerk, Treasury Dep't	2d Lieutenant, U. S. Army
Robert Leopold, Jr. Statistician, Comptroller's Dep't	Private, U. S. Army
Clifford A. Lohr, Messenger, Gen'l Serv. Bureau	Private, U. S. Marine Corps
Paul F. Nagle, Engineer, O. & E. Dep't	Lieutenant, U. S. Navy
John J. O'Brien, Senior Clerk, Treasury Dep't	Chief Storekeeper, U. S. Navy
Norwood C. Potter, Statistician, Comptroller's Dep't	Major, Ordnance Dep't, U. S. Army
Howard G. Raymond, Clerk, O. & E. Dep't	Private, U. S. Army
John L. Riker, Physician, Pers. Rel. Dep't	Captain, Medical Corps, U. S. Army
Paul S. Rippier, Senior Clerk, Comptroller's Dep't	Private, U. S. Army
David R. Rutter, Engineer, O. & E. Dep't	Lieutenant, U. S. Navy
Albert J. Schaufler, Type Stamper, Gen'l Serv. Bureau	Private, U. S. Marine Corps
James L. Schulte, Type Stamper, Gen'l Serv. Bureau	Private, Air Corps, U. S. Army
John Seehof, Photostat Operator, Gen'l Serv. Bureau	Private, Air Corps, U. S. Army
Edward L. Sherman, Engineer, O. & E. Dep't	Lieutenant, U. S. Navy
Theodore L. Simis, Trimmer, Gen'l Serv. Bureau	Private, Signal Corps, U. S. Army
Arthur J. Squires, Clerk, Comptroller's Dep't	Apprentice Seaman, U. S. Navy
John M. Stewart, Messenger, Gen'l Serv. Bureau	Apprentice Seaman, U. S. Navy

J. H. RAY ELECTED VICE PRESIDENT–GENERAL COUNSEL, SUCCEEDING THE LATE C. M. BRACELEN

At the meeting of the Board of Directors on October 21, John H. Ray was elected Vice President and General Counsel of the American Telephone and Telegraph

Company. Mr. Ray has been Counsel of the company since 1936. During nearly 20 years of service with the Bell System he has also served as Vice President and General Counsel of the Western Electric Company and, before that, as General Solicitor of the A. T. and T. Company. Prior to joining the A. T. & T. Co. in 1923, he practiced law in Minneapolis. In his new post Mr. Ray succeeds the late Charles M. Bracelen.

Mr. Bracelen, Vice President and General Counsel of the A. T. & T. Company for more than 16 years, died October 8 at his home in New York City. He was 64 years old. Mr. Bracelen joined the company in 1918 after spending several years in general legal practice in Minneapolis. He was a graduate of the University of Nebraska, class of 1902, and later studied law there and also at Creighton University, Omaha. After coming with the company in 1918, Mr. Bracelen temporarily went into Federal government service in the office of the Postmaster General, where he handled litigation arising out of war-time government control of wire systems. In 1919, when telephone and telegraph systems were returned to private management, Mr. Bracelen resumed his service with the American Company, first as an attorney, then as General Solicitor in 1921, as a Vice President in 1924, and two years later in the post he held at his death.

INDEX TO VOLUME XXI AVAILABLE

An Index to Volume XXI (1942) 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, N. Y.

CONTRIBUTORS TO THIS ISSUE

Entering the first Officers' Training Camp at Fort Sheridan, Ill., as a student artillery officer, at the time of graduation from the University of Wisconsin with the B.S. degree in chemical engineering in 1917, Keith S. McHugh was commissioned a First Lieutenant in the Ordnance Department three months later. He became an instructor in machine guns and small arms at Springfield Arsenal, and was later made commanding officer of the national machine gun and small arms school at Camp Hancock, Ga., before sailing overseas as a Captain in September of 1918. Returning to this country in February, 1919, he joined the A. T. & T. Company as a clerk the following month. From July, 1919, to November, 1921, he was an engineer in the O. & E. Department. He was then for three and a half years General Commercial Engineer of the Chesapeake and Potomac Telephone Company in Washington, D. C. For the next four years he was General Commercial Manager of the Upstate and then of the Long Island area of the New York Telephone Company, and became a Vice President of that company in May of 1929. In October of that year he became Commercial Engineer of the A. T. & T. Company; was appointed an Assistant Vice President in December, 1934; and in January of 1938 was elected a Vice President.

Graduated from Dartmouth College with the B.A. degree in 1909, Harold M. Prescott entered the Bell System two years later as a traffic student with the Pacific Telephone and Telegraph Company at Los Angeles. He was engaged in traffic work on the Pacific Coast for 17 years; from 1919 to 1925 he was general toll supervisor, and division traffic manager from 1925 to 1928. In the latter year he transferred to the A. T. and T. Company as head of the central office results group in the Department of Operation and Engineering. In 1929 he became Traffic Results Engineer, and on January 1, 1940, was appointed Traffic Engineer of the company. He is the author of "Toward a More Pleasing Service," in the Bell Telephone Quarterly for April, 1940.

Graduated from the University of Kansas in 1915, Austin Bailey received his Ph.D. degree from Cornell University in 1920, after having served during the World War as a Second Lieutenant in the Signal Corps, assigned to the radio laboratories at Camp Alfred Vail (now Fort Monmouth). In 1920 he accepted a position as superintendent of the apparatus division of Corning Glass Works, leaving this in the Fall of 1921 to become Assistant Professor of Physics at the University of Kansas. He joined the Bell System in 1922, his first assignment being on radio problems in the Department of Development and Research of the American Telephone and Telegraph Company. Dr. Bailey was sent to England and Scotland in 1926 for a year's work in connection with the establishment of the first commercial transatlantic radio telephone circuit. In 1934 he was transferred to the Bell Telephone Laboratories, where he continued with the development of radio for Bell System applications. In 1937 he returned to the A. T. and T. Company, in the Department of Operation and Engineering, where he has since been engaged with the technical aspects of numerous radio projects, such as ship to shore, overseas, emergency, point to point, and vehicular services. He has contributed to several Bell System publications articles dealing with various aspects of radio telephony—most recently as co-author of "New Channels for Old," in the issue of this Magazine for August, 1941.

Receiving the B.A. degree from Lafayette College in 1907, and the LL.B. degree from New York Law School in 1909, Robertson T. Barrett practiced law until 1918, and for the next three years was engaged in newspaper work. He joined the Information Department of the A. T. & T. Company in 1921; and since 1936, when he was appointed Historical Librarian, he has combined the duties of that post with other departmental activities. He is editor of the *Telephone Almanac,* and has contributed a number of articles to the Magazine, the most recent being "The Conquest of a Continent," in the issues for July and October, 1940, and February, 1941.

Entering the University of Kansas in 1916, Erle S. Miner left school in 1917, a few days after the beginning of World War I, to enlist in the 35th Division of the United States Army. Returning from overseas in 1919, he reëntered the University and received his B.S. in E.E. in 1922. He then joined the Southwestern Bell Telephone Company at Topeka, Kansas, and for the next four years worked on various plant department assignments, including those of central office repairmen, toll engineer, exchange engineer, and district plant chief. In 1926 he was transferred to the general plant supervisor's office of the Southwestern Company in St. Louis to assist with construction methods and results work. After a year, he was appointed general plant installation supervisor, and later became general plant training supervisor. In 1929 he was transferred to the A. T. and T. Company to work on plant training problems in the Operation and Engineering Department. From 1933 to 1936 he served on a committee handling problems affecting the Bell System in connection with the NRA Codes. In 1937 he became Safety Engineer, the position he now holds. During the last two years Mr. Miner has been closely identified with the Bell System first aid training program as part of the safety engineering assignment. He is author of "Safety in the Bell System Companies," which was published in the BELL TELEPHONE QUARTERLY of October, 1939.

ENTERING the Bell System in 1914, after graduation from Williams College with the B.A. degree, CLINTON S. VAN CISE was employed in the accounting department of the New York Telephone Company. He saw service on the Mexican border in 1916; and he was commissioned as First Lieutenant in the Ordnance Corps in 1917 and was discharged in March of 1919 with the rank of Captain in the Reserve. He returned to the New York Company, but later that year took a position with an investment firm, with which he remained until the close of 1920. On January 1, 1921, he joined the A. T. & T. Company in the statistical division of the Comptroller's Department. Later that year he was transferred to methods work in the Treasury Department. On January 1, 1923, he became Assistant to Treasurer, and the following March he was appointed an Assistant Treasurer. In the Treasury Department, he heads the administration division.