BELL TELEPHONE MAGAZINE

VOLUME XX, 1941

INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

PRINTED IN U. S. A.

BELL TELEPHONE MAGAZINE

VOLUME XX, 1941

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VOL. XX | FEBRUARY, 1941 | NO. 1

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE MAGAZINE

Continuing the BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

VOL. XX FEBRUARY, 1941 NO. 1

PAGE

Published by the Information Department of the
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York, N. Y.

SERVICE TO THE NATION
IN PEACE AND WAR

Bronze and marble group in the lobby of the American Telephone and Telegraph Company building, New York

THE BELL SYSTEM AND NATIONAL DEFENSE

The System's Nation-wide Organization and Capacities Enable It to Meet the Vast Needs of the Armed Forces and of Industry for the Services and Equipment So Vital to the Defense Program

By JUDSON S. BRADLEY

On the wall of an inner office in the Bell System's headquarters building in New York hangs a large map of the United States. It is studded with a mosaic of more than 400 vari-colored pins. They cluster along the seaboards, are thick in the south and the industrial mid-west, scatter seemingly without pattern in other parts of the country. Were one to journey to all the places designated by those bright pin-heads, he would see much of the nation's defense activity: columns of marching men, and men spread thin in skirmish line; rows of tents, and barracks springing up over vast areas; the long runways of airports, and bulldozers knocking down hills to make more; pile drivers hammering away at new docks, and sleek gray vessels taking shape on the ways; huge factories in various stages of construction. For each pin in that map marks a point where the Bell System operating companies are providing communication facilities for a military or naval establishment—Army training camp, naval base, Coast Guard station, aviation field, ordnance or airplane plant.

Inspiring would be such a comprehensive view of the country's defense program. And it would gain in interest for System people because at each point visited there would be—either actually or figuratively—telephone men at work.

The Bell System's capacity for this and other defense work was the theme of a radio broadcast by President Gifford, and of an advertisement in magazines of nation-wide circulation, a few months ago. Current advertisements include the statement, "The Bell System is doing its part in the country's program of national defense." Such pledges are, necessarily, generalizations. To the question of what the System's part is, and how it is doing it, there are, in detail, many answers. Of these that pin-studded map is a partial summary.

A city of 40,000 or 50,000 is a sizable community. Such a place represents many years of growth. It has a history, traditions, an individuality. Among the many services which have grown with it through the years is that of the telephone. Yet today "cities" of that size are being built,

THE CAPTAIN GOES UP

The Post Signal Officer of a huge Army camp examines the fine points of a splice in an Army cable just completed by the Bell System men on the ground

constructed from the ground up, in the course of a few months, at a number of locations in the United States: Army camps for the young Americans who are to receive a year of military training, for members of the National Guard who have already been called out by Presidential order. And for those "cities" telephone service must be provided—likewise, in many cases, from the ground up. Smaller camps—and there are many—present the same problem in scale. Government-owned munitions and aviation plants must have service too. So must the Federal housing projects which are planned or going up near many of the cantonments and factories.

As President Gifford pointed out, the Bell System is able to provide that service, and the necessary equipment, through systematic planning, ample stocks and manufacturing capacity, skilled and loyal men and women; and through and with full coöperation between all branches of the System and all branches of the Government concerned in the defense effort in all its many aspects.

Service to the Many Camps

THE nation's defense program centers in Washington, of course. There the American Telephone and Telegraph Company has for some years maintained an office, in order that it may be in a position to coöperate quickly and completely with the various government departments. Word is received there as soon as a decision has been reached to construct a new Army camp or expand an existing post, to set up an Army or Navy air base, to build a munitions or airplane plant. First definite news may include not much more than the location, the size of the establishment, an estimate of the communication requirements, and the expected dates for start of construction and for occupancy. But that is enough to put the wheels in motion.

All available necessary information is flashed to the Associated Bell Company in whose territory the project is to take shape, to the Western Electric Company, the System's manufacturing and supply arm, and to A. T. & T. headquarters in New York. Certain preliminary deductions can be made at once. A camp for a given number of troops will require a private branch switchboard to serve a certain number of lines; about so many feet of distribution cable; an estimated number of public telephones and booths for the convenience of the men. The telephone company's engineering, plant and commercial officials, Western Electric's local distributing house manager, confer, plan. Western can look ahead, schedule tentatively.

Service *on* the post is only part of the story, however. What about service *to* the post? Big new military establishments are being built in thinly populated territory, often miles from the nearest town. And that may be a small town, receiving telephone service through a switchboard ample for the needs of its few residents but not originally engineered to handle the number of calls which will flow to and from a camp where the daily life and training of thousands of men are being administered. In such case, the central office switchboard will have to be enlarged, perhaps two or three fold. An addition to the building may be necessary. In more than one instance, an entire new central office has been created near the camp as the most satisfactory solution of the problem.

Do a few open wires run past the site of the proposed camp? Those poles should be carrying cable too by the time the constructing Quartermaster and the contractors have opened their field offices and are ready for service, providing pairs later for

FULL CO-OPERATION

Signal Corps and Bell System men working on an Army cable close to the camp telephone headquarters in the background, where Western Electric has installed a multiple P.B.X.

READY ON TIME

Three months, to the day, after ground was broken, this new central office was ready to give service to a big camp located between two small towns. The 30-position switchboard is the largest of its type in the Bell System, and space has been provided for another 30 positions if they should be needed

the Army's P.B.X. too. What about toll circuits? The facilities will in all probability have to be enlarged to handle a sizable increase in long distance calls.

All these things are reviewed by the operating company and Western Electric. They discuss, plan, on the basis of experience and present knowledge. A. T. & T. staff men are always available for consultation.

MEANWHILE, the picture takes on constantly clearer definition. Supplementary information in more and more detail becomes available: in Washington, from the War Department or the Navy Department, as the case may be; from the headquarters of the corps area or the naval district. Plans for the camp become definite, the scheduling of telephone equipment and construction can proceed with assurance. The Government signs the order for service—but that is nearer the last step than the first, for much has gone before.

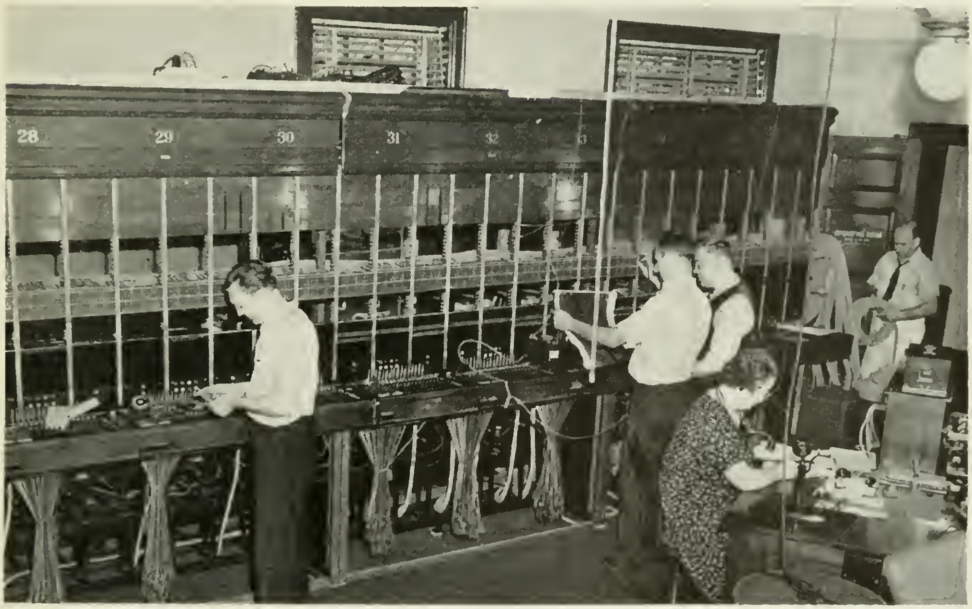
A big camp does not go up literally over night; it takes time to build. So does telephone equipment. Those two facts are complementary. Thanks to the opportunity for advance planning in the field, preliminary scheduling of manufacture, and ample shop facilities, "shipped same day ordered" is a frequent notation against Western Electric's record of the disposition of some piece of apparatus for Government service. Central office switchboard sections must be added, larger quarters provided, cables run, more operators provided and trained—all on schedules carefully worked out to meet the needs for service.

Not all of the Government's defense projects are as large as some of the huge new Army cantonments. Nor do all of them require the manufacture and installation of large amounts of plant and equipment, since some call simply for additions to existing facilities. But communication is vital to them all, and the defense program does call for new service or additions to existing service at Army and Navy headquarters in Washington, at Corps Area and District headquarters, at regular Army posts, Army air bases, anti-aircraft firing centers, National Guard concentration camps, replacement centers for draftees, Quartermaster supply depots, National Guard aviation units, Coast Artillery units, Coast Guard stations, Marine Corps bases, present naval bases, naval air bases, naval training stations, ordnance and airplane plants, hospitals, and housing projects.

Some of these establishments are located in the territories of independent telephone companies. They too furnish the Government with nation-wide long distance service through connection with the Bell System network.

In normal times, the Army buys, builds, maintains and operates its own telephone systems and its own fire-alarm systems at the larger permanent posts on Government reservations. It always builds, maintains, and operates its harbor defense fire control and target range systems. An agreement of long standing with the Bell System covers the furnishing of and payment for lines to the telephone company central offices; similar agreements are in effect with the independent telephone companies concerned.

Said Major John G. Grable, Signal Corps, U. S. A., in an address before the U. S. Independent Telephone Association:



CENTRAL-OFFICE ENLARGEMENT

An addition was made to the building and the switchboard was more than doubled in this central office, in anticipation of the telephone needs of a near-by Army cantonment

ARMY SWITCHBOARDS

Communication on a post is provided through a Private Branch Exchange switchboard, either manual or dial, as needed, which also connects with a telephone company central office. Above: A Bell System P.B.X. instructor trains an Army operator. Left: A Western Electric installer discusses circuit layouts with members of the Signal Corps

"The Chief Signal Officer wishes to express his appreciation of the excellent coöperation that has been rendered during the present emergency by commercial telephone companies and manufacturers of telephone material and equipment. Without a single exception, the demands made by the Army for service and for rush shipments of material and equipment—and I would like to say that many of those requests have been of such a nature that they would appear impossible in other circumstances—have been met right on time and every effort made to assure that the service and equipment are satisfactory."

Research and Manufacture

ONLY the most general mention may be made of certain special undertakings which both the Bell Telephone Laboratories and the Western Electric Company are carrying out directly with and for the Army and Navy.

Since the Laboratories is one of the major development organizations in the communications field, it is natural that its unique knowledge and facilities should be directed toward defense measures where they will be of greatest value. The adaptation of telephone circuits to serve new and special needs, and the application of scientific principles to the solution of new problems, are matters currently receiving major attention. It is also reassuring to know that substitutes have been developed for certain materials which have become difficult to obtain in recent years, and that research along these lines is actively continuing.

Similarly, the Western Electric specializes in the methods and manufacture of communication equipment. In Western's Specialty Products Division, wheels hum and lights burn late to turn out communication equipment of many kinds ordered by and to be delivered directly to the Army and Navy. The full implications of that statement may best be understood from the brief explanation that the value of these orders, at the beginning of the present year, is about $31,000,000.

Aircraft Warning Service

For a number of years, the Bell System and independent telephone companies have coöperated with the Army, during various military maneuvers, in technical exercises looking

HELPING TRAIN SIGNAL CORPS INSTRUCTORS

The Signal Corps men shown here are going through a complete Bell System Plant School course, including the various phases of construction and maintenance (right) as well as class-room instruction (below). They will, in turn, become instructors in their battalion

CAMOUFLAGED BATTALION COMMAND TELEPHONE POST

During maneuvers and field exercises, Signal Corps men simulate war-time conditions. The equipment shown here is of Western Electric manufacture

toward the establishment and operation of an Aircraft Warning Service.*

Briefly, a corps of observers is organized from the civilian population to man observation points located throughout large sections of the country. Each observation post is provided with telephone facilities which permit reports of hostile airplanes seen or heard by the observers to be flashed directly to Air Defense Command operation centers, where officers direct defense measures against the invading bombers. Observers' reports are handled with special priority and by special operating methods over the regular communications network of the telephone companies.

A large-scale test of the effectiveness of such an aircraft warning service took place in the northeastern part of the country early this year. The Bell System's experience, gained in earlier similar activities, was placed at the service of the Army, and telephone company officials in the territory covered worked closely with officers of the Air Defense Command in charge of the exercises.

Service to Expanding Industry

THE Army and Navy have long been known as our first line of de-

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

fense. But against the kind of war being waged today, is Industry any less so? Each day's newspaper headlines, the newscasters' radio summaries, the grist of reports and statements from Washington, have made the answer familiar to everyone; it is *no*. To Industry the nation looks for the things which make defense possible, from ships and shoes to—perhaps—sealing wax; there is no need to recount here the multiplicity of products, from uniforms to airplanes, which the country's defense program requires for fulfillment.

Equally well known is the manner in which Industry is responding to the pressing need: speeding up production, doubling and tripling ultimate capacity by additions to existing plants and the construction of new buildings.

To this aspect of defense, communication is as vital as it is to the Army and Navy directly. Administration of a vastly expanding business calls more than ever for telephonic intercommunication within a plant, for adequate facilities for local and long distance services. A P.B.X. switchboard which has long been quite sufficient must now be replaced, almost over night, by one two or three times its size. New central-office connections must be provided. Cables must be run from the firm's main office to serve telephones in new buildings, and wires must be run in those. It is not unusual in the experience of more than one Bell System company to find

NEW SWITCHBOARD FOR THE NAVY

A yeoman stands by at this P.B.X. recently installed to serve a Naval District headquarters

THE PELORUS WATCH STANDS BY

Bearings on objects, or on other vessels, are communicated to the Navigator by telephone

it expedient to assign several plant men regularly to one expanding industrial establishment, simply to take care of the day-to-day requirements for changes and extensions of telephone service.

All this is occurring not in occasional isolated instances, nor even here and there, but in hundreds of plants working on Government orders all over the country. And here, again, the Bell System generally finds it possible to meet Industry's requirements for service and equipment adequately and promptly.

And, obviously, there must be, and is, provision for an increasing use of telephone service which reflects the heightened tempo of activity throughout the nation.

The Country's Telephone Network

IN aerial wire lines and in cable the Bell System and the independent connecting companies have nearly one hundred million miles of wire. These wire facilities are used to interconnect the nearly twenty-two million telephones which are served by some nineteen thousand central offices throughout the United States. On a map of the country the lines are suggestive of a loosely and irregularly woven fabric overlaying the entire nation.

For the past twenty years or more, construction of toll and long distance lines has been planned not only to furnish the circuits necessary to meet an increasing use of the service but also to provide alternative routes between the country's largest cities. The purpose, of course, has been to insure maintenance of communications in almost any contingency. As a result, today the Bell System has access, telephonically, to every major city over several different routes. In this way, even though an accident should completely disrupt service over one route, a detour will usually continue the flow of calls with little or no delay to traffic.

Traffic control bureaus for the longer haul routes are located in New York, Cleveland, and Chicago. They keep a general watch over the ebb and flow of traffic throughout the country, and manipulate the supply of circuits to meet the constantly changing pattern of traffic.

Due to anticipated defense requirements and to the general stimulation of business which accompanies the defense program, the Long Lines Department of the American Telephone and Telegraph Company increased its 1940 construction program to $21,-000,000, which was $9,000,000 above the amount spent in 1939. The Associated Companies also increased their building programs during 1940 above those of the previous year by amounts depending upon their several requirements.

Chief among the major projects of this construction program were a new underground cable laid last year between Baltimore and Washington at a cost of about $1,000,000; and the start of construction of a new cable between Omaha and Denver. This cable will be pushed through to California, and will connect the long distance cable network serving the East with that which serves the Pacific coast.

Last year communications facilities along the eastern seaboard routes were supplemented by important additions on various links all the way from Boston to Florida. Here, "carrier" systems provided many new channels along the Atlantic coast, as did they also along the fourth transcontinental line from Oklahoma City to Los Angeles.

An important extension scheduled for this year is that of twin underground cables linking Richmond and Norfolk, Va., to serve Norfolk, Newport News and the vicinity, where there are concentrated extensive ship building, naval, and army activities. Others planned for the next few years include twin underground cables about 700 miles in length, from Atlanta, Georgia, to Miami, Florida; a new cable between Los Angeles and San Diego; and twin cables between Seattle and Portland. A second cable to be placed along each of several existing routes will substantially increase long distance

THE FIRE ROOM WATCH AT SEA

On a modern battleship, the fire room watch maintains telephonic communication with other departments facilities into the southwest, where Army activities on a large scale, particularly aviation, will be centered. This program envisions by the end of 1943, exclusive of the transcontinental route mentioned above, cable construction on more than 4,000 miles of principal toll routes which are now served by open wire.

The construction of these new cables will be accompanied by the extension of the network of broad band telephone transmission systems. "Carrier" systems are being superposed not only on new cable facilities but on existing cable routes. Circuits so provided are of high quality and are particularly well suited for use in establishing alternative and protection circuit routes. Each of the multi-cable routes, as proposed, can accommodate as many as 50 or more carrier systems, each of which will provide twelve telephone circuits.

Various measures, mentioned below, have been taken to protect the physical telephone plant. But above and beyond such steps as are possible to guard against injury of any kind, the greatest protection to the nation's telephone service, now so vital to the defense program, is the criss-crossing web of wire and cable which stretches from border to border and from ocean to ocean. Its very size makes it, in its entirety, unassailable, while the provision of so many alternative speechways precludes that any important place, or section of the country, should be cut off for long from the rest of the nation.

Protecting the Service

PROTECTION of every phase of the service against serious interruption, either accidental or intentional, is, of course, a highly important aspect of the Bell System's responsibility for nation-wide communications. It is not the intention to defeat the purpose of precautions which have been taken by describing them in detail or by connecting those mentioned with any definite locality. On the other hand, a summary of the more important steps taken belongs in any comprehensive account of the System's part in the national defense program.

The protective measures fall into three general groups: those dealing with personnel, those safeguarding the outside plant, and those having to do with protecting the buildings and the equipment inside them.

Before proceeding with other parts of the program, it was highly important that telephone employees—particularly those in the Plant Departments and others whose work includes actual contact with vital telephone equipment—should be acquainted with the purposes of the precautionary measures to be taken. Letters from company officers impressed upon such employees the need for protective measures, and further emphasis was given by group meetings and discussions held throughout the organizations.

STUDENT PILOT

In this Link Trainer, the naval aviation student gets his instructions by telephone while he is "in the air"

MOBILE COMMUNICATION POST

Pictured here is the interior of an Army truck, where the teletypewriter has been installed for field use

Surveys of citizenship have been made which confirm the fact that extremely few employees are not citizens, either by birth or by naturalization. Detailed information about employees—up to and including department heads—who work directly with international telephone circuits, both wire and radio, has been furnished the Federal Communications Commission at the latter's request.

Records have been prepared showing the men who are subject to call for military duty. Plans have been developed for replacing men so affected. Data relating to prospective temporary employees are being maintained with an eye to insuring an adequate service force in case of emergency.

In addition to the alternative toll routes previously mentioned, alternative toll entrance routes are being established, and other safeguards have been employed at points of importance where operating centers might be isolated through the temporary loss of toll entrance cables. Various plans are in effect for emergency routing of toll service, while other plans exist for the provision of toll service in case of serious damage to a toll building or an intermediate repeater station. Another safety precaution bearing on the outside plant is the application of continuous gas pressure to more hundreds of miles of the toll cable system.

The provision of emergency power in case of possible failure of the normal supply has received attention. A considerable number of large fixed engine-alternator sets and smaller portable sets are being added to supplement the many already available to fill the breach in the event of the temporary loss of outside power.

Other potential emergencies have been anticipated—so far as it is possible for experienced telephone men to foresee and to provide against accidents or other causes of interruption to the service. Plans already exist, for example, for the restoration of telephone service to various government buildings, hospitals, police headquarters, railroad stations and important manufacturing plants, in case the facilities serving these buildings should be damaged or destroyed.

One of the most interesting items in the emergency program is the expanding use of portable radio telephone sets, to span temporarily line breaks which would take a considerable length of time to repair and which might be so widespread as to leave no alternative routes in service.

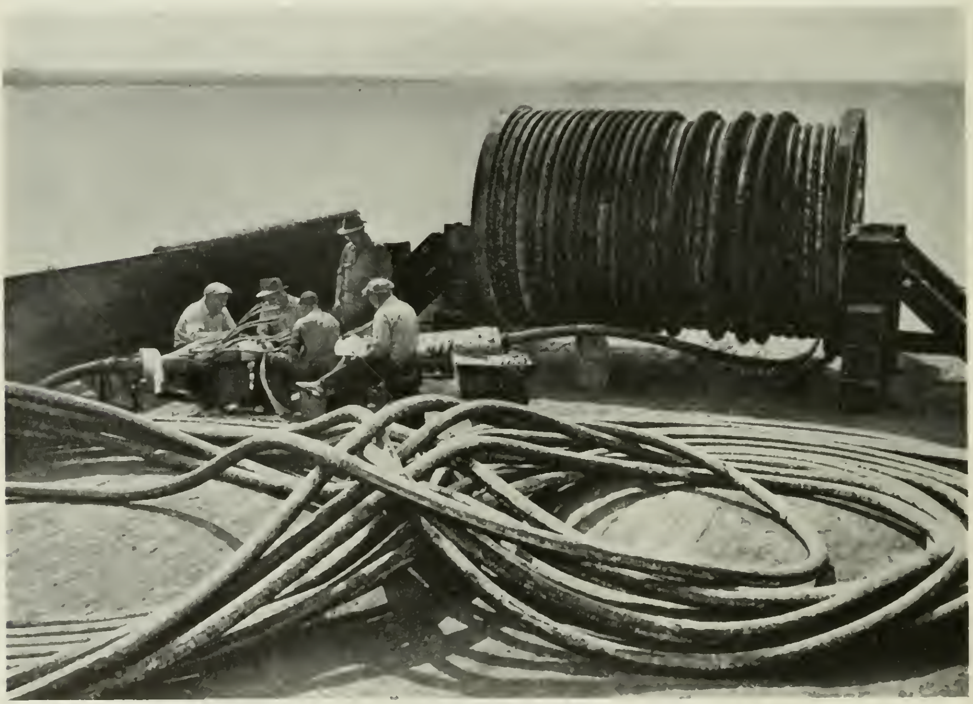
Several emergency uses in the past year or two have proved the worth of these portable radio sets in times of disaster. While each pair—sending and receiving—provides only one circuit, there are times when even one circuit is priceless. It is natural, therefore, that the Bell System companies are adding to their present supply of such equipment.

Telephone buildings — local exchanges, toll centers, test stations, repeater stations, radio telephone stations, factories and warehouses—each presents its own individual problem of protection. Particular attention has naturally been paid to guarding all means of entering buildings housing important telephone equipment, as well as their immediate surroundings. Every important telephone office has been given individual consideration and has been provided with precautionary measures, both inside and out, designed to meet its individual situation.

In response to a questionnaire sponsored by the National Association of Railroad and Utility Commissioners, the several units of the Bell System have furnished to the respective public utility commissions in the states in which they operate a large amount of information about existing and projected plant facilities, measures taken for the maintenance and restoration of service in emergency, and similar matters relating to national defense.

Men in Service

A considerable number of Bell System men who are members of the National Guard, Army and Navy Reserve, etc., are now on active duty. Operation of the Selective Service Act has taken relatively few as yet, but will no doubt call more in successive drafts. The Adjutant General has di-



SUBMARINE TELEPHONE CABLE

Laid under an eastern river recently, this speechway is an important addition to communication facilities along the Atlantic coast

PLOWING CABLES INTO THE GROUND

Pulled by two powerful tractors, the plow in the middle of this rig can cut a narrow slot in the ground from 30 to 48 inches deep, into which telephone cables from the two reels at the rear are fed as the train moves along. Under favorable conditions, several miles of cable can be buried in a day

rected that employees of the Engineering and Plant Departments who are chosen be assigned to the Signal Corps.

For men called into the service under the terms of Public Resolution No. 96 (summoning the National Guard, Reserves, etc.) or the Selective Service and Training Act of 1940, the Bell System provides, in brief, that employees will be granted a year's leave of absence, will receive credit for System service during that period, will have the protection of the Benefit Plan in the event of death, and will be offered re-employment in accordance with the provisions of the Selective Service Act. In addition, each of the Companies makes an adjustment payment to employees, for periods ranging from one or two weeks up to three months, of the difference between their Company pay and government pay.

Several System officials already occupy important posts in the defense program. Dr. Frank B. Jewett, Vice President of the A. T. and T. Company and Chairman of the Board of the Bell Laboratories, is serving as a member of the National Defense Research Committee, heading the group concerned with transportation and communication, in addition to his responsibilities as President of the National Academy of Sciences. William H. Harrison, A. T. & T. Vice President and Chief Engineer, who has been on leave of absence for some months as Director of the construction division of the production department of the National Defense Advisory Commission, has recently been appointed a chief executive of the Production Division of the Office of Production Management, in charge of ships, construction, and supplies. Still others from the A. T. and T. Company, Western Electric, the Associated Bell Companies—experts in engineering, statistics, personnel work—have been loaned to those branches of the defense effort where their experience and capabilities will have particular value.

At the request of Mr. James Lawrence Fly, Chairman of the Defense Communications Board created by Executive Order last September to determine, coördinate, and prepare plans for the national defense, President Walter S. Gifford of the A. T. and T. Company is serving on the Board's Industry Advisory Committee on behalf of the Bell System companies, and has been elected its chairman. The System has also named representatives and alternates on five of the eleven committees designated by the Board to assist in carrying out its functions by providing for continuing studies and for contact with other government agencies and with the civil communication industry. These committees are the Telephone, the Telegraph, the Radio Communication, the Domestic Broadcasting, and the Aviation Communications Committees.

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

RPB—1-2-41—50M

CONFERENCE ON AIRCRAFT WARNING SERVICE

Seated at the end of the table are President Walter S. Gifford of the A. T. and T. Company, and Major General James E. Chaney, head of the Air Defense Command during the recent test of the Aircraft Warning Service. Others in the group are Air Corps and Signal Corps officers, and officials of the A. T. & T. Co. and the New York Telephone Company. Below is a Flash Message form used by civilian observers in telephoning their reports

CONSTRUCTION SPECIALISTS

Center figure in this group, observing progress at an Army camp, is William H. Harrison, A. T. & T. Vice President and Chief Engineer, who after seven months as head of the construction division of the NDAC has been placed in charge of ships, construction, and supplies in the Production Division of the Office of Production Management in Washington

THE nation's defense program is, in size and scope, stupendous beyond description. What part the Bell System, with its Associated Companies from coast to coast, its headquarters group, its research and manufacturing organizations, is playing in this program has been but sketched in outline here.

Enough has been said, however, to indicate that the Bell System has long realized—and soberly faced—its share of responsibility for national defense.

The outbreak of war on the continent of Europe in the Fall of 1939 had immediate repercussions throughout the System. Every aspect of the business was completely and thoroughly reviewed, with the objective of being adequately prepared for an increase in demand for service which might arise for any cause or from any source. (It is notable that in that fateful September of 1939 an upward surge in toll calls throughout the country of from 25 to 40 per cent—a huge increase, in absolute numbers—was handled smoothly and efficiently.) The steps which have followed, from review to planning, from planning to action, have kept pace so far with the communication needs of the country's defense program. No man can say surely what these next momentous months will bring; but the Bell System hopes to keep abreast of the service requirements which are still to come—and is implementing those hopes with all the skill and the resources of its nation-wide organization and the sincerity of the 325,000 men and women of which it is composed.

In 1928 there was placed in the lobby of the American Telephone and Telegraph building in New York the heroic bas-relief which is reproduced as the frontispiece of this issue. Sculptured in bronze and marble, it bears as its sole legend the words "Service to the Nation in Peace and War." The last dread word referred, of course, to the events of 1917 and 1918. None could dream that again so soon this country would be engaged in a program of national defense. But such a program is here. In it the Bell System has its essential share, and its pledge remains:

Service to the Nation. . . .

PIONEERING IN RADIO TELEPHONY

The Part Played by Individuals Co-operatively in the Events Which Ushered In a New Era of Communication Is Revealed in the Records Compiled in the Historical Library

The following article on the historic radio telephone experiments of 1915 is based in the main on the personal recollections of some fifteen of the men who took part in them. Their memoirs were collected several years ago at the suggestion of Dr. Frank B. Jewett, now Chairman of the Board of the Bell Telephone Laboratories, Inc., who himself played a leading role in the events of more than a quarter of a century ago. These intensely interesting documents are on file in the American Telephone Historical Library, New York.

—The Editors

In one of his poems, Rudyard Kipling uses these arresting lines:

Things never yet created things—
Once on a time there was a man.

Rarely have these words found more striking illustration than in the development of the radio telephone as the world knows it today: a means of communication by the spoken word that is world-wide in its reach; facilities for radio broadcasting which bring millions of listeners within the sound of a speaker's voice. In order to make possible these globe-girdling facilities for the transmission of speech, "things" almost innumerable have had to be created: vacuum tubes in a wide variety of forms; tuning coils and condensers; intricate networks of wires for antennas; even more intricate systems of wires that form the circuits of transmitting and receiving apparatus.

But none of these "things" created itself. Behind each of them—down to the least essential element of this far-flung system of facilities—has been human imagination, human effort. Behind each small detail of this vast Thing that is called Radio Telephony there lies the statement of fact with which so many nursery stories begin, and which Kipling paraphrases: *"Once on a time there was a man."*

Or, more properly speaking, behind each of these details that have been built into the creation of modern radio telephone communication there has stood not one man, but many. For it is impossible to put one's finger on a single contribution to the achieve-

QUARTER-CENTURY ANNIVERSARY MEETING

Reunited on October 21, 1940, the twenty-fifth anniversary of transatlantic radio telephony, were: (Standing) R. A. Heising, W. Wilson, O. E. Buckley, A. M. Curtis, B. W. Kendall, R. H. Wilson, H. Weinhart, R. V. L. Hartley, C. R. Englund and H. W. Everitt; (Seated) F. B. Jewett, H. E. Shreeve, B. B. Webb, L. Espenshied and E. H. Colpitts ment of this modern miracle, and to say of it, "This thing was done by such an one, alone and unaided." Modern research is not carried on in that way. It accomplishes its results, if another quotation may be permitted,

By the everlastin' teamwork of every bloomin' soul.

Even a quarter of a century ago, Bell System research and experimentation were carried out on this coöperative basis. So far as the achievements of 1915, in which the human voice was made to span the ocean, were concerned, they could have been brought about in no other way than by the coordinated effort of many men, working on many phases of an over-all problem.

A New Problem and a New Art

THIS problem was new. Some experimentation in radio telephony, over relatively short distances, had been carried on by DeForest, Fessenden, and others, but it was not short-haul radio telephony that was now contemplated. Bell System scientists and engineers, under the leadership and direction of John J. Carty, then Chief Engineer of the American Telephone and Telegraph Company, had succeeded, in 1914, in transmitting speech across the continent. Even before this was achieved, Carty had begun to dream of making the human voice span the seas. And transmission over such distances involved new factors that made whatever had been learned by previous experiments practically useless for the project then contemplated.

For satisfactory radio telephone transmission over great distances, a high power current had to be supplied to the antenna of the transmitting station, and this current had to be modulated—that is, varied in pitch and intensity, so as to reproduce the variations of the human voice. Up to this time radio telephone transmission over really long distances had been impracticable because, although there were known ways of establishing high frequency currents in the antenna, the variations in those currents corresponding to voice sounds were too small, and it was these variations which carried the spoken word.

THE system developed by the engineers and research men under Carty's direction was so completely a departure from those previously tried that in reality it constituted a new art. Essentially it consisted in generating a very small current of the radio type —a current so small that it could be completely modulated by a current from a telephone transmitter. The current thus modulated was then amplified until it was strong enough, when flowing in an antenna, to produce the desired effects at a distance.

In order to provide this amplification, one group of Bell System men undertook a series of studies in the electronic nature of the three-electrode vacuum tube. This was the invention of Lee DeForest, and rights to its use had been acquired by the American Telephone and Telegraph Company several years before. Much research and experimental work had already been done in developing the device (originally used by its inventor as a detector of radio signals and called by him the Audion) into a dependable high-vacuum tube which could be used as an amplifier or repeater of the Transcontinental Telephone Line. This important achievement was in the main due to the efforts of the late H. D. Arnold.

These studies were continued under Arnold's direction after the development of the telephone repeater, and on their basis, new types of tubes were produced, a hundred or more times as powerful as any that had been previously designed or even imagined. Methods were worked out for the use of the vacuum tube as a modulator. To receive these radio telephone signals, new and improved receiving circuits, also utilizing vacuum tubes and the principles and methods of amplification which had been developed in part for transcontinental wire telephony, were devised.

How the Job was Assigned

In general charge of the entire radio experimental program, and reporting directly to Carty, was Frank B. Jewett, then Assistant Chief Engineer of the Western Electric Company, which at that time maintained what is now the Bell Telephone Laboratories. He was assisted by E. H. Colpitts, Research Director of the same company. In no small measure as a recognition of the outstanding work he had already done on the vacuum tube, Arnold was made senior member of the research group.

Besides initiating many of the steps required in carrying on the program of research and experimentation in this new field, these three key men were responsible for coördinating the efforts of the groups to which specific problems or developments were assigned. These included two laboratory groups reporting to R. V. L. Hartley: one headed by R. H. Heising, working on the development and design of transmitter apparatus; the other, under R. H. Wilson, performing a similar function as to receiving apparatus development. In addition to supervising the work of both of these groups, Hartley was individually responsible for much of what was done on the receiving equipment.

Continuing the basic studies of the electronics of the vacuum tube, initially instituted, as has been seen, for the purpose of repeater development, was H. J. Van der Bijl. The production of high power tubes of the proper quality and in sufficient quantities for the purposes of the experiments was assigned to O. E. Buckley. Concentrating on various phases of this preliminary work were B. W. Kendall, W. Wilson, C. R. Englund and others. When the actual work of radio transmission and reception began, many of these men did duty in the field, at first at Montauk, Wilmington and St. Simon's Island and later at Arlington, Panama, San Francisco, San Diego, or Honolulu, as did others, including John Mills, B. B. Webb, H. W. Everitt, Lloyd Espenschied, H. E. Shreeve and A. M. Curtis.

Nearly All Still in Service

Indicative of the rapidity with which radio telephony has been developed—and of the youth of the men who were responsible for this development in its early stages—is the fact that, with the exceptions of Carty and Arnold, the men who played prominent parts in the experiments of 1915 are still living. A few, like Colpitts and Shreeve, have retired from active

GROUP AT MONTAUK POINT, L. I., ON APRIL 4, 1915
Left to right: Messrs. Christopher, Arnold, Blackwell, Mills, Jewett, Carson, Robert A. Millikan, Espenschied, Carty, Col. Samuel Reber, Thurber, Scribner, and Gherardi

service. Van der Bijl was for some years Director of Research and Chairman of the Power Authority of the Union of South Africa, where he is now Director General of War Supplies. The remaining members of the group are still actively engaged in the research and experimental work of the Bell System.

The youth of these men—and their lack of practical experience with the radio art—is one of the features that first and most forcibly impresses one who reads their accounts of their experiences. Thus Buckley had become an employee of the Bell System in July, 1914, and had been in the laboratories less than a year when he was precipitated headlong into production and tests of the power tubes which were to be used in attempting to transmit the voice through space across the Atlantic and wide stretches of the Pacific. R. A. Heising arrived at the laboratories at about the same time, and his reminiscences assure us that he saw his first three-element vacuum tube on July 27, 1914. Van der Bijl had a similar experience, though about a year earlier.

THOUGH they lacked practical experience with the vacuum tube, these young Bell System scientists had something far more valuable. Many of them had Ph.D. degrees; all of them were trained physicists, mathematicians, or engineers. They knew the formulae for approaching the job of finding out what they had to learn. They could compute, observe, reach conclusions, and apply these conclusions to the problem at hand.

The spirit with which they went about their work recalls that of the nameless hero who is quoted as having said: "I will find a way—or make one!" Each phase of the over-all problem was assigned to one man, or a small group of men, and they went to work with a will. Arnold found—or made—a way to transform DeForest's device into a really efficient high-vacuum tube. Others patiently studied its characteristics, learned how to stabilize its performance; found—or made—ways of putting it to different uses.

For they had another quality, in addition to their fundamental training as scientists. If they had the inexperience of youth, they had also compensating characteristics that went with or arose out of their youthfulness. Out of the pages of their reminiscences—which, by the way, are written with a curious degree of modesty, each writer protesting that the part which he played in the success of the project was, after all, only a minor one—there leaps at the reader an inescapable feeling of the enthusiasm, the optimism, and the boundless energy with which these young engineers went about their job. There were, as we shall see, phases of that job that called for high courage, when sleet-covered towers had to be climbed.

THERE were other phases that called for an even higher form of patient endurance—"two-o'clock-in-the-morning courage"—when men stationed alone at distant points had to listen, night after night, for signals or spoken words which, it seemed, the crashes of static would never let through to their ears. There were menial jobs to be done with hammer and saw, pick and shovel, broom and dustpan, which were done with a laugh and a humorous shrug of the shoulders that still is suggested in the light-hearted way in which the writers of these reminiscences have recounted their experiences, a quarter of a century after those days of humdrum tasks which later proved to be historic.

As has been intimated, it would be impossible, even if it were desirable, to evaluate the part which any particular man played in the work that was then being done in laying the foundation for the radio telephony of today. It may be impossible, in the present article, even to mention the names of all of those who took part in this work. It will certainly be impossible to give any detailed and connected account of what happened in the field of radio telephony during that memorable year, a little over a quarter of a century ago. It is not the purpose of this article to do so. Its aim is, rather, to catch glimpses of some of these men at their work, in order that thus the reader may understand the spirit that lay behind the over-all job that then was done.

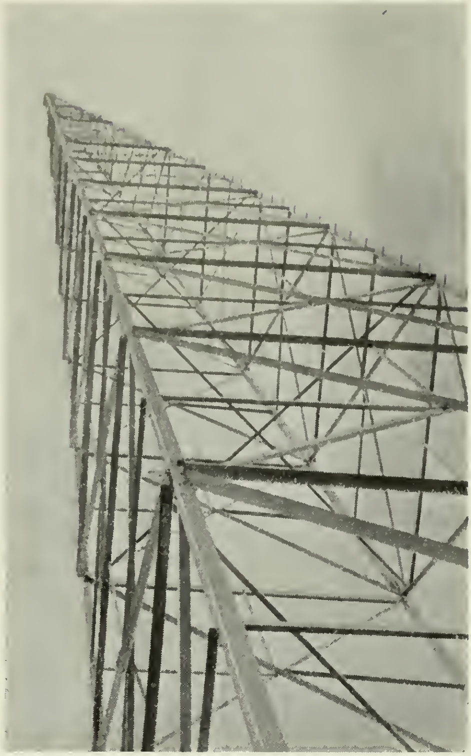
The Challenge of the Oceans

IT would appear that, as early as the end of 1913, Carty had tentatively suggested experimentation in radio telephony as an activity in which the Bell System research staff might well engage. The final order to go ahead seems to have been given about the end of 1914. When it was given, it was accompanied by an injunction to proceed without delay. From Carty down to the most recently employed college graduate on his research staff, they looked upon what they were about to engage in as a great adventure, and one that they approached with a zest that made them impatient of inaction.

And so these young physicists and engineers were instructed to drop everything else and prepare for what was to be the first convincingly successful demonstration of the transmission of speech by radio telephony. As has been pointed out, the over-all task was subdivided into parts, and a part assigned to one man or a group of men: some to work on the transmitting sets; some to design the best possible "hook-up" for a sensitive receiver; some to make surveys for advantageous locations for transmitting and receiving stations; some to put up the temporary buildings to house these stations, erect towers, string antennas; some to coördinate all these highly specialized efforts.

THE notes of almost all of these men give evidence of long periods characterized by results that were discouraging in the extreme; failures, followed by the trial of something else that worked a little better; dogged and patient cutting and trying until, at last, fairly satisfactory results were achieved.

But alertness—the habit of keeping one's eyes and mind open for any possible suggestion that might prove helpful—played its part as well. One of the men, for example, had been sent to Virginia to make a study of points that might be selected for a receiving station. As his train was pulling into Wilmington, Delaware, his eye caught a glimpse of two tall masts on a roof in the business section. He investigated, found that they were on the Dupont Building, and had been used by a now defunct wireless telegraph station to support its antennas. Upon his recommendation, the location was selected for the receiving station for the Bell System's radio telephone experiments.



MONTAUK POINT TOWER

This is the 165-foot structure which Espenschied had to ascend on April 4, when a blizzard had laid the antenna on the ground

Other shrewd observations by young engineers, equally alert to the relevance of the seemingly insignificant, led to vitally important improvements in apparatus or in methods of its operation. Much of this work went on simultaneously, and had to be coördinated by Carty, Jewett, Colpitts and others who had general supervision of the job. By the last of March, such progress had been made that Easter Sunday, April 4, was set for the first demonstration.

Montauk to Wilmington

Receiving apparatus had been set up at the point selected at Wilmington. Meanwhile John Mills and others had erected two 165-foot steel towers at Montauk Point, Long Island, had strung their antennas, and had installed transmitting apparatus in a small wooden structure built for the purpose. A group of executives of the American Telephone and Telegraph Company, with prominent guests, including the physicist Robert A. Millikan and Col. Samuel Reber, of the U. S. Army Signal Corps, made their way to the wind-swept point of Long Island to witness the tests.

But Mother Nature was in no mood to yield without a struggle to the conquest of a realm over which she had for ages held undisputed dominion. On the night before the scheduled demonstration, a blizzard, accompanied by severe sleet, blew in from the ocean. As Sunday morning dawned, the tall steel towers were coated with ice—and the transmitting antenna lay on the ground, useless.

John Mills describes with not a little relish his recollection of the scene as Espenschied, a stiff derby hat jammed firmly on his head, climbed the ice-coated steps of one of the towers to replace an end of the antenna, while H. J. Christopher, a New York Telephone Company lineman, performed a similar service on the other tower. The job was not without inconvenience, not to say peril, for 165 feet is a long way up when it has to be traveled foot by foot on steel steps glazed with ice, and with a high wind blowing in from the stormy Atlantic. But, some way, Espenschied and Christopher reached the top, restrung the antenna, and got back to solid ground without mishap.

The demonstration went off, a little delayed, but with encouraging success. Speech transmitted from Montauk was picked up at Wilmington and was carried back over a long distance telephone circuit to those who were listening at its point of origin. It was also received at a monitoring radio station which had been set up at the laboratories, 463 West Street, New York City. The distance of the Montauk-Wilmington transmission was approximately 200 miles—not great, as radio channels are measured in these days, but an epochal achievement twenty-five years ago.

Reaching for New Goals

But 200 miles was not enough for people who were dreaming of sending speech by radio telephone across the Atlantic. They reached out for new goals, and their next objective was transmission from Montauk to St. Simon's Island, off the Georgia coast—some 800 miles. Here we catch glimpses of John Mills, who had been sent down to select a site and erect a line of masts to support the receiving antenna. He was joined by Sydney Hogerton, then District Superintendent of the Long Lines Department, with headquarters at Atlanta, and a crew of construction men who were to erect the masts.

Each mast was to be made by lashing two poles together. The poles had been ordered, but did not come. Mills, Hogerton, and their plant gang awaited their arrival, with growing impatience. Without asking instruc-

ST. SIMON'S ISLAND RECEIVER

The improvised masts, and the apparatus shack in the distance, are shown in this picture

tions from New York, Mills further illustrated the formula: "Find a way —or make one!" Buying a number of beams and planks from a local lumberman, these telephone men set six thirty-foot beams in the marsh, so that their ends projected about ten feet from the ground. To the top of each of these, two planks were bolted, one being about twice the length of the other. This staggered arrangement made possible the progressive raising and bolting of new sections of planks and beams, each slightly smaller than the last, so that when the structure was completed, it was tapered. When properly guyed, this improvised line of radio masts, with the antenna which they supported, was quite adequate to the purpose for which it was intended. Incidentally, they prompted no end of speculation on the part of the natives of St. Simon's as to just what they were for. Mills recalls that he was supposed by some of them to be a German agent, but that most people thought he was in the pay of Japan.

A crew from the Southern Bell Telephone and Telegraph Company built a six-pole loop to connect the testing hut with a nearby toll line. On May 21, 1915, speech sent out from Montauk was picked out of the ether at St. Simon's. Two-way conversation was made possible by using a long distance circuit from St. Simon's to Montauk and New York.

MEANWHILE, demonstrations had been given to officers of the United States Navy, including Captain (later Rear Admiral) W. H. G. Bullard. It was the generous coöperation of such open-minded officials as Bullard and Colonel Reber, a personal friend of Carty, that later made it possible to attempt the more pretentious program of transmitting speech across the Atlantic. But in the early stages of his contact with these Bell System engineers, Bullard was far from being enthusiastic. Writes R. A. Heising, in his reminiscences:

> Captain Bullard told me late that year that he had no faith in our being able to talk across the Atlantic when the subject was first broached to him. He felt it was the idea of people who knew nothing of radio. He didn't expect telephone people, of all people, to be able to do it. It was only the fact that the engineers who approached him had unquestioned reputations in the engineering world that prevented him from throwing them out and dismissing the proposal from his mind. He therefore listened politely to what they had to say, and witnessed the tests without being convinced. They seemed to be so enthusiastic about the project, however, that he finally thought that as it was their own money they wanted to spend, they should be given whatever opportunity there was, and he would look into the matter further.

Contagious Enthusiasm

THE enthusiasm of this group of radio telephone pioneers was, as a matter of fact, the driving power that not only convinced outsiders, like Captain Bullard, and later the French military authorities in Paris, but inspired the less sanguine of their own associates to believe that the telephone organization was embarked upon an adventure which would eventually lead to vitally important results. If there ever was, in the history of scientific research, what may be described as self-starting zeal, that was the thing which kept these young engineers at their tasks, despite all too frequent experiences that would have dampened the spirits of less ardent souls.

The demonstrations before the naval officers led to the Bell System's obtaining permission for the use of certain government radio telegraph stations for the more ambitious project which was now to be undertaken. It was realized that enormous expense and delay would be involved if the Bell System were to erect towers of sufficient height for use in attempting to transmit speech across the Atlantic, and other towers at the various points at which it was planned to attempt to receive this speech. It was proposed that the United States Navy give permission to the Bell System engineers to connect transmitting apparatus to the antenna at the great wireless telegraph station at Arlington, Virginia, and that similar permission be granted to connect receiving equipment at naval stations at Darien, Canal Zone; Mare Island, near San Francisco; Point Loma, San Diego; and Honolulu, Hawaii. The good offices of the United States Navy were also sought as a means of persuading the French military authorities to permit receiving apparatus to be installed in the Eiffel Tower, Paris.

Getting Ready for the Tests

THANKS in no small measure to the interest and coöperation of Captain Bullard, all of the desired arrangements were made, and by the end of May, 1915, the necessary apparatus was on its way to these widely scattered points. The mere job of manufacturing, packing, and shipping this equipment was in itself a formidable one. This was particularly true of the vacuum tubes which were to supply the power for the transmitter at Arlington. On this point, Dr. Buck-

ANTENNA AT HONOLULU
This was Espenschied's listening post at Pearl Harbor

ley's brief account of his experiences sheds an interesting light. After describing how he and his associates at times worked on a twenty-four hour basis while producing the tubes (one of them, on one occasion, doing a thirty-six hour stretch) Dr. Buckley writes:

> Not the least exciting incident was the shipment of the tubes to Washington. A special express car had been set aside; I had personally seen to the packing of the tubes and had ordered a heavy truck for the purpose of transporting them safely. Our shipping department fell down on the job and at the last moment came through with a light horse-drawn cart on which we packed our precious tubes and with which I rode, in fear and trembling lest they be smashed, to the ferry and escorted them to the special express car reserved for the shipment and saw them safely aboard. This completed my contribution to the Arlington demonstration.

Twelve to fourteen tubes, connected in parallel, had been used in the transmission to Wilmington and St. Simon's Island. It was recognized that more tubes would be required if speech was to be sent over the vastly greater distances now contemplated. Before Paris and Honolulu were reached, after months of effort, 550 of these tubes had been installed in banks at the Arlington station, filling practically every nook and corner of the little building which the Bell System men had erected at the base of the tower to house their apparatus.

Pioneers in More than Name

FREQUENTLY these tubes would become overloaded and explode with a bang and a crash of broken glass, falling into the air-blowers that were installed below them to keep the tubes from becoming too hot. Now and then an engineer would inadvertently get his knuckles in the way of the

H. E. SHREEVE IN 1915
It was he who heard, in Paris on October 21, the words transmitted from Arlington, Va.

blades of the blower fans, with most unpleasant results. On at least one occasion, one of the men in charge at Arlington received more voltage than any human form could absorb without serious discomfort, not to say danger. They were pioneers in more than name, these young men who blazed the trail for modern radio telephony. They did things—of necessity—"the hard way."

Nor was the task of those who had been sent out to listen for the speech which their associates were to transmit from Arlington a job for what Thomas Paine described as "sunshine patriots." At their distant listening posts they waited, like sentries assigned to patrol a given post, for something to happen that, it must have seemed to them, never would happen. Most of them reached the points to which they had been assigned early in June, 1915. The earliest of them to report the reception of speech from Arlington was R. H. Wilson, who did so from Darien on August 25.

R. V. L. Hartley was at San Francisco, W. Wilson at San Diego, Lloyd Espenschied at Honolulu and H. E. Shreeve and A. M. Curtis at Paris. If circumstances had been different —or, perhaps, if as much had then been known as is known now about the effect of atmospheric disturbances on radio transmission—it is quite likely that this ambitious project might not have been undertaken during the time of year that was, unfortunately, chosen for it. Particularly in the tropics, distant flashes of heat lighting, if not the roll of not-so-distant thunder, were almost daily or nightly occurrences. Crashes of static formed an almost impenetrable wall through which no speech could possibly have made its way. At some of the receiving points, moreover, reception was all but blotted out by the "sparks" of high-powered wireless telegraph stations. The time allotted at all receiving points, with the single exception of Honolulu, was limited to periods when the authorities in charge of the stations were not using facilities for their own communication purposes. This was particularly true as to the use of the Eiffel Tower, for France was engaged in a death struggle with Germany, and every moment of antenna time was precious.

Sentries of Science

THE problem that faced these men at their "listening posts," therefore, resolved itself into one of sitting for minute after minute, night after night, with receivers at their ears—and fervently praying that, by the grace of Providence, a period of particularly strong transmission from Arlington might coincide with a period favorable for reception at the point where they were stationed, with both static and spark interference miraculously hushed at just the right moment. Weary business, for although acoustic shock was prevented by a volume limiter built into the receiving apparatus, listening to sudden crashes of static in the headset was not a pleasant sensation, to put it mildly! These sentries of science might have recalled the words of Milton: *"They also serve who only stand and wait."*

But atmospheric conditions were getting better; and improvements in the transmitting apparatus, increased power, modifications in the receiving equipment, and skilled and patient attention to details at the Arlington transmitter and at all listening points gradually resulted in success.

Espenschied, at Honolulu, had given another demonstration of making a way when one could not be found. He had received permission to connect his receiving apparatus to the radio telegraph station in downtown Honolulu. On all sides of the naval base ran electric light and power wires, and he surmised—and on experiment proved—that these would seriously interfere with reception. But he found, at the Pearl Harbor Naval Reservation, then under construction some distance from the city proper, conditions that were more favorable. So between a water tank, a power house chimney, and a steel building he strung his antenna, installed his apparatus in part of a small shack used by naval engineers as an office, and went to work at his job of listening. Incidentally, he had an opportunity to demonstrate anew his ability at climbing, of which he had made use at Montauk, for he himself had to mount the power house chimney in order to get his aerial in place.

B. B. WEBB

It was his voice that Shreeve heard in Paris. Note the high-quality microphone, 1915 version, used in transmission from Arlington

A Job Requiring Diplomacy

THE job assigned to these listeners at their distant outposts was one requiring qualities that would have fitted them for the diplomatic corps. For obvious reasons, the whole project was undertaken with considerable secrecy. It was distinctly *not* intended that publicity should be given to the enterprise until it had reached a satisfactory conclusion. On this point it may perhaps be of interest to record that the good people of Honolulu gave evidence of considerable inquisitiveness as to just what it was that the young visitor from the States was doing in their tropical midst. And it may be of further interest to add that the first information they got on this point was an account published in a Honolulu paper of October 1, based on cables received from the United States, to the effect that words spoken in Arlington had been heard in Hawaii. A later account gave sufficient details to apprise the Hawaiians of the fact that it was their Mystery Man who heard these ocean-spanning words, and that this had been what he had come to Honolulu for, some months earlier.

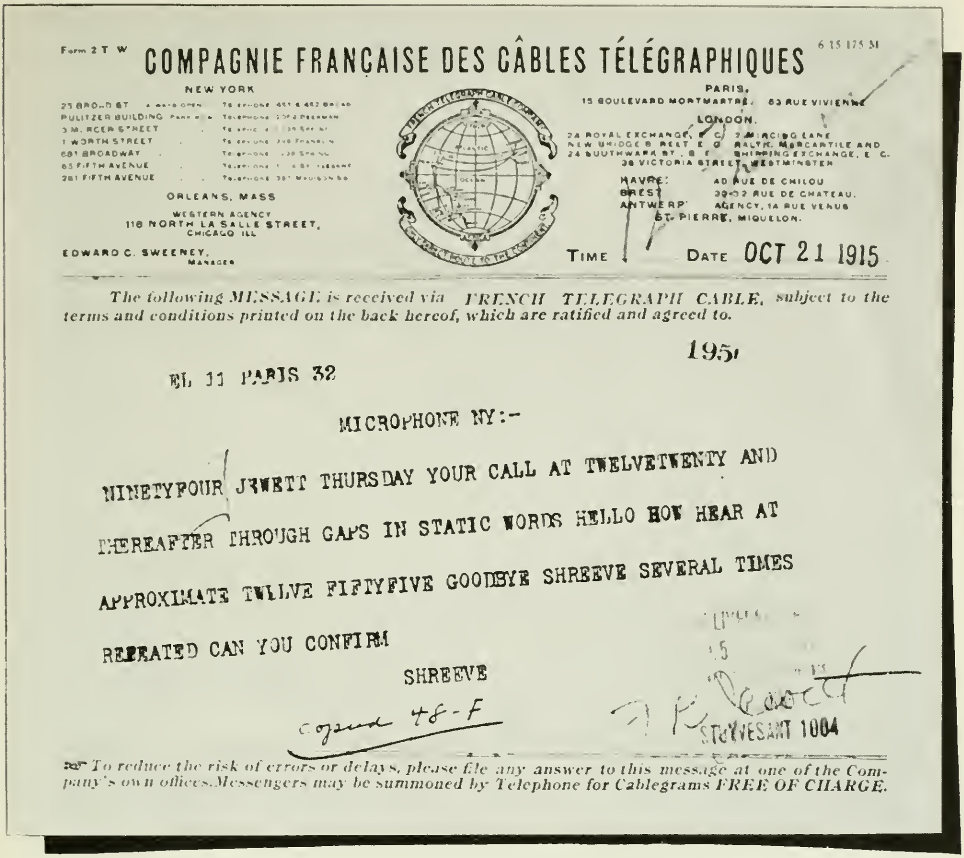
Meanwhile, satisfactory reception had been achieved at San Francisco and San Diego, and a demonstration of transcontinental radio telephony had been given on September 29. During this demonstration, Theodore N. Vail, then President of the American Telephone and Telegraph Company, and a group of other telephone officials in New York, had talked to Mr. Carty in San Francisco by radio telephone and had received his replies over the newly-opened transcontinental telephone line. It was, as a matter of fact, a part of a coast-to-coast conversation that Espenchied had picked up in Hawaii.

As far as these widely separated outposts in the Canal Zone, on the Pacific Coast, and in Hawaii were concerned, the enterprise had been an undoubted success. But with Shreeve and Curtis in Paris, things were going badly. The French military authorities, through General Ferrié, had graciously and generously granted the use of their largest antenna for brief periods, when Shreeve had applied to them, through the United States Embassy, early in June. It was now October, and the struggle on the battle front was taking on more and more of the characteristics of a mortal combat. The listening period had to be still further shortened, lest messages of vital military importance, including German transmissions, which were sometimes picked up at the Eiffel Tower, be missed altogether. As days lengthened into weeks and little or nothing came through from Arlington, it was apparent that the time was fast approaching when, courteous though the French were, the two Americans would find that they had worn out their welcome.

Encouragement from Col. Ferrié

Some of the French officers who had been assigned to coöperate with Shreeve and Curtis had already made it apparent that their patience was becoming exhausted. Shreeve writes:

> I decided that we had better have a heart to heart talk with Ferrié and find out just where we stood. . . . I explained that things were not going very satisfactorily with our experiment and that there was some evidence that we were making nuisances of ourselves. I told him that if this were the case I wanted to be advised of it officially, and that we would then withdraw. General Ferrié listened to me very patiently and said, "What you say is quite correct in some respects. Your experiment has taken longer than we expected. We are a very busy people,



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PARIS,

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TIME DATE OCT 21 1915

The following MESSAGE is received via FRENCH TELEGRAPH CABLE, subject to the terms and conditions printed on the back hereof, which are ratified and agreed to.

195

EL 11 PARIS 32

MICROPHONE NY:-

NINETYFOUR JEWETT THURSDAY YOUR CALL AT TWELVETWENTY AND

THEREAFTER THROUGH GAPS IN STATIC WORDS HELLO HOW HEAR AT

APPROXIMATE TWELVE FIFTYFIVE GOODBYE SHREEVE SEVERAL TIMES

REPEATED CAN YOU CONFIRM

SHREEVE

STUYVESANT 1004

To reduce the risk of errors or delays, please file any answer to this message at one of the Company's own offices. Messengers may be summoned by Telephone for Cablegrams FREE OF CHARGE.

SUCCESS!

Shreeve's cablegram to Jewett, announcing that he had heard in Paris words transmitted from Arlington

engaged in a terrible war in which our existence as a nation is at stake. However (and at this point General Ferrié left his chair and came over to where I was sitting and put his hand on my shoulder) I say to you, sir, *continue*, for two reasons: first, we have taken the time to check you up and know you are gentlemen and what you represent yourselves to be; and second, you are engaged in a very interesting experiment which I hope will succeed. . . . Permit me to issue to you a sufficient number of passes to insure that you will have no difficulty in reaching your experimental apparatus."

But if this long wait in Paris had its moments of tension, it had also its moments at which Shreeve and Curtis can now look back with not a little amusement. Thus, Shreeve tells of an experience when he and Curtis, strolling in the Montmartre district on an evening when their duties did not require their presence at the Eiffel Tower, were spotted by a group of French nursemaids as strangers, and were hurried by a gendarme before the *Maire*. To both of these officials the Americans exhibited *permis de sejour*, passports, etc., without appar-

GOUVERNEMENT MILITAIRE DE PARIS

COMMANDEMENT DU GÉNIE

DIRECTION
du Matériel du Génie

TÉLÉPH. : SAXE 28-80 / SAXE 18-28

Paris, le 191

Le Lieutenant-Colonel FERRIÉ.
Directeur Technique de la Radiotélégraphie Militaire.

à Monsieur

PROCES-VERBAL sommaire des expériences de télépnonie sans fil faites entre ARLINGTON et la TOUR EIFFEL.-

La station américaine d'ARLING TON, ayant été munie de générateurs d'ondes spéciaux, établis par (la Cie american telegraph and telephone) la WESTERN [illegible] electric et disposés de manière à permettre de faire des émissions de Télépnonie sans Fil, la dite compagnie dûment accréditée auprès du Département de la Guerre par l'Ambassade des ETATS-UNIS à PARIS, a chargé un de ses Ingénieurs, M. SHREEVE. d'essayer d'entendre ces émissions téléphoniques au poste radiotélégraphique de la Tour Eiffel, en utilisant des récepteurs également créés par elle.

Tous les essais faits ont été suivis à la Tour Eiffel en tous détails par le soussigné ou par des Officiers de son Service (Capitaines BRENOT et PINCEMIN, Lieutenant de VALBREUZE);

Une première série d'expériences faites en Juin 1915 n'a pas donné de résultats, probablement en raison des perturbations électriques naturelles très intenses en cet e saison.

Une deuxième série ,en Octobre 1915, a été plus heureuse. Il a été possible de percevoir très distinctement à plusieurs reprises des paroles telles que " One two three etc; good bye etc." Suivant l'intensité des perturbations électriques naturelles ou l'état de l'atmosphère, les paroles étaient entendues plus ou moins distinctement et avec plus ou moins d'intensité.

Ces resultats, bien qu'imparfaits, sont extrêmement intéressants et il est permis d'espérer qu'ils pourront être bien améliorés.

Paris, le 22 Octobre 1915

Le Lieutenant-Colonel du Génie FERRIE, Directeur technique de la Radiotélégraphie Militaire.

Ferrié

OFFICIAL CONFIRMATION

Statement by Lieutenant-Colonel Ferrié regarding the successful reception in Paris of speech transmitted from the United States ent effect. Finally Shreeve played his trump card. He writes:

> I then remembered the letter of introduction which had been given me by Mr. Thayer and I asked him if he could read English. He said that he could and I handed him the letter. He grabbed it upside down, looked at it for a minute and then returned it to me saying it was all right.

Shreeve and Curtis had had a similar experience with a country constable while on leave in England during a period when experiments at the Eiffel Tower were suspended.

So matters went on, with the monotony of their long wait lightened for the two American engineers only by an occasional incident such as that above described. They had resumed listening in September, but heard nothing from Arlington until early October, when on several occasions they thought they heard the sounds of a voice counting "One, two, three, four, five," etc.

When History Was Made

ON October 21, 1915—now recognized as one of the historic dates in communication history—successful reception, capable of full verification, was achieved. On that date the listeners in Paris heard B. B. Webb, at the transmitter in Arlington, speak the words, "Good-bye, Shreeve." These were several times repeated.

Shreeve at once cabled to Frank B. Jewett, reporting this reception, and asking if the message could be confirmed. Jewett could confirm it, and did. The long vigil at Paris was ended. The voice of man had been carried by radio telephony across the Atlantic!

All that remained now was to obtain from General Ferrié a statement certifying that he, too, had heard speech transmitted from Arlington to Paris. This Shreeve did, and, after obtaining the authority of the proper French officials, hurried off to get it on the cables to the United States, so that it might be included in a statement to the press which it was proposed to release immediately. The New York papers of the next day headlined the dramatic story of how human speech had leaped the Atlantic.

A great pioneering adventure had been carried to success—a success that had been made possible only by the patience, the painstaking attention to a multitude of details, the endurance, the resourcefulness and the unwavering enthusiasm of a group of men who for months had given all they had to a Thing in which they profoundly believed.

All of which is important for only one reason, for history has significance only in so far as it may be related to the present. That reason may be briefly stated: Behind and beneath the qualities which made it possible for these pioneers in radio telephony to accomplish what they did lay a spiritual something that still inspires those of them who are yet in the telephone service, as they go about their daily duties; that inspires others who share with them the responsibilities of the laboratory or the field—the hundreds of Bell System scientists and engineers who spend their working lives in a quest of means by which the value of America's telephone service to its users may be constantly increased.

MAKING TELEPHONE DIRECTORIES BETTER

Type, Paper, Covers, Informative Material Are All Under Constant Review and Frequent Improvement to Make This Important Element of Telephone Service More Satisfactory to Its Users

By OTIS M. HANCOCK

The Bell System publishes about 2,200 different telephone directories. They range in size from two-page cards with a few listings to the Chicago alphabetical directory of 1,500 pages, each of which contains about 450 listings. About thirty million directories are printed each year, and on many hundreds of thousands of telephone calls each day the directory is the first point of contact between the customer and the telephone company. Since the planning and production of these directories are an important part of the System's constant effort to make telephone service more and more pleasing and satisfactory to the user, they are the subject of continuous study by the directory organizations of the Associated Companies which publish them, as well as by the staff engineers of the American Telephone and Telegraph Company.

In considering the quality and adequacy of directory service, it is natural to think first of the results as measured by technical standards: listing errors, delivery failures, production time, etc. These technical results are very important, because the value of the customer's telephone service is affected adversely if his listings are in error or if he fails to receive his new directory promptly.

Of equal importance, however, and possibly of more concern to all telephone users, is what may be called the physical characteristics of directories. While such things as type face, cover and text paper, introductory page and miscellaneous information, cover design, etc., do not have any bearing upon the technical accuracy of the customer's directory or of his telephone service, they do affect the facility with which he may use his directory, and thus influence his satisfaction with telephone service. It is therefore the purpose of this article to review some of the things which have been done or are being done to improve directories from the standpoint of their appearance, physical characteristics, and general service value.

One of the most important problems which those charged with the responsibility for telephone directories have had to face is the selection of type for the listing pages. In the early days of the telephone business, when customers were few and directories small, almost any type face which the printer happened to have available served the purpose. But, as the telephone business grew, and the directories became larger and larger, there developed a need for type faces which would be easy to read and yet provide the maximum number of listings on each page, in order to keep the directories down to a conveniently usable size.

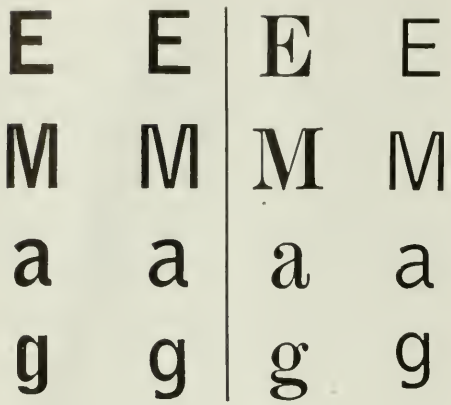
About 1915 the Bell System engaged type experts who, working with type manufacturers, studied and tested many different type faces. From these tests there was developed a special type face for directories. This type served its purpose well, and was used for many years in the larger directories. Later a similar type face was developed in slightly larger size for use in the smaller directories. During subsequent years, the possibility of further improving these special directory type faces was kept constantly in mind. All current developments in typography and printing were carefully watched, and new designs of type analyzed for their appropriateness for directory use. Some modifications in letters and numerals were made from time to time as a result of these studies.

In 1937 the New York Telephone Company was faced with the necessity of resetting all the listings in its New York City directories. Before doing

La Rue W H r 903 State.......MA in-1874	La Rue W H r 903 State.......MA in-1874
Larue W K groc 1916 Walnut.......CO ngress-7942	Larue W K groc 1916 Walnut.......CO ngress-7942
Laundry Airdry 612 Clark.......NO rth-10126	Laundry Airdry 612 Clark.......NO rth-10126
Le Blanc Inc 1361 Grant av.......BE lmnt-8839	Le Blanc Inc 1361 Grant av.......BE lmnt-8839
Leblanc J phys 1422 Park av.......MY stic-5940	Leblanc J phys 1422 Park av.......MY stic-5940
Lee Hong 3905 State.......ⓉMilton-1012-W	Lee Hong 3905 State.......ⓉMilton-1012-W
Lee Wa Co 4289 Clark.......LI ncoln-2951	Lee Wa Co 4289 Clark.......LI ncoln-2951
Leroy F H r 121 North.......BE lmnt-3071	Leroy F H r 121 North.......BE lmnt-3071
Le Roy G H meats 435 Arnold.......WE st-0506	Le Roy G H meats 435 Arnold.......WE st-0506
Lincoln A & Bros 8323 Grant av.......BE lmnt-5290	Lincoln A & Bros 8323 Grant av.......BE lmnt-5290
Lincoln A & Co 3289 North.......CO ngress-3932	Lincoln A & Co 3289 North.......CO ngress-3932
Lincoln A Inc 144 Walnut.......WE st-1043	Lincoln A Inc 144 Walnut.......WE st-1043
Lincoln A & Son 427 Beacon.......LI ncoln-1565	Lincoln A & Son 427 Beacon.......LI ncoln-1565
Lincoln A & Sons 30 Clark.......NO rth-3315	Lincoln A & Sons 30 Clark.......NO rth-3315
Lincoln A & Sons Co 581 Arnold.......ⓉMilton-2000	Lincoln A & Sons Co 581 Arnold.......ⓉMilton-2000
Lincoln A Jos r 1918 Beacon.......MA in-0266	Lincoln A Jos r 1918 Beacon.......MA in-0266
Lincoln Bradley B r 7414 Park av.......AD ams-1688	Lincoln Bradley B r 7414 Park av.......AD ams-1688
Lock Port Fisheries 501 Beacon.......BE lmnt-3932	Lock Port Fisheries 501 Beacon.......BE lmnt-3932
Lockport Engine Co 781 Walnut.......MY stic-2401	Lockport Engine Co 781 Walnut.......MY stic-2401
Long Low Tai r 136 Arnold.......MA in-6318	Long Low Tai r 136 Arnold.......MA in-6318
Looman Geo r 1593 McAllister.......WE st-2336	Looman Geo r 1593 McAllister.......WE st-2336
Louisville Varnish Co 628-3rd.......KA rny-2200	Louisville Varnish Co 628-3rd.......KA rny-2200
Love G A Sons contrs 378 Diamond.......MI ssion-3562	Love G A Sons contrs 378 Diamond.......MI ssion-3562
Lowrey Alan J ofc 331 Montgomery.......SU ttr-0130	Lowrey Alan J ofc 331 Montgomery.......SU ttr-0130
Lowry H lds furnshngs 2447-44th.......MI ssion-4069	Lowry H lds furnshngs 2447-44th.......MI ssion-4069
Lucas M soft drinks 2301 Market.......PA rk-7914	Lucas M soft drinks 2301 Market.......PA rk-7914
Lunsmann A W groc 447 Irving.......SU nset-2461	Lunsmann A W groc 447 Irving.......SU nset-2461
Lurch Clara Mrs r 74 Portola.......MA rket-3484	Lurch Clara Mrs r 74 Portola.......MA rket-3484
Lutz & Fritsch violins 45 Geary.......DO uglas-2127	Lutz & Fritsch violins 45 Geary.......DO uglas-2127
Lux Hand Lndry 316 Eddy.......FR ankln-0165	Lux Hand Lndry 316 Eddy.......FR ankln-0165
Mabury Oliver nurse 721 Park av.......LI ncoln-5290	Mabury Oliver nurse 721 Park av.......LI ncoln-5290
MacDonald A J r 847 Grant av.......WE st-5290	MacDonald A J r 847 Grant av.......WE st-5290
Macdonald B J groc 51 State.......BE lmnt-4634	Macdonald B J groc 51 State.......BE lmnt-4634
Mace L V r 1360 Arnold.......CO ngress-1547	Mace L V r 1360 Arnold.......CO ngress-1547
Macomber A A r 15 Grant Av.......AD ams-4211	Macomber A A r 15 Grant av.......AD ams-4211
Mansfield Walter atty 1210 ParkAv.......BE lmnt-5934	Mansfield Walter atty 1210 Park av.......BE lmnt-5934
Mark-Off Shoe Co 124 North.......MY stic-9728	Mark-Off Shoe Co 124 North.......MY stic-9728

OLD AND NEW DIRECTORY LISTING TYPE FACES

The column at the right is set in the specially developed "Bell Gothic"



Design Details Enlarged

Examples of the simpler, more open, and therefore more legible "Bell Gothic" type (at the right in each pair). The pair at the left represents an enlargement of the former and present type face used for names; at the right, for addresses

so, it undertook to see what could be done to improve further the directory type then in use. Working with the Mergenthaler Linotype Company, the directory engineers altered a number of the characters by opening up the inside of the type to permit more white space to show through, and eliminated all serifs from the type used for the address portion of the listing. Thereby they derived a new type face which was more clean cut and appeared larger than the type formerly used—although it actually required no more space. As a result, individual listings were more legible and the directory as a whole was improved in appearance. This new type, known as Bell Gothic, has been made available in three sizes. It has already been adopted in about 700 directories, including practically all of the large city books, and has met with immediate favorable reaction from the public and the press.

Directory Paper

Like the type, the current blue-white paper used in telephone directories is the result of numerous improvements made during the past several years.

While telephone directories printed on a good grade of book paper might be impressive, it became evident many years ago that this would be impractical, since the thickness of book paper would increase the size of directories to the point where they would be too big to be usable or would have to be split into a number of volumes, which would be inconvenient from the customers' viewpoint. As a consequence, directory people turned to the type of paper ordinarily used in newspapers as a starting point in the development of a satisfactory paper for directory use.

A recent article in the Quarterly * described how Bell System engineers, working with the paper manufacturers, developed methods for the bleaching of pulp, the filtering of water, the selection of fillers and the establishment of specification controls which have resulted in a directory paper which meets exacting requirements as to color, cleanliness, thinness, opacity, and sturdiness, and yet is not unduly costly. During the past few years, changes in the ingredients of the paper or in the manufacturing processes have been made four different times, each resulting in a distinctly better stock. At the present time research is being directed toward increasing the opacity of the yellow paper used for the classified sections, in order to im-

* "Directory Paper Purchasing," Quarterly, April, 1939.

prove the general appearance of these pages and to increase the attractiveness of the "yellow pages" to business customers as a desirable advertising medium.

Similarly, directory cover paper is studied to take advantage of any possible improvements in the quality of the stock, its appearance and printability. Recently a study was made of the effect of different dyes and different surface finishes on the general tone of the cover paper. As a result, two new colors, buff and gray, were selected which, with the green formerly used, have been accepted by the Associated Companies as standard for future use. These new colors, when printed with an attractive cover design, greatly improve the appearance of the directories.

Introductory Pages

FROM the very beginning of the telephone business it has been the universal practice to devote the first few pages of the directory to general information regarding the telephone and its use. For many years this material consisted largely of detailed and often somewhat technical directions for making telephone calls, together with the rules and regulations applying to the furnishing and use of the service. Recognizing that the need for much of this type of information no longer generally exists, the telephone companies in recent years have made important revisions in these pages.

Page 1 is used uniformly now to list emergency call numbers such as Fire, Police, and Ambulance, and for service calls, that is, calls to the telephone company. Many of the companies also include on Page 1 an index to the material on the following introductory pages. A typical current introductory-page section includes information on how to transact business with the telephone company, brief instructions on how to dial, and a description of the types of out-of-town calls and how to make them. Then follows a page or two devoted to the various classes of telephone services and instruments available for the home and business, and how the customer may make us of them to get the most out of his telephone service. All of this material is carefully edited to eliminate technical language so far as possible, and the text is liberally illustrated. Great care is taken in the selection of type and the design of the pages to insure easy reading and attractive appearance. Some of the Associated Companies print these pages on a special color of paper to add to their attractiveness and to encourage their use.

Civic Information in Directories

A NEW feature of telephone directories adopted by many of the Associated Companies, which has resulted in many expressions of approval from the public, is the inclusion of a certain amount of non-telephone information of general interest. This feature has been developed as a result of evidence that the public looks to the telephone company for certain services which go somewhat beyond the rendering of satisfactory telephone service, and appreciates the value, convenience, and accessibility of the telephone directory as a place to publish appropriate miscellaneous information.

The information carried in the directories includes such material as

PITTSBURGH CIVIC SECTION

Designed to help both residents and visitors in locating the many points of interest in and around Pittsburgh.

★ POINTS OF GENERAL INTEREST ★

ALLEGHENY COUNTY COURTHOUSE—An architectural landmark in the Romanesque style, the masterpiece of one of the foremost American architects of fifty years ago, Richardson of Boston. Dedicated in 1888, it occupies the entire block at Grant Street, Diamond Street, Ross Street and Fifth Avenue.

ALLEGHENY OBSERVATORY—A department of the University of Pittsburgh, situated in Riverview Park, North Side. Some of the most noteworthy work in astronomical photography was done here by the late Prof. James E. Keeler. Visitors admitted free, but reservations must be made in advance.

BUHL PLANETARIUM AND INSTITUTE OF POPULAR SCIENCE—Gift of The Buhl Foundation to the City of Pittsburgh, it is dedicated to the popular understanding of astronomy and the natural sciences. It was opened to the public on October 25, 1939, and is the fifth of the American Planetaria and the world's most modern and complete. In the five spacious galleries of the Institute of Popular Science, the miracles of twentieth century are told by hundreds of moving and talking exhibits which operate at the will of the visitor. The building is open daily from 10 A.M. until 10 P.M. and on Sundays from 1:15 P.M. until 10 P.M. Sky shows are presented in the Planetarium every afternoon and evening. The Buhl Planetarium is located at Federal and West Ohio Streets on the North Side, five minutes from the Golden Triangle.

CARNEGIE FREE LIBRARY OF ALLEGHENY, at Federal ... North Side, is the original Carnegie ... umes on its shelves and 600 pub- ... The ... co

CITY-COUNTY BUILDING—Located in the block next to the Courthouse on Grant Street, it is occupied by both city and county offices, as well as Courts of Justice. Growth of the city and county necessitated the construction of this building, but it was inadequate to accommodate all demands and a beautiful stone building, known as the County Office Building, was erected in the rear, on Ross Street. The Courthouse, City-County Building and County Office Building form one of the most notable groups of municipal buildings in the country.

EAST LIBERTY PRESBYTERIAN CHURCH—At the corner of Penn Avenue, South Highland Avenue and Baum Boulevard. A beautiful Gothic structure, a masterpiece of the famous architect, Ralph Cram. Built by the late Mr. and Mrs. Richard B. Mellon, as a memorial to their parents. Open to visitors on week days at 10 A.M., 1 and 3 P.M.

FEDERAL BUILDING—The U. S. Government Building in Pittsburgh, containing the postoffice, federal courts and many other federal agencies. The Pittsburgh Postoffice has 26 substations for delivery of mail and there are 148 postoffices in Allegheny County. The Federal Building occupies 83,200 square feet of ground, in the block at Grant Street, Seventh Avenue and Bigelow Boulevard.

FRICK PARK—An extensive and beautifully wooded district in the extreme east portion of the residential district of the city. Includes facilities for many types of recreation. This park was presented to Pittsburgh by Henry C. Frick.

GENERAL LOGAN ARMORY—Named after the late Gen. Albert J. Logan and situated on Thackeray Street in the Civic Center, this is th... 76th Field A...

TYPICAL OF A NEW FEATURE IN DIRECTORIES

Part of the first page of a section such as is being introduced between the alphabetical and classified sections in many books. Other topics in the Pittsburgh Civic Section are: historic shrines, education and the arts, public libraries, office buildings, national and state parks and recreation areas, and postal information

maps showing city streets, with the main transportation arteries; postal information; the location of principal office buildings; the location of public libraries and branches, together with their open hours and regulations applying to the borrowing of books; traffic rules and regulations; points of local historical interest, with pertinent information concerning each; and selected economic data for the community. The amount and scope of such information varies, of course, according to the size and type of community served by the directory. It may range from two pages to eight or ten pages for the large books. In many instances the information in these so-called "Civic Sections" has been related to local civic activities such as, for example, the featuring of traffic rules and regulations during local safety campaigns, or of material devoted to the historical background and the development of the community, both commercially and culturally, during centennial celebrations, etc.

The response of the public to these civic sections has been extremely favorable. Customers not only feel that the telephone company is taking a real interest in their home cities, but much of the information has been found of considerable usefulness, particularly such things as the maps, indexes to streets, locations of office buildings, etc. In one resort city some of the hotels instructed their bellboys, when showing guests to their rooms, to open the telephone directory to the civic section and suggest that the guests familiarize themselves with the local points of interest. In another city several doctors commented that they had found the index to the location of streets particularly helpful when called to sections of the city with which they were not familiar. Municipal governments, civic bodies, post office departments, and other public utilities have coöperated wholeheartedly both in developing the information shown and in calling attention to its availability in directories.

Civic information is generally placed on the first pages of the classified section of the directory. In this location, public reference to this section is increased and thus they tend to become a more familiar daily convenience. This in turn should stimulate a greater use of the classified sections for finding both telephone numbers and buying information.

Toll Rates in Directories

ANOTHER recent development is the use of the inside front covers of directories for showing toll rate information. For several years Bell System national toll advertising, in addition to being designed to impress customers with the ease of telephoning out of town, has emphasized the low cost of the service, and advertisements have sometimes quoted typical point-to-point rates. Despite this, many telephone users are still under the impression that long distance rates are higher than is actually the case. While a certain number of typical toll rates have always been included in most directories, and toll advertising has often asked the customer to refer to his local directory, there has been no direct reference heretofore because there was no one standard place in all directories where customers could be told to look for rates from their own telephones. With this in mind, the suggestion was made in 1939 that the inside front cover of all directories be reserved for a table of toll rates. This would make possible the inclusion in both local and national toll advertising some such line as "See inside front cover of your directory for rates from your city." The inside front cover was chosen because it is a prominent location, easy to find in all directories, and it avoids complications which might arise from the selection of any other page because of the varying number of pages in directories of different sizes.

This suggestion was quickly adopted, and at the present time over 75 per cent of all Bell System book-type directories show a list of typical toll rates on the inside front covers. This year, for the first time, national toll advertising will include reference to rate information in that location. Directories are thus used to localize the Bell System's national advertising in much the same way that other national advertisers utilize Trade Mark Service in the classified sections of directories to increase the effectiveness of their advertising in other media.

From MANHATTAN* to:	Station-to-Station Week-days	Station-to-Station Nights and Sunday	Person-to-Person Week-days	Person-to-Person Nights and Sunday
Akron, Ohio	$1.40	$ .85	$1.85	$1.30
Albany, N. Y.	.75	.45	1.05	.75
Albuquerque, N. M.	5.00	3.25	6.75	4.75
Allentown, Pa.	.50	.35	.70	.55
Amityville, L. I.	.30	.30	.40	.40
Asbury Park, N. J.	.35	.35	.50	.50
Atlanta, Ga.	2.20	1.35	2.95	2.10
Atlantic City, N. J.	.55	.35	.75	.55
Babylon, L. I.	.35	.35	.50	.50
Baltimore, Md	.75	.45	1.05	.75
Bayonne, N. J.	.10	.10	.20	.20
Bay Shore, L. I.	.35	.35	.50	.50
Bennington, Vt.	.70	.45	1.00	.75
Birmingham, Ala.	2.50	1.50	3.25	2.25
Bloomfield, N. J.	.15	.15	.25	.25
Boise, Idaho	5.75	3.75	7.75	5.75
Boonton, N. J.	.30	.30	.40	.40
Boston, Mass.	.80	.50	1.10	.80
Bridgeport, Conn.	.40	.35	.55	.50
Bronxville, N. Y.	.20	.20	.30	.30
Buffalo, N. Y.	1.25	.75	1.65	1.15
Burlington, Vt.	1.00	.60	1.35	.95
Butte, Mont.	5.25	3.50	7.00	5.25
Cedarhurst, L. I.	.15	.15	.25	.25
Charleston, W. Va.	1.45	.90	1.95	1.40
Charlotte, N. C.	1.70	1.05	2.25	1.60
Cheyenne, Wyo.	4.50	3.00	6.00	4.50
Chicago, Ill.	2.20	1.35	2.95	2.10
Cincinnati, Ohio	1.80	1.10	2.40	1.70
Cleveland, Ohio	1.40	.85	1.85	1.30
Cliffside, N. J.	.10	.10	.20	.20
Columbia, S. C.	1.85	1.15	2.45	1.75
Columbus, Ohio	1.50	.90	2.00	1.40
Concord, N. H.	.85	.55	1.20	.90
Denver, Colo.	4.50	3.00	6.00	4.50
Des Moines, Iowa	3.00	1.80	4.00	2.75
Detroit, Mich.	1.55	.95	2.05	1.45
Dumont, N. J.	.20	.20	.30	.30
Elizabeth, N. J.	.20	.20	.30	.30
Ellenville, N. Y.	.50	.35†	.75	.60†
Englewood, N. J.	.15	.15	.25	.25
Fargo, N. Dak.	3.50	2.10	4.50	3.00
Floral Park, L. I.	.15	.15	.25	.25
Freeport, L. I.	.25	.25	.35	.35
Garden City, L. I.	.20	.20	.30	.30
Glen Cove, L. I.	.20	.20	.30	.30
Great Neck, L. I.	.15	.15	.25	.25
Greensboro, N. C.	1.45	.90	1.95	1.40
Greenwich, Conn.	.25	.25	.35	.35
Hackensack, N. J.	.15	.15	.25	.25

From MANHATTAN* to:	Station-to-Station Week-days	Station-to-Station Nights and Sunday	Person-to-Person Week-days	Person-to-Person Nights and Sunday
Harrisburg, Pa.	$ .70	$ .45	$1.00	$ .75
Hartford, Conn.	.55	.35	.75	.55
Hastings, N. Y.	.20	.20	.30	.30
Haverstraw, N. Y.	.30	.30	.40	.40
Hempstead, L. I.	.20	.20	.30	.30
Hicksville, L. I.	.25	.25	.35	.35
Hoboken, N. J.	.10	.10	.20	.20
Houston, Texas	4.00	2.50	5.25	3.75
Huntington, L. I.	.30	.30	.40	.40
Indianapolis, Ind.	1.95	1.20	2.60	1.85
Jackson, Miss.	3.00	1.80	4.00	2.75
Jersey City, N. J.	.10	.10	.20	.20
Kansas City, Kans.	3.25	1.95	4.25	2.90
Kansas City, Mo.	3.25	1.95	4.25	2.90
Kearny, N. J.	.15	.15	.25	.25
Kingston, N. Y.	.55	.35	.80	.60
Larchmont, N. Y.	.20	.20	.30	.30
Leonia, N. J.	.15	.15	.25	.25
Liberty, N. Y.	.55	.35†	.80	.60†
Little Rock, Ark.	3.25	1.95	4.25	2.90
Long Beach, L. I.	.20	.20	.30	.30
Long Branch, N. J.	.30	.30	.40	.40
Los Angeles, Cal.	6.25	4.25	8.50	6.50
Louisville, Ky.	1.95	1.20	2.60	1.85
Lynbrook, L. I.	.20	.20	.30	.30
Mamaroneck, N. Y.	.20	.20	.30	.20
Manhasset, L. I.	.15	.15	.25	.25
Memphis, Tenn.	2.80	1.70	3.75	2.60
Miami, Fla.	3.25	1.95	4.25	2.90
Milwaukee, Wis.	2.30	1.40	3.00	2.10
Minneapolis, Minn.	2.90	1.75	3.75	2.60
Montclair, N. J.	.20	.20	.30	.30
Monticello, N. Y.	.50	.35†	.75	.60†
Morristown, N. J.	.30	.30	.40	.40
Mount Kisco, N. Y.	.35	.35	.50	.50
Mount Vernon, N. Y.	.15	.15	.25	.25
Newark, N. J.	.15	.15	.25	.25
New Brunswick, N. J.	.30	.30	.40	.40
Newburgh, N. Y.	.45	.35	.65	.55
New Haven, Conn.	.45	.35	.65	.55
New Orleans, La.	3.50	2.10	4.50	3.00
New Rochelle, N. Y.	.15	.15	.25	.25
Norfolk, Va.	1.05	.65	1.40	1.00
Norwalk, Conn.	.35	.35	.50	.50
Nyack, N. Y.	.25	.25	.35	.35
Omaha, Nebr.	3.25	1.95	4.25	2.90
Ossining, N. Y.	.30	.30	.40	.40
Oyster Bay, L. I.	.25	.25	.35	.35
Passaic, N. J.	.15	.15	.25	.25
Patchogue, L. I.	.45	.35	.65	.55

From MANHATTAN* to:	Station-to-Station Week-days	Station-to-Station Nights and Sunday	Person-to-Person Week-days	Person-to-Person Nights and Sunday
Paterson, N. J.	$ .20	$ .20	$ .30	$ .30
Peekskill, N. Y.	.35	.35	.50	.50
Pelham, N. Y.	.15	.15	.25	.25
Perth Amboy, N. J.	.25	.25	.35	.35
Philadelphia, Pa.	.45	.35	.65	.55
Phoenix, Ariz.	5.75	3.75	7.75	5.75
Pittsburgh, Pa.	1.15	.70	1.55	1.10
Plainfield, N. J.	.30	.30	.40	.40
Pleasantville, N. Y.	.30	.30	.40	.40
Port Chester, N. Y.	.25	.25	.35	.35
Portland, Maine	1.00	.60	1.35	.95
Portland, Ore.	6.25	4.25	8.50	6.50
Port Washington, L. I.	.20	.20	.30	.30
Poughkeepsie, N. Y.	.50	.35	.75	.60
Providence, R. I.	.70	.45	1.00	.75
Red Bank, N. J.	.30	.30	.40	.40
Reno, Nev.	6.25	4.25	8.50	6.50
Richmond, Va.	1.05	.65	1.40	1.00
Ridgewood, N. J.	.20	.20	.30	.30
Rochester, N. Y.	1.15	.65	1.55	1.05
Rockville Centre, L. I.	.20	.20	.30	.30
Rutherford, N. J.	.15	.15	.25	.25
Rutland, Vt.	.85	.55	1.20	.90
Rye, N. Y.	.25	.25	.35	.35
St. Louis, Mo.	2.60	1.60	3.50	2.45
St. Paul, Minn.	2.90	1.75	3.75	2.60
Salt Lake City, Utah	5.25	3.50	7.00	5.25
San Francisco, Cal.	6.50	4.25	8.75	6.50
Saratoga Spgs., N. Y.	.90	.55†	1.25	.90†
Scarsdale, N. Y.	.20	.20	.30	.30
Scranton, Pa.	.55	.35	.75	.55
Seattle, Wash.	6.25	4.25	8.50	6.50
Sioux Falls, S. Dak.	3.50	2.10	4.50	3.00
Springfield, Mass.	.60	.40	.85	.65
Stamford, Conn.	.30	.30	.40	.40
Summit, N. J.	.25	.25	.35	.35
Syracuse, N. Y.	1.05	.60	1.40	.95
Tarrytown, N. Y.	.25	.25	.35	.35
Teaneck, N. J.	.15	.15	.25	.25
Trenton, N. J.	.40	.35	.55	.50
Tuckahoe, N. Y.	.20	.20	.30	.30
Tulsa, Okla.	3.50	2.10	4.50	3.00
Union City, N. J.	.10	.10	.20	.20
Washington, D. C.	.85	.55	1.20	.90
Westfield, N. J.	.25	.25	.35	.35
Wheeling, W. Va.	1.25	.75	1.65	1.15
White Plains, N. Y.	.25	.25	.35	.35
Wilmington, Del.	.55	.35	.75	.55
Worcester, Mass.	.70	.45	1.00	.75
Yonkers, N. Y.	.15	.15	.25	.25

* If you are calling from upper Manhattan, the rates may be somewhat different from those shown.
† From June 25 to Sept. 10 inclusive, reduced rates apply only from 4:30 a.m. Sunday to 4:30 a.m. Monday.

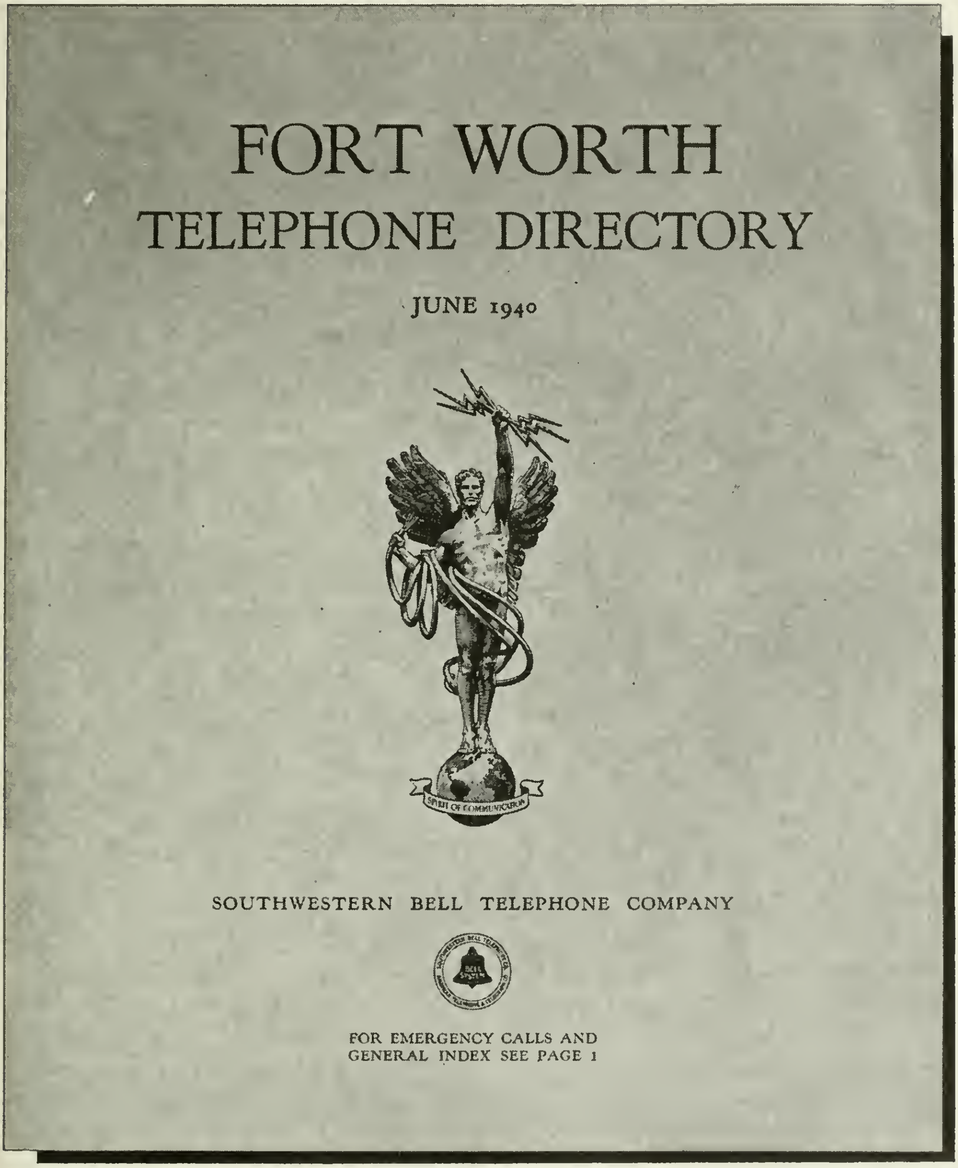
SEE PAGE 8 FOR ADDITIONAL LONG DISTANCE INFORMATION AND RATES TO POINTS OUTSIDE UNITED STATES

INSIDE FRONT COVER

This location is generally being adopted for toll rate information

Directory Cover Design

For a number of years the Associated Companies have been desirous of eliminating advertising from the front covers of directories, and of improving the appearance of the books by more attractive covers. Much progress has been made, and the companies have developed and used many attractive cover designs. More recently, it was suggested that there would be advantages in a uniform front cover for all Bell System directories. All the then current covers were reviewed, together with other designs newly created for consideration, and a design was selected which was felt to be appropriate for the front covers of directories throughout the System.



STANDARD DESIGN

Bell System directories are gradually becoming everywhere identifiable as such

The central figure of this new standard cover is the symbolic figure, "The Genius of Electricity," which surmounts the Bell System headquarters building in New York City. As modified for reproduction on directory covers, the figure is identified as the "Spirit of Communication." More than half of all System directories now bear this common design on their front covers, and this number is expected to be largely increased during the present year. Bell System telephone directories will be readily recognizable as such to telephone users in any part of the country, and the new cover will doubtless have a definite recognition value in much the same way that the Blue Bell has come to be known everywhere as the sign of the public telephone.

It is appropriate that this review of constant improvement in the planning and production of telephone directories should close with a reference to the symbolic figure of the "Spirit of Communication;" for it represents, when translated into action, the motives and the efforts of telephone people everywhere. To make telephone directories both more useful and more usable is all part of the obligation assumed by the Bell System in its pledge to provide "the best possible service." The record shows what has already been accomplished and is the sign that progress will continue.

HOW OUR POPULATION IS CHANGING

A Slower Rate of National Growth and of the Growth of Cities, and Other Significant Trends Revealed by the 1940 Federal Censuses, Are Important to the Telephone Industry

By ROBERT L. TOMBLEN

Some of the most revolutionary changes in American social history occurred during the 1930–1940 decade. Among the outstanding developments of this period were a greatly reduced population growth, with several states actually losing inhabitants; a sharp drop in the average size of the household, associated with a much more rapid rate of increase in number of families than in population; a drastic decline in city growth, due largely to a very marked slowing down in the rural-to-urban migration; the lowest rate of natural increase on record; and, for the first decade in history, a net outward migration from the United States. The returns of the 1940 Federal Census of Population, some of which are still preliminary, confirm and measure the changes which students of population have known were taking place in this country.

These developments are accounted for by a combination of unusual circumstances peculiar to the past decade and so pronounced in their effect upon national growth as to cause radical alterations in many previous population trends. Not only have past trends with respect to the size and geographical distribution of the telephone market undergone marked change, but the composition of this market has been vitally affected. The census data available at present permit only a quantitative analysis, but such an appraisal of population numbers and their location should prove helpful to the telephone industry in evaluating and anticipating future demands for its services.

National Population Growth

The total population of the United States on April 1, 1940, was 131,669,275, according to final returns of the Sixteenth Decennial Census. This figure represents an increase of 8,894,229, or 7.2 per cent, since 1930, as compared with a recorded growth of 17,064,426, or 16.1 per cent, between 1920 and 1930. The numerical gain between 1930 and 1940 is the smallest for any decade since the Civil War, and the per cent of increase is less than one-half of the lowest previous decennial rate in our national history.

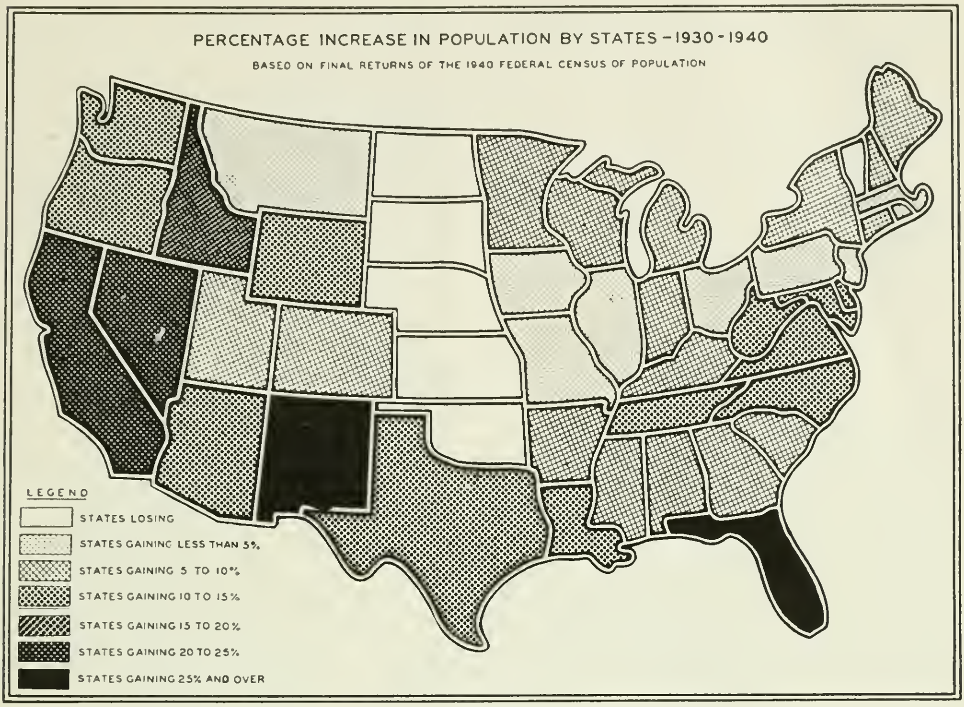
The decline in the rate of population growth was foreshadowed by the annual Government reports on vital statistics and foreign immigration. The reports of the Commissioner of Immigration show an excess of emigration over immigration from 1930 to 1940 of about 200,000 (including United States citizens who departed permanently), as against a net immigration of approximately 3,000,000 between 1920 and 1930. The reports of the Bureau of Vital Statistics show an excess of births over deaths between 1930 and 1940 of about 8,100,000. (Exactly corresponding figures for the 1920–1930 decade are not available, because the registration areas for births and deaths were far from complete during that period.) The net gain in population between 1930 and 1940 indicated by data from these two sources was 7,900,000, or about 1,000,000 short of the recorded census growth.

There are several possible explanations for this apparent discrepancy, among which the following seem to be the most logical. First, an improvement in the efficiency of census enumeration, such as characterized the 1930 count, may have been in evidence again in 1940, with the result that the reported population gain may be somewhat greater than the real growth. While cities in the aggregate probably were enumerated with a degree of accuracy fairly comparable to the 1930 standard, many rural areas seem to have been canvassed relatively better in 1940 than they were in 1930. Second, there may be some justification for the theory that vital statistics, particularly births, are not fully reported, and that some allowance for under-registration should be made in the official figures, especially in regions where the completeness of registration is still subject to question. Finally, there is always the possibility that official immigration figures are too low because of unreported aliens who may have been smuggled into this country or who otherwise entered it illegally. The relative validity of these explanations cannot be determined with any degree of accuracy until such additional information as the age and nativity composition of the population is published.

Urban and Rural Population

Final figures indicate that the urban and rural populations grew at nearly equal rates during the past decade, 7.9 per cent for the urban and 6.4 per cent for the rural. This represents a sharp contrast with the 1920–1930 decade, when the rate of increase in the urban population was more than six times the rural rate. Since there was very little difference between the urban and the rural rates of increase in the 1930–1940 decade, the proportions of the total 1940 population that were urban and rural remain approximately the same as they were in 1930: about 56 per cent and 44 per cent respectively.

One of the principal explanations of the growth in rural population between 1930 and 1940 lies in the relatively large increase in the number of persons living on farms during the decade. In this connection it might be noted that the United States Bureau of Agricultural Economics has estimated the farm population on January 1, 1940, to be 32,245,000, the



POPULATION CHANGES BY STATES

Percentage increases in the past decade ranged from 25 per cent and over (black) to minus figures (white)

largest in 24 years and close to the 1916 all-time high record of 32,530,000. The increase of 2,100,000 in farm population during the 1930's followed a decrease of 1,500,000 during the 1920's. Whereas the net migration from farms to cities during the 1920's was approximately 6,300,000, the corresponding figure during the 1930's was only 2,200,000 persons.

This difference was not due primarily to any substantial back-to-the-land movement largely offsetting the cityward migration, but to the fact that the farms retained a much larger proportion of their natural increase between 1930 and 1940 than in the preceding decade. Reduced employment opportunities in industry caused many young people to remain on farms who in normal times would have migrated to the cities. The number of youth reaching the age when migration is usually at its height increased during the past decade, and will continue to increase for several years more, as the effect of the peak in births of 1921–1925 is reflected in a correspondingly large number of young persons currently reaching maturity, when they ordinarily start out for themselves.

In some areas the greater utilization of abandoned or semiabandoned farms for subsistence farming by people who returned to the country after a stay in the city, or who retained their city jobs while supplementing their incomes by incidental farming operations, may have been a factor in rural growth. Furthermore, Government agricultural policies have tended to make commercial farming increasingly attractive during the past decade.

Growth by States and by Major Regions

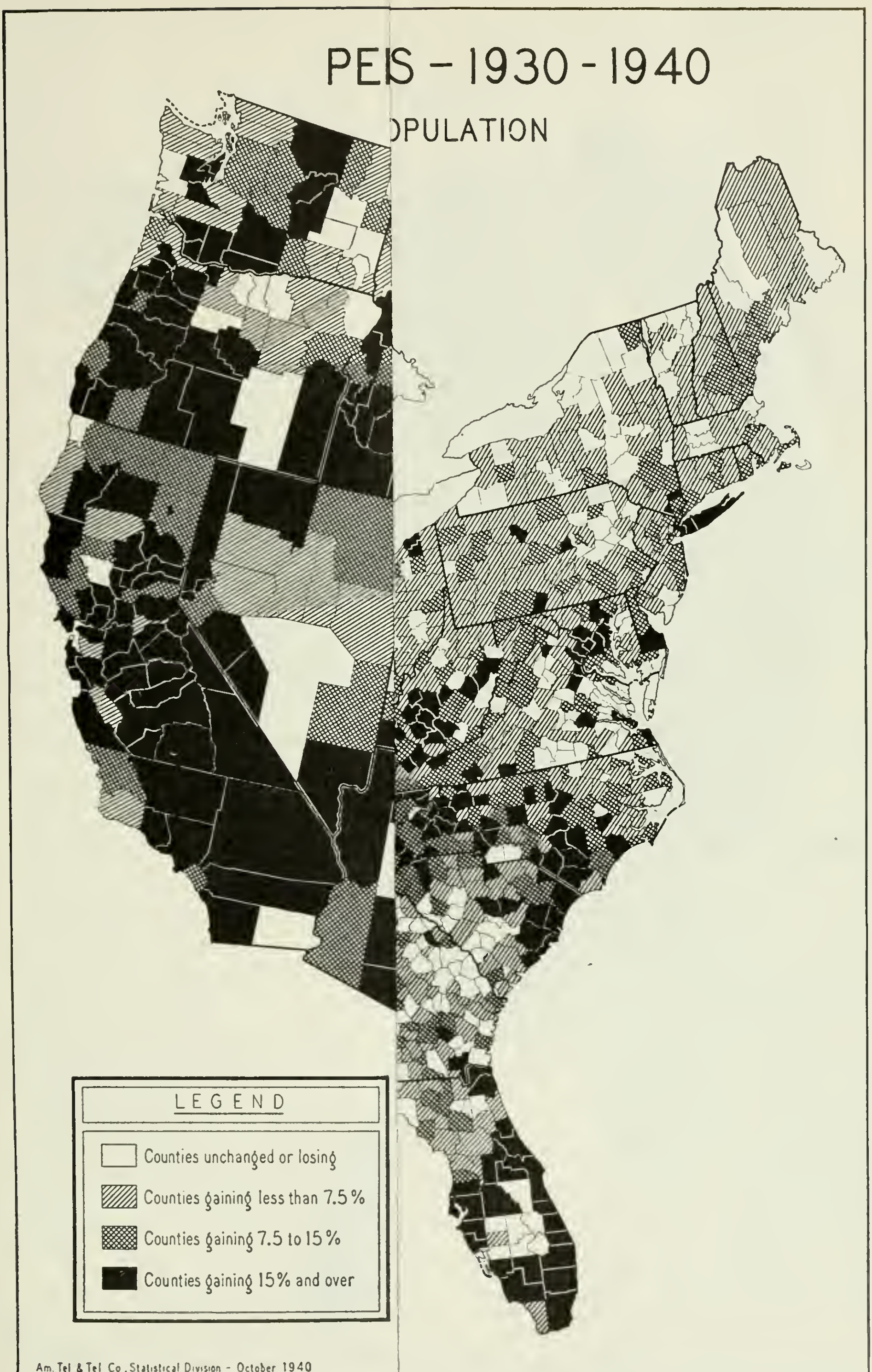
The population growth between 1930 and 1940 was very unevenly distributed among the states and the principal subdivisions of the country. This situation is brought out graphically on map on the preceding page. These wide variations in population changes during the past decade reflect not only differences in rates of natural increase but also extensive interstate migrations.

The states east of the Mississippi River received a slightly smaller proportion of the national increase between 1930 and 1940 than their proportion of the actual population in 1930, while the group of states between the Mississippi and the Rocky Mountains, which contained one-fifth of the total population in 1930, received only one-eighth of the decade growth and the states from the Rockies to the Pacific, with less than one-tenth of the 1930 population, gained more than 22 per cent of the ten-year increase.

A further consideration of these broad areas according to the division of their population gains between natural increase and migration reveals some interesting differences. Population growth in the states east of the Mississippi was about equal to their natural increase, with no appreciable migration in or out of this general region. However, there were such marked differences in the rates of natural increase between the northern and southern sections of this region that all the southern states grew faster than the country as a whole, while the northern states, with the exception of Michigan, had rates of gain below the national average. Within this eastern region three areas were conspicuous in their relatively heavy gains from inward migration, namely, the New York and Washington metropolitan areas, and Florida. At the same time Pennsylvania, although gaining 270,000 population, experienced a net outward migration of nearly 300,000 residents, the largest loss from this cause for any state.

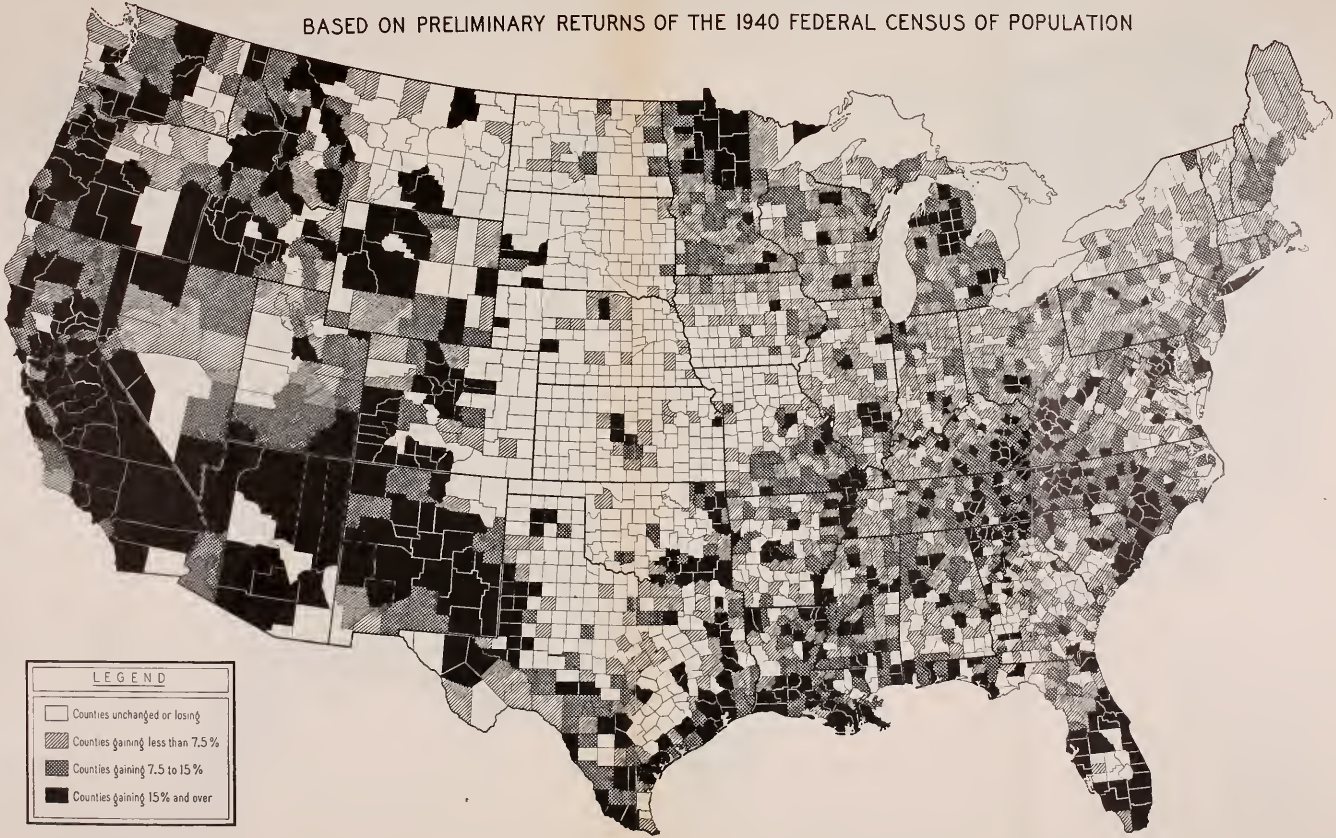
The central belt of agricultural states retained only one-half of their natural increase, losing about one million persons through net outward migration to other states. Most of this loss occurred in five states: North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma. Each lost population, the aggregate loss amounting to over 300,000. Among the possible explanations of these losses were successive prolonged droughts, excessive soil erosion, and severe dust storms, along with increased mechanization of agriculture which contributed to consolidation of farms and to reduced labor needs.

The western group of states grew four times as fast as the central area, despite the lowest rate of natural increase among the three regions, and gained about one million new residents


PES - 1930 - 1940
OPULATION
LEGEND
Counties unchanged or losing
Counties gaining less than 7.5 %
Counties gaining 7.5 to 15 %
Counties gaining 15% and over
Am. Tel & Tel Co., Statistical Division - October 1940

PERCENTAGE INCREASE IN POPULATION BY COUNTIES - 1930 - 1940

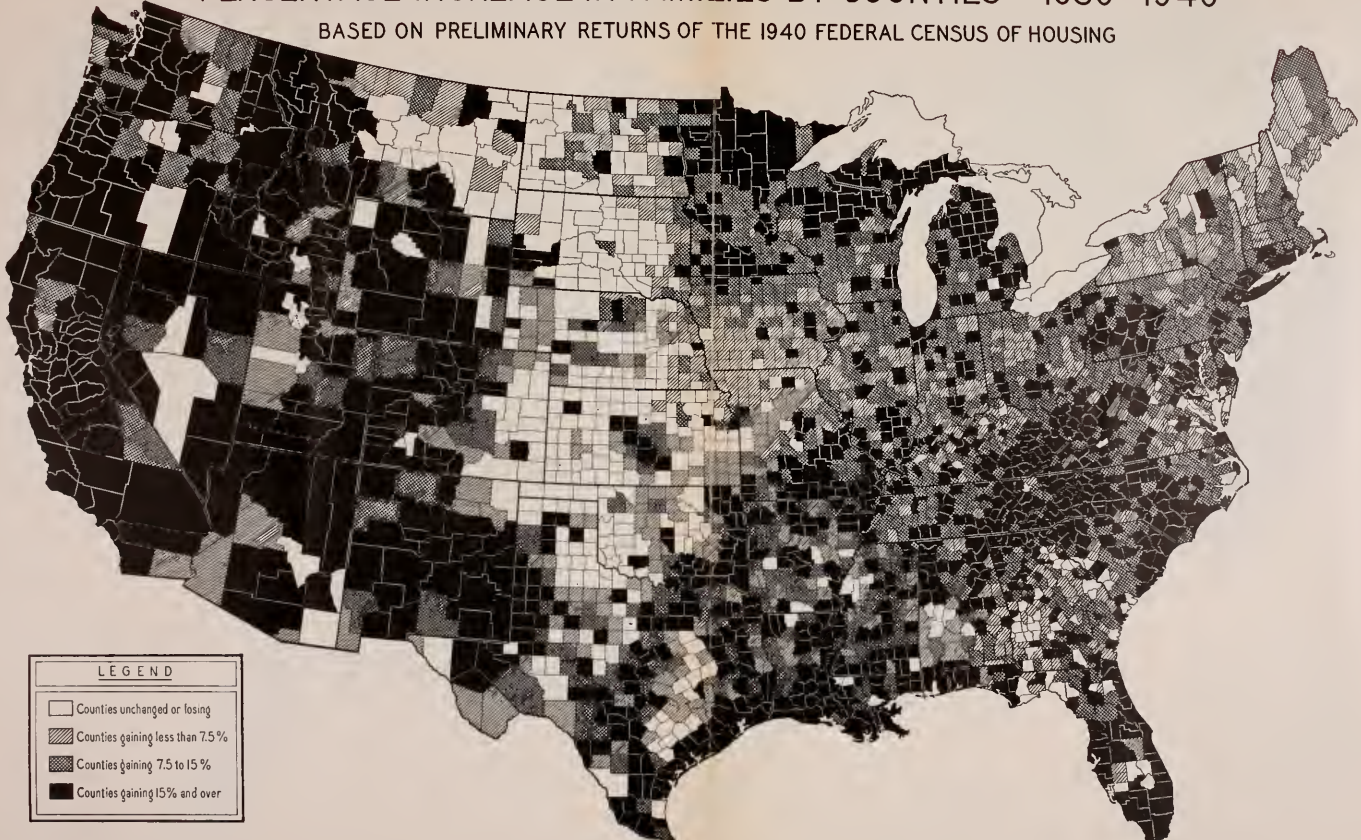
BASED ON PRELIMINARY RETURNS OF THE 1940 FEDERAL CENSUS OF POPULATION



Am Tel & Tel Co Statistical Division - October 1940

PERCENTAGE INCREASE IN FAMILIES BY COUNTIES – 1930-1940

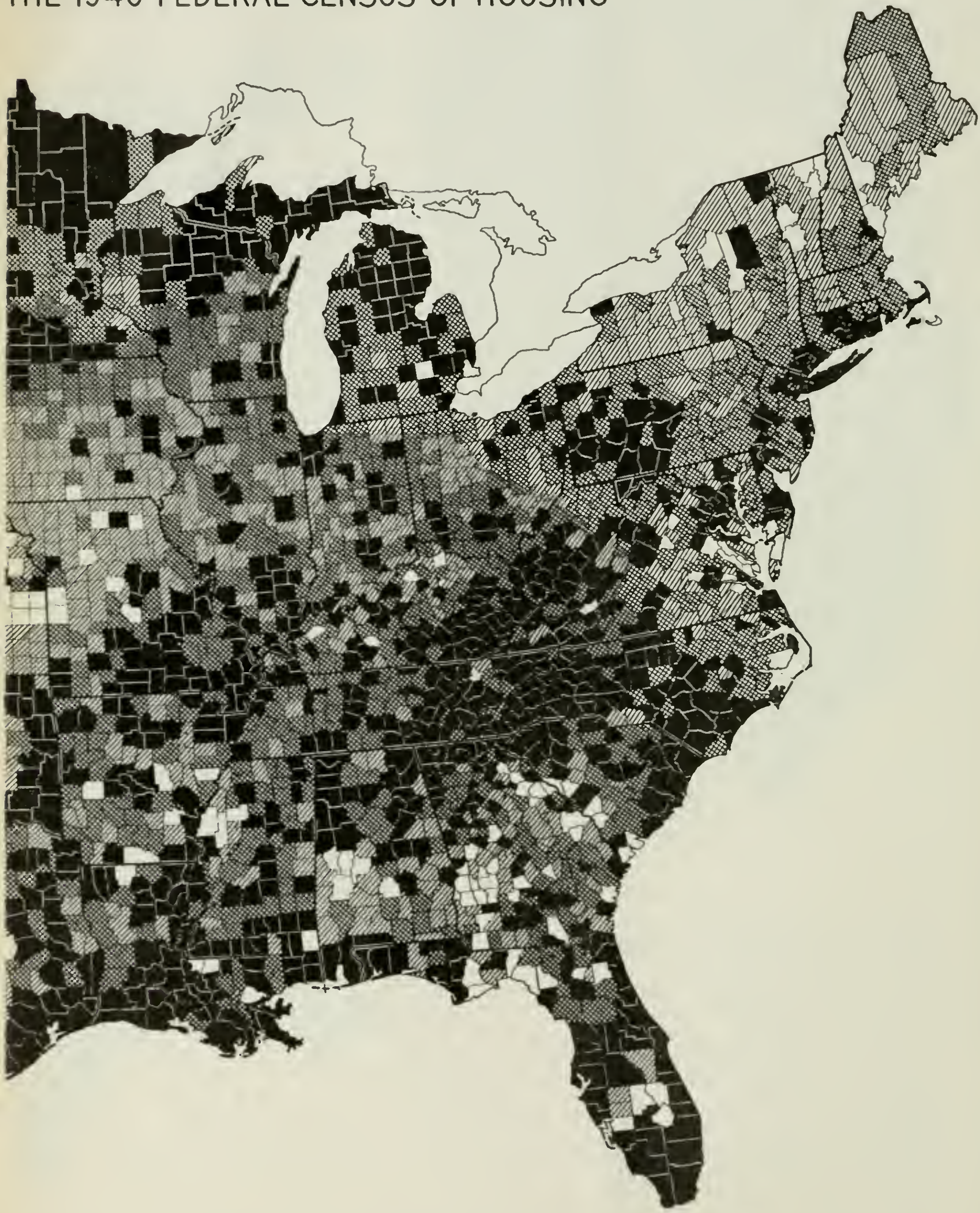
BASED ON PRELIMINARY RETURNS OF THE 1940 FEDERAL CENSUS OF HOUSING



Am. Tel & Tel Co. Statistical Division - December 1940

.IES BY COUNTIES - 1930 - 1940

THE 1940 FEDERAL CENSUS OF HOUSING



from net inward migration. Indeed, all these states except Montana grew faster than the country as a whole. In absolute numbers the increase of population in California was considerably greater than that in any other state, amounting to slightly over 1,200,000 as compared with nearly 900,000 in New York, the next highest state in this respect. Among the reasons for the rapid growth of the western region, the greater activity in silver mining and the influx of refugees from drought-stricken areas were undoubtedly important factors. Of course, California, like Florida, benefited materially from the inward migration of the retired classes.

A more detailed picture of population changes between 1930 and 1940 is available from the census returns by counties. The map opposite page 50 shows the relative population gains by counties during the past decade.

There were 983 counties, or 32 per cent of the total number, that had fewer inhabitants in 1940 than 1930, in contrast with only six states that lost population. One-third of these counties were located in the losing states, while another third of them were distributed elsewhere in the central area. Indeed, a large majority of the counties between the Mississippi and the Rockies lost population during the past decade. Counties in this region that gained population were largely concentrated in the coastal area and the lower half of the Mississippi River valley.

Growth by Cities

The material decrease in the rate of urban growth during the past decade is reflected in individual cities of all sizes throughout the country. The decline in the rate of growth between 1930 and 1940, as compared with the 1920–1930 period, was much more marked in the larger cities than in the smaller ones, however. The comparative figures for cities grouped according to size in 1930 are shown in the following table:

Size of City (Based on 1930 Population)	Percentage Gain	
	1920–1930	1930–1940
500,000 and over	23.8	3.7
100,000–500,000	23.2	5.4
50,000–100,000	28.9	4.2
25,000– 50,000	29.3	6.4
10,000– 25,000	31.2	8.3

With few exceptions, cities lost their drawing power for migrants from foreign countries, farms, and small towns. In fact, a large number of cities experienced a considerable net outward migration during the past decade. In many cases this migration exceeded their natural increase. Thus, 257 out of 982 urban places of 10,000 or more inhabitants in 1930 lost population between 1930 and 1940, whereas only 84 of the same communities declined in size in the preceding decade. Of the 93 cities having 100,000 or more inhabitants in 1930, 31 lost population during the past ten-year period. None of these big cities, except New Bedford, had ever recorded a loss in their entire history until the 1930–1940 decade. Among them are several of the largest cities in the country and they include such cities as Philadelphia, Cleveland, St. Louis, Boston, Newark, Kansas City (Mo.), Rochester, Jersey City, Toledo, Akron, Syracuse, Worcester, and Youngstown. Almost all of these 31 losing cities are industrial centers located in the northeastern states. Furthermore, 33 of the 98 cities between 50,000 and 100,000 population in 1930 declined in size during the past census decade. In some instances, however, the inclusion of communities suburban to these cities would erase the losses by small margins. The aggregate urban growth is commensurate with national growth only because a few metropolitan areas gained heavily, usually for special reasons.

There are other factors in addition to the decline in the birth rate and the cessation of immigration that account for the marked changes in city growth. Some of the slow urban growth can be attributed to the reduction in employment opportunities caused by curtailed business activity and by decentralization of industry. Another factor can be found in the movement of population toward residential suburban communities which can easily be reached by train, bus, and automobile, and which combine lower living costs and other advantages to make life more attractive there than in the large city. Thus, all over the country the suburban areas outside the large and even moderate-sized cities have grown rapidly, while the central cities themselves have experienced little gain or have even decreased in size.

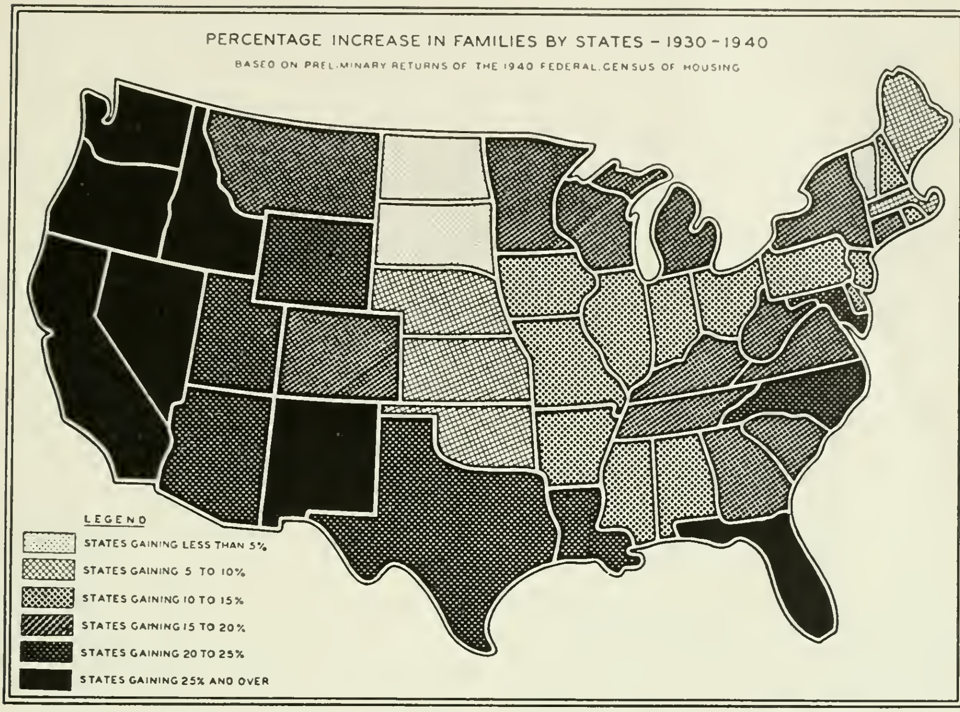
Of the cities which did experience growth, New York was first in numerical increase, while the next largest growth occurred in Los Angeles. Washington had the highest rate of growth among the large cities and also ranked third in amount of absolute gain, reflecting the great expansion of government activity during the decade. In this connection it is noteworthy that capital cities generally grew faster than their states, and considerably more rapidly than other cities in their size groups. This is shown in the accompanying table:

Size (in 1930)	Percentage Gain 1930–1940	
	Capital Cities	Other Cities
100,000 and over	8.4	3.9
50,000–100,000	12.7	2.9
25,000– 50,000	23.3	5.8
10,000– 25,000	23.1	8.0

Several other individual cities which experienced relatively large gains were in the coastal districts of Florida, Texas, and Southern California.

Family Growth

The Housing Census, introduced in 1940 and taken in conjunction with the Population Census, has furnished data on occupied dwelling units, which are approximately equivalent to the private family, or household, of the 1930 census. Final figures now show that the total number of occupied dwelling units, or families, in the United States on April 1, 1940 was 34,861,625. This figure represents a growth of 4,956,962, or 16.6 per cent, since 1930. Since population increased during the same period at the rate of 7.2 per cent, as already cited, it is apparent that during the decade from 1930 to 1940 the number of families increased at a considerably faster rate than did population. Indeed, this relatively greater growth



ALL STATES GAINED FAMILIES

Note that, in contrast with the map on page 49, no state suffered a net decrease in families

in families occurred in every state with a remarkable degree of consistency. The same situation held true for more than 97 per cent of all urban places of 10,000 or more inhabitants. This development may be considered a favorable factor from the standpoint of the telephone industry, in view of the fact that the residential market for telephone usage is usually measured in terms of households rather than of individuals.

Although six states lost population between 1930 and 1940, every state gained families during this period. The accompanying map indicates, for each state, the rate of family growth within specified limits. A comparison of this map with the one on page 49 will emphasize the relatively greater growth in households than in individuals and will reveal that many states with only nominal population gains, or even decreases, experienced relatively substantial family increases.

Furthermore, while 983 counties had fewer persons in 1940 than they had in 1930, only 402 counties lost families during the same period. The map opposite page 51 shows the location of the counties that lost families between 1930 and 1940 and also the distribution of the counties that gained according to their relative rates of growth. The table on page 54 shows the marked contrast in the percentage changes in population and in families by counties classified according to their rate of population gain.

Counties Classified by Their Rate of Population Gain	Number of Counties	Percentage Gain 1930–1940	
		Population	Families
Gaining Population:			
15.0% or more	558	26.3	36.2
7.5 to 15.0%	584	10.3	19.2
0 to 7.5%	947	3.6	12.8
Losing Population:			
0 to 2.5%	243	−1.1	8.3
2.5 to 5.0%	181	−3.5	4.9
5.0 to 10.0%	240	−7.0	2.5
10.0 to 20.0%	231	−13.5	−3.7
20.0% or more	88	−24.8	−14.9

The relatively larger growth of families than of population between 1930 and 1940 is reflected in the sharp decline in the average size of the household, which, for the nation as a whole, dropped from 4.10 to 3.78 persons. This change in the persons-per-family ratio was greater than in preceding decades and was due primarily to the cumulative effect of declining birth rates. Indeed, the number of adults per family has varied but little for several decades, while the number of children per household has declined steadily.

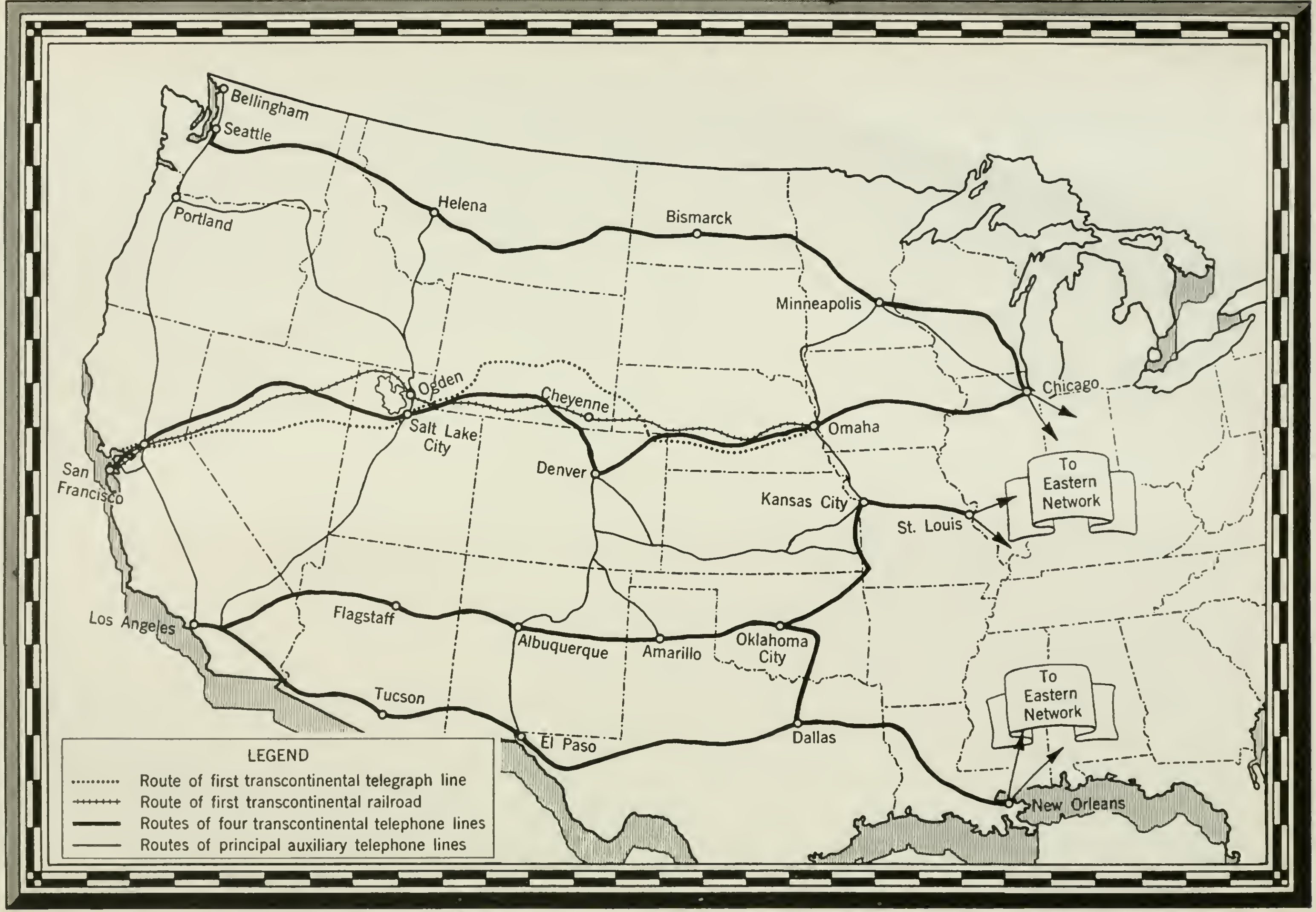
The decline in the average size of family was quite substantial in most states, ranging from practically no change in the District of Columbia to 0.46 persons per family in North Dakota, 0.44 in Washington, and 0.42 in Montana and Utah. The smallest average households were in the Pacific Coast states, with 3.22 persons in Washington, 3.23 in California, and 3.24 in Oregon. The largest families were in the South, where the average ratios were 4.52 in North Carolina, 4.37 in South Carolina, 4.28 in West Virginia, 4.27 in Virginia, 4.20 in Alabama, and 4.15 in Georgia.

As perhaps might be expected in view of the more rapid decline in city birth rates, the change in the average size of household was more pronounced in urban than in rural territory. The number of persons per family dropped from 3.98 in 1930 to 3.60 in 1940 for incorporated places of 10,000 or more inhabitants, while the corresponding decline in all other places was from 4.23 to 3.96.

The increase in the number of families since 1930 greatly exceeded the number of family living quarters provided by new construction, as indicated by building permit data. This apparent deficiency in new building in addition to the large accumulation of vacancies among dwelling units reported by the Housing Census implies that many living quarters have been subdivided in order to provide more low-rent dwelling units. The families that have been obliged to occupy these smaller accommodations because of reduced income during the depression have in most cases been forced to adopt a lower standard of living and have thereby become relatively poorer prospects for telephone service.

The Picture as a Whole

The most pronounced tendency indicated by the 1940 Federal Census is the sharp decline in the national rate of population growth to the lowest level ever experienced in this country. This is accounted for by the lowest rate of natural increase in our national history and by the fact that for the first time on record emigration from the United States exceeded immigration. The number of families, however, increased relatively faster than population and so the average size of household dropped sharply. Sizeable shifts in population caused a considerable redistribution of people throughout the country, with marked gains occurring in some areas and large losses in other places. In contrast to the 1920–1930 decade, economic conditions between 1930 and 1940 were far less favorable to industrial activity and urban employment, with the result that there was a marked slowing-down in city growth, with many cities actually declining in size. Despite the rapid growth of some resort centers through the influx of tourists and retired classes, there has been a deterioration in living standards for large numbers of the population. All of these changes have a bearing on the market for telephone service, and consideration of them is important to the telephone industry in planning for additional facilities.



STEPS IN TRANSCONTINENTAL COMMUNICATION

THE CONQUEST OF A CONTINENT

The Successive Means Which Have Been Devised for Coast-to-Coast Communication Have Been Fundamental to the Growth of This Country and to Its Unity as a Nation

By ROBERTSON T. BARRETT

PART III*

PART I of the present article contained an outline of some of the social and economic factors which have led to the development of various means of transcontinental communication, and touched upon those facilities which antedated the use of steam for land transportation from coast to coast. In Part II, the roles played by the railroad and the airplane as factors in communication between the Atlantic and the Pacific were discussed. Thus we have considered those instrumentalities of communication which, beginning with the Pacific mail steamers of nearly a hundred years ago and ending with the air mail planes of today, have depended on the physical transportation of written messages. In this concluding section of the discussion, we turn to those products of man's inventive faculty which, in one form or another, have employed electricity for the transmission of intelligence over distances.

* Parts I and II appeared in the BELL TELEPHONE QUARTERLY for July and October, 1940.

The first of these was the electric telegraph. We are not concerned with its invention, in the form that it took in America, by Morse; nor with the picturesque history of its development in the United States up to the point where its use was seriously considered as a means of transcontinental communication. Even when so limited, our subject takes us back more than eight decades.

If the name of Butterfield is to be linked with the Overland Mail, and that of Russell with the Pony Express, the name of Hiram Sibley should be forever associated with the building of the first telegraph line that connected the Atlantic and Pacific coasts. As early as 1857—hardly more than a dozen years after Morse's historic transmission of the sentence "What hath God wrought!"—this far-seeing ex-sheriff of Rochester, New York, was seriously proposing a coast-to-coast telegraph line. He submitted his project first to the Board of Directors of the Western Union Telegraph Company, of which he was president.

Sibley's experience provides a striking example of what can be accomplished by one man when fired by an idea for which he is willing to fight. His proposal at first found his associates of the Western Union directorate so conservative as to drive him to the point of ill-concealed exasperation. It is said that in one of their early conferences, when the argument on his proposal had been particularly protracted, Sibley rose from his chair, stalked toward the door, turned and said crisply, "Gentlemen, if you won't join hands with me in this thing, I'll go it alone."

The hesitancy of those who objected to the proposal that the Western Union proceed with the project on its own account was not without justification in sound business judgment. Many of them shared with Sibley a conviction as to the importance of building a transcontinental telegraph line but, according to James D. Reid, in "The Telegraph in America," felt that "it was too hazardous a venture to be undertaken by a company having the care of so many interests, and which was not yet thoroughly established in some of its undertakings."

Sibley also proposed his plan to the North American Telegraph Association, an organization which included in its membership representatives of a number of companies not connected with the Western Union, at a meeting held in August, 1857. As such organizations still do, the association passed a resolution appointing a committee to devise measures by which the work might be prosecuted. And, as committees sometimes still do, the committee accomplished little or nothing.

Nevertheless, Sibley did not have to "go it alone," although he provided most of the driving force and enthusiasm which pushed his project forward to final fulfillment. To supplement the support which he hoped to get from private investors, he enlisted the coöperation of other Western Union directors in applying to the government for a subsidy to finance a part of the cost of the building of the line.

Aid from Congress

At length, after Sibley, with the prestige of the Western Union behind him, had conducted a masterful campaign in Washington, an act of Congress was passed, on June 16, 1860, "to facilitate communication between the Atlantic and Pacific states by electric telegraph."

The following November 1, Salmon P. Chase, Secretary of the Treasury, executed a contract with Sibley, individually. Among its provisions were two of which the substance was as follows:

1. The line was to be completed within ten years following July 31, 1860.
2. The government was to pay a subsidy of $40,000 a year for ten years, to be "taken out in trade." In exchange for this subsidy, the government was given certain service preferences, and certain government bureaus or agencies were to be given free service, during the life of the subsidy.

Meanwhile, steps were under way that led to an arrangement which disposed of the most serious objections to Sibley's original plan. A separate

THE PONY EXPRESS SALUTES THE TELEGRAPH

This old drawing of the extension of the telegraph lines across the plains was originally published in Harper's Weekly

company was organized to undertake the building of the line westward toward the Pacific. This was the Pacific Telegraph Company. Its principal stockholders were largely directors of the Western Union, but its funds were provided by them as individuals, not by the Western Union as such.

Selection of a Route

MEANWHILE, too, Jeptha H. Wade, of the Western Union, had gone to California and presented the project to a number of telegraph companies which were operating independently of each other in that state. Catching some of Sibley's enthusiasm, as a result of Wade's conferences with them, the executives of these companies agreed upon a merger with the California State Telegraph Company. It was also agreed that this company should follow the example of the Western Union and organize a separate company—the Overland Telegraph Company—to build the line eastward.

The selection of a route was a difficult problem. This important phase of the work Sibley assigned to Edward Creighton, the only man whose training and experience qualified him for the task. After rejecting two alternative routes as being too long, Creighton personally surveyed the line finally chosen, beginning this historic piece of communication engineering on November 18, 1860. With the exception that its eastern terminus was Omaha, instead of St. Joseph, Missouri, this route substantially followed the route of the Pony Express, which we have already described. Creighton covered the distance from Omaha to Salt Lake City by stage coach, but from this point westward he made the difficult journey alone, on the back of a mule. On the basis of his report, arrangements were pressed for beginning construction of the line at the earliest practicable date.

Building Begins

Actual building began—as if in recognition of the important part the line was to play in the affairs of the nation—on July 4, 1861. Creighton himself took charge of operations for the Pacific Telegraph Company, which built westward from Omaha, his assignment covering a 700-mile stretch which was to connect with a 400-mile line to be built by Charles M. Stebbins, working eastward from Salt Lake City. The crews of the Overland Telegraph Company, in charge of James Gamble, began at Fort Churchill, which had previously been linked with San Francisco, and worked eastward to Salt Lake City, which was agreed upon as the point at which the eastern and western sections of the completed line were to meet. A bonus or prize was to be paid by the losers to the builders who reached that city in advance of the others.

But considerations more important than the winning of bonuses or prizes made speed the essence of success in this difficult task which was being undertaken. Issues between North and South had reached and passed the breaking point; Fort Sumter had been fired upon. It became doubly important that every possible link which would assure the loyalty of California and Utah to the Union be strengthened without delay.

To this critical need, both groups of builders responded with a will. Armies of men, oxen, mules, with necessary supplies and equipment, were put to work at different points of the line. Despite the natural difficulties inherent in the task of building a line through rough terrain, across a region largely uninhabited; despite misunderstandings with local contractors in Utah, who had agreed to furnish poles and then decided that the price which they had agreed upon was too low; despite mistrust, if not open opposition, on the part of the Indians, which required a high degree of diplomatic skill to overcome—despite all this, and much more, the line was built.

Completed in Record Time

And it was built at a speed which made the ten-year limitation provided for in Secretary Chase's contract seem almost humorous, when contrasted with what was actually accomplished. On October 18, 1861, Creighton raised the last pole on the Omaha-Salt Lake City section of the line. On October 22, Gamble's men—who had worked through far more difficult country—reached Salt Lake City. On October 24, the Atlantic and the Pacific were linked by telegraph. To Abraham Lincoln, in the White House, there must have been special significance and special cause for gratitude in the words which the telegraph ticked off:

> "The people of California desire . . . to express their loyalty to the Union and their determination to stand by its government on this, its day of trial."

The cost of building the line was estimated, in advance of construction,

PONY EXPRESS, OVERLAND MAIL, TELEGRAPH

These three modes of communication, contemporaneous for a brief interval, are here pictured by William H. Jackson, Secretary of the Oregon Trail Memorial Association, at the Red Buttes stage and pony express station

at between $400,000 and $600,000. Probably its actual cost was nearer the latter figure than the former. The expense of maintaining the line was estimated at $150,000 a year.

Determining the rates which should be charged for telegrams over the coast-to-coast line was a difficult problem. Few, if any, of the communication services which had hitherto been established across the continent had paid their own way, and it seemed probable that, even with the government subsidy, this might be the case with the transcontinental telegraph, unless in fixing the rates a wise balance could be maintained, with due regard to the investment in the line, the value of the service, and the public demand for it. The rates finally fixed, for telegrams from San Francisco to the following points, were:

	Ten words	Additional word
St. Louis	$5.00	$.45
Chicago	5.60	.40
New York	6.00	.75
Boston	7.00	.60

One measure of the advances that have been made in the communication art since the building of this pioneer transcontinental telegraph line may be had by contrasting the above rates with those now in effect. The Western Union's present rate between San Francisco and St. Louis or Chicago is $.90 for the first ten words and six cents for each additional word. Between San Francisco and New York or Boston, the rate is $1.20 for the first ten words and eight and one-half cents for each additional word. These rates are for regular telegraph messages. Day letters and overnight telegrams may be transmitted considerably more cheaply.

Modern Telegraph Facilities

But the cost of a communication service is never the full measure of its value. The expense of transmitting President Lincoln's annual message of 1862 from Washington to San Francisco is stated to have been $600—which was not considered too high a price at a time of crisis when every word of the national executive was fraught with meaning. Similarly, the importance of the role played by the facilities provided by the two principal telegraph companies which serve America today cannot be gauged by the cost of sending any particular telegram, nor by the total sums paid to them each year for their services.

Statistics afford some measure of the extent of these services, to be sure. According to the Federal Communication Commission's "Selected Financial and Operating Data from Annual Reports of Telegraph, Cable and Radiotelegraph Carriers" for the year ended December 31, 1938 (the most recent available at the time of writing) the Western Union Telegraph Company had operated during that year a total of 213,123 miles of pole line; 5,005 miles of single-duct underground conduit; 3,713 independent and 16,258 joint telegraph offices. It had handled during the year 146,063,679 domestic telegraph revenue messages. During the same period the Postal Telegraph-Cable Company's land line system had operated 32,094 miles of pole line; 1,104 miles of single duct underground conduit; 1,980 independent and 2,377 joint telegraph offices. It had handled 40,288,453 domestic telegraph revenue messages.

Behind these bare statistics, if it could be read, is written the story of the nation's industrial, commercial and social life, in which each of these telegraph messages, speeding over miles of wire, had played its part, great or small.

How much of this large volume of telegraph business was transcontinental, it is impossible even to estimate. It is hardly more possible to estimate how much of the total wire mileage operated by these telegraph companies might be described as belonging to transcontinental circuits. Both companies maintain large numbers of permanently set-up circuits from coast to coast. In addition to these, there are many alternative routes which may be "patched in" for use in transcontinental communication if this becomes necessary or desirable for any reason.

Out of the development of telegraph, and later, of telephone service, have grown the network of private teletypewriter or printing telegraph lines, and the news and stock ticker systems that play so important a part in the business life of modern America.

Teletypewriter Exchange Service

Of particular interest in connection with a discussion which centers around the establishment of transcontinental telephone service is a form of communication by the written word

FIRST TELEGRAPH OFFICE IN SALT LAKE CITY

It was here, in October of 1861, that the wires from East and West were joined

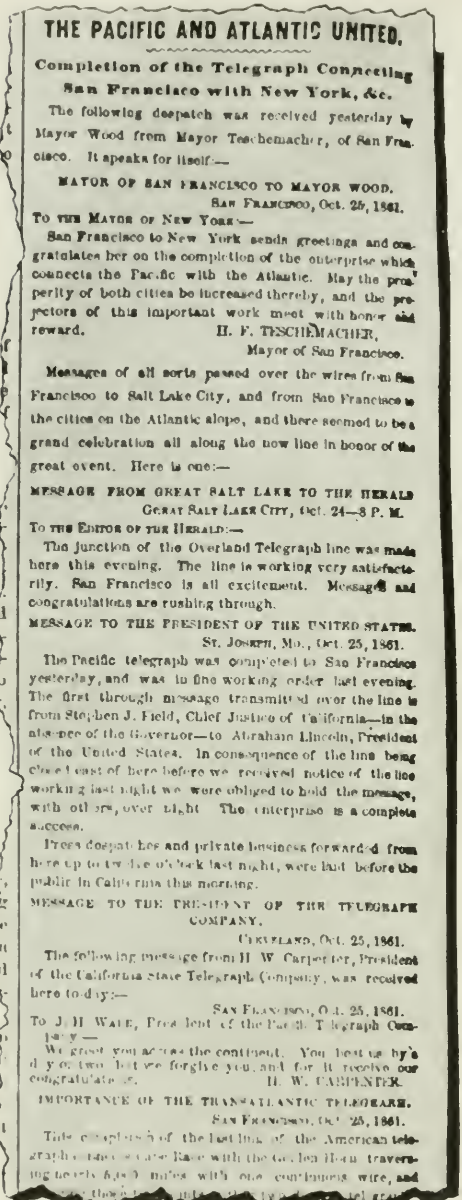
which is in some important respects analogous to telephone service and which utilizes telephone facilities for transmission—the so-called TWX or teletypewriter exchange service which for some years has been provided by the Bell System.

As its name implies, the teletypewriter is a device for "far-typewriting." It makes possible the electrical transmission of messages in typewritten form. Whatever is typed on the keyboard of the apparatus, while functioning as a transmitter, is transformed into electrical impulses which travel over the circuit to the distant apparatus which, functioning as a receiver, reproduces the original message exactly as it was typed on the transmitting machine. In most cases, the same machine may be used either for transmitting or receiving.

For many years, the Bell System has been providing private-line teletypewriter service to large numbers of subscribers. In 1931 it inaugurated teletypewriter exchange service, which enables any subscriber to the service to be connected with any other subscriber, after which transmission may be in either direction, as above described. This service has been discussed in detail in previous issues of the BELL TELEPHONE QUARTERLY.*

In the nine years that have elapsed since the inauguration of teletypewriter exchange service, its growth has been little less than phenomenal. The TWX directory of July, 1940, shows 13,337 customer stations and 218 of-

* "Modern Business Adopts the Teletypewriter," by J. M. Tuggey; QUARTERLY, October, 1935. "'TWX'—Its Growing Importance to the Nation's Business," by R. E. Pierce and J. V. Dunn; QUARTERLY, October, 1937.



THE PACIFIC AND ATLANTIC UNITED.

Completion of the Telegraph Connecting San Francisco with New York, &c.

The following despatch was received yesterday by Mayor Wood from Mayor Teschemacher, of San Francisco. It speaks for itself:—

MAYOR OF SAN FRANCISCO TO MAYOR WOOD.

SAN FRANCISCO, Oct. 25, 1861.

TO THE MAYOR OF NEW YORK:—

San Francisco to New York sends greetings and congratulates her on the completion of the enterprise which connects the Pacific with the Atlantic. May the prosperity of both cities be increased thereby, and the projectors of this important work meet with honor and reward.

H. F. TESCHEMACHER,
Mayor of San Francisco.

Messages of all sorts passed over the wires from San Francisco to Salt Lake City, and from San Francisco to the cities on the Atlantic slope, and there seemed to be a grand celebration all along the new line in honor of the great event. Here is one:—

MESSAGE FROM GREAT SALT LAKE TO THE HERALD.

GREAT SALT LAKE CITY, Oct. 24—8 P. M.

TO THE EDITOR OF THE HERALD:—

The junction of the Overland Telegraph line was made here this evening. The line is working very satisfactorily. San Francisco is all excitement. Messages and congratulations are rushing through.

MESSAGE TO THE PRESIDENT OF THE UNITED STATES.

ST. JOSEPH, Mo., Oct. 25, 1861.

The Pacific telegraph was completed to San Francisco yesterday, and was in fine working order last evening. The first through message transmitted over the line is from Stephen J. Field, Chief Justice of California—in the absence of the Governor—to Abraham Lincoln, President of the United States. In consequence of the line being closed east of here before we received notice of the line working last night we were obliged to hold the message, with others, over night. The enterprise is a complete success.

Press despatches and private business forwarded from here up to twelve o'clock last night, were laid before the public in California this morning.

MESSAGE TO THE PRESIDENT OF THE TELEGRAPH COMPANY.

CLEVELAND, Oct. 25, 1861.

The following message from H. W. Carpenter, President of the California State Telegraph Company, was received here to-day:—

SAN FRANCISCO, Oct. 25, 1861.

To J. H. WADE, President of the Pacific Telegraph Company:—

We greet you across the continent. You beat us by a day or two, but we forgive you, and for it receive our congratulations. H. W. CARPENTER.

IMPORTANCE OF THE TRANSATLANTIC TELEGRAPH.

SAN FRANCISCO, Oct. 25, 1861.

The completion of the last link of the American telegraph [illegible] with the Golden Horn, traversing nearly [illegible] miles with one continuous wire, and

A CONTEMPORARY ACCOUNT

This announcement of the consummation of a great undertaking, and summaries of congratulatory messages exchanged between the Atlantic and Pacific coasts, is reproduced from the New York Herald *of October 26, 1861*

ficial stations. These include subscribers in 1501 different towns. With cross references, the book contains 1871 separate locality listings, made up not only of the more important cities from coast to coast, but of hundreds of relatively small communities. To meet the needs of these varying sized communities, new types of TWX switchboards have been developed, and circuit setups have been improved. Scientific research and engineering skill, which gave the telephone a nation-wide reach, have given this new form of transcontinental service a network of facilities, and an acceptance by the public, that is also continent-wide.

Transcontinental Wireless Telegraph

WE have thus far considered only those instrumentalities of transcontinental communication which have as their purpose the physical transportation of written messages, or the electrical transmission of such messages over physical, wire circuits. Let us turn briefly to the part which the wireless (or radio) telegraph plays in providing contacts between the two coasts of the United States.

Lack of space forbids an extended discussion of the early experiments of Hertz or the contributions of Clerk-Maxwell, Fleming, and others to the development of wireless communication. We cannot, indeed, dwell on Marconi's discoveries and inventions of practical means of sending messages through space, or on the developments in that field in which men like DeForest, Fessenden, and Alexanderson have played important parts.

It early became evident that the chief field of usefulness of the radio telegraph (and later of the radio telephone) was for communication between points which could not practicably be connected by land wires or cables. One of its first uses, as might have been expected, was in providing service between ships at sea and stations on shore. Its next field was in the establishment of transoceanic telegraph service, often in direct competition with existing telegraph cable services.

Following the establishment of such overseas telegraph services, the radio companies of the United States established overland radio services, primarily as a means of relaying messages from overseas, but secondarily as a means of providing purely domestic point-to-point communication. Such radio telegraph services have been inaugurated and are operated by the Radio Corporation of America, the Mackay Radio and Telegraph Company and Press Wireless, Inc. As above intimated, it is probable that the greater part of the traffic handled over these transcontinental radio telegraph channels is supplemental to transoceanic services. These companies, however, do a considerable amount of purely domestic business between a limited number of points.

Transcontinental Wire Networks for Radio Broadcasting

RADIO broadcasting is so essentially different in purpose from the point-to-point service provided by the facilities of the Bell System that it might almost be considered a different form of communication, and to deserve a section of its own in any study of the means which have been developed for linking the eastern and western coasts of the American continent. Broadcasting, as it is known in the United States today, particularly in its transcontinental aspects, is so vitally dependent upon networks of wire telephone circuits that the two means of communication become, in some respects, different forms of the same thing.

The story of the development of radio broadcasting, and of the place which telephone networks have had in this development, has been treated so often and so fully that there is little point in here dwelling on it at length. The transcontinental aspects of this development may, perhaps, deserve more than mere mention, for certainly the remarkable growth of radio broadcasting has been a vitally important factor in the recent economic, social, and political history of the United States.

A transcontinental telephone hook-up was first demonstrated to the public as an adjunct to radio broadcasting on February 8, 1924, when seven stations, at Havana, Washington, New York, Providence, Chicago, Oakland, and San Francisco were linked by 5,141 miles of wire, for the simultaneous broadcasting of a program being held at a dinner of the Bond Club, at the Congress Hotel, Chicago. General John J. Carty, who was in charge of proceedings at Chicago, "called the roll of the Continent" and twenty test stations, along the circuit linking Havana with the Golden Gate, responded as their names were called. Millions of people undoubtedly listened to this dramatic demonstration of the extent of the facilities of the telephone system, and of the possibilities of radio broadcasting on a coast-to-coast scale. More than 4,000 letters were received by station WEAF, in New York, alone, expressing admiration for what was then considered an outstanding achievement of science and engineering, and is today accepted as a commonplace.

From this beginning grew the transcontinental radio broadcasting networks of today, over which it is not uncommon to serve more than 500 radio stations, with radio listeners running into millions that it is almost impossible to estimate. This development, in turn, had its beginning when the first transcontinental telephone line was built, twenty-five years ago—although the transmission afforded over that line would be far from satisfactory for broadcasting purposes today. Circuits intended for use in radio networks have to be specially engineered in order to provide the high quality of sound reproduction that their purpose demands.

Not Unlike Evolution

Such is the background against which must be viewed the opening for service of the first transcontinental telephone line, just a quarter of a century ago. We have called this development of coast-to-coast communication facilities the "conquest of a continent," and such it has been—a peaceful conquest achieved by a succession of steps, each one of which has followed the others by a process not unlike that of evolution.

As has been seen, there has been an irresistible force which has prompted Americans, from the very beginning of their history, to push their frontiers farther and farther westward. But there has been another force, equally irresistible—the urge to link these westward-moving frontiers with that which lay to the east of them. In doing this, Americans have inevitably chosen the best form of communication that, at any given time, man had been able to create. Always they have made use of the swiftest, most direct, and most dependable means then available for speeding their messages.

That the telephone would, some day, be numbered among these instrumentalities of transcontinental communication was almost a matter of predestination from the moment Bell spoke his first full sentence over an electric wire—*"Mr. Watson, come here; I want you!"* It was the wants of the American people—their social and economic and political needs—that made manifest the destiny of Bell's then crude instrument. Coast-to-coast telephone service was created, a quarter of a century ago, because nothing less direct and personal could longer meet the new and growing needs of the American nation.

Times of Testing

By one of those unexplainable "coincidences" with which history is filled, this pioneer transcontinental telephone line was completed just in time to play its part in meeting a great national crisis. Even while gangs of linemen were setting its poles and stringing its wires, the nations of Europe were engaged in a titanic struggle. Hardly more than two years after it was opened for service, the United States entered that conflict. Just as Overland Mail, Pony Express and Transcontinental Telegraph had, in turn, played their part in American life during a period of crisis, so this highway for coast-to-coast communication by the spoken word was to play its part when the American people were passing through a new time of testing.

To the first Transcontinental Telephone Line have been added three others. In a quarter of a century, telephone service has been speeded up, made vastly more efficient, more economical. Epochal advances have been made also in other forms of coast-to-coast communication that serve America—the railway and air mail services, telegraph service by land lines and by wireless, radio broadcasting.

ONCE more, America faces troublous days—days filled with problems which can be solved only by a people possessed of a common purpose, prepared for common action. That, just at this time, all of these facilities for the exchange of thought and opinion have been brought to so high a degree of effectiveness, may be only another "coincidence." But to those who are engaged in providing them, these continent-spanning instrumentalities for national unification are more than the mere results of fortuitous circumstance. They are manifestations of an age-old purpose, any contribution to the achievement of which by present-day Americans is a high privilege, carrying with it large responsibilities.

That purpose has created the wires and waves and rails and pathways for planes which stretch from the Atlantic to the Pacific today, as it created the Overland Mail and the Pony Express. It is a purpose that was best stated when our American form of government came into being: "We, the people of the United States, *in order to form a more perfect union. . . .*"

FOR THE RECORD

THOMAS I. PARKINSON ELECTED A DIRECTOR

At the meeting of the Board of Directors of the American Telephone and Telegraph Company on November 20, Thomas I. Parkinson was elected a Director to fill the vacancy caused by the death of Hale Holden. Mr. Parkinson is President of The Equitable Life Assurance Society of the United States, and has been a director of the Western Electric Company, Inc.

F. P. LAWRENCE IS NEW HEAD OF LONG LINES

Frank P. Lawrence, Vice President and General Manager of the Manhattan Area of the New York Telephone Company, has been elected Vice President of the American Telephone and Telegraph Company in charge of the Long Lines Department, effective January 1. Mr. Lawrence succeeds Vice President Cleo F. Craig, who will take charge of the Department of Personnel Relations upon the retirement of Vice President Karl W. Waterson next March. Mr. Lawrence was born in Newark, New Jersey, and was graduated from Lehigh University. He entered the telephone business in 1912 as an engineer in the Southwestern Bell Telephone Company in St. Louis. He served in Kansas and Oklahoma before coming to New York in March, 1929, as General Plant Manager for the Upstate Area, with headquarters in Albany. He moved to New York City in 1933 and was elected Vice President and General Manager in 1938.

RADIO TELEPHONE SERVICE OPENED WITH GREECE

Greece was brought within reach of Bell and Bell-connecting telephones on January 12, when the A. T. & T. Company's transatlantic telephone service was extended to include that country. The new service is provided by means of a short wave radio circuit between New York and Berne, Switzerland, and from there to Athens by means of land lines via Zurich and Belgrade. The New York-Athens connection is nearly 5,000 miles long.

NOW MORE THAN 17,600,000 BELL TELEPHONES

In 1940 there was a net gain of about 949,900 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 876,000 in 1937. The gain in 1939 was 775,000. At the end of December, 1940, there were about 17,483,800 telephones in the Bell System. The gain during January of 1941 was about 129,400, bringing the total Bell System telephones to about 17,613,200 as of January 31. By the end of 1940, all the operating telephone companies in the Bell System had passed their pre-depression peak numbers of telephones in service.

The total number of telephones in the United States which could be interconnected, including those of the Bell System and several thousand independent telephone companies, was about 21,830,000 at the end of 1940. As of January 31, 1941, the number is approximately 22,000,000.

THE "QUARTERLY" BECOMES THE "MAGAZINE"

Beginning its twentieth year with the present issue, this publication changes its name from the *Bell Telephone Quarterly* to the Bell Telephone Magazine. While no change in editorial policy is contemplated, the new name seems more appropriate to the magazine's scope and content, and the change of title will permit greater flexibility of publication dates.

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 re-entered 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 several articles to the Quarterly, of which the most recent was "At the Customer's Service," in the issue for October, 1940.

Graduating from Purdue University with the degree of B.S. in E.E. in 1921, Otis M. Hancock entered the Bell System immediately as a student engineer with the Ohio Bell Telephone Company in Cleveland. After completing the student training course he was assigned to commercial work, and in 1923 was made Directory Production Supervisor. In 1927 he joined the staff of the Commercial Engineer of the A. T. & T. Company, and since 1929 has been in charge of the group handling directory production and service problems.

Bates College graduated Robert L. Tomblen with the degree of B.A. in 1914, and Worcester Polytechnic Institute with the degree of B.S. in E.E. in 1917. He joined the Long Lines Department of the A. T. and T. Company in July of the latter year as a student in traffic engineering, but left for military service in September. After 19 months of army duty in this country and overseas he rejoined the A. T. and T. Company in the Commercial Engineer's Division of the Department of Operation and Engineering. Here he was engaged for several years in making commercial surveys of some of the principal cities of the country. In 1929 he transferred to the Chief Statistician's Division of the Comptroller's Department, where he continued his market research and population studies. He is a member of the Population Association of America, and has contributed a number of articles to the QUARTERLY, the most recent being "The Sixteenth Decennial Census," in the issue for April, 1940.

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. In 1921 he joined the Information Department of the A. T. & T. Company, and since 1936 he has combined his duties in that department with those of Historical Librarian of the A. T. & T. Co. He is editor of the *Telephone Almanac*, and has contributed a number of articles to the QUARTERLY, the most recent being "The Telephone as a Social Force" in the issue for April, 1940.

Bell Telephone Magazine

Vol. XX | May, 1941 | No. 2

American Telephone & Telegraph Co. • New York

BELL TELEPHONE MAGAZINE

Continuing the Bell Telephone Quarterly

A Medium of Suggestion and a Record of Progress

VOL. XX MAY, 1941 NO. 2

Published by the Information Department of the
American Telephone and Telegraph Company
195 Broadway, New York, N. Y.

A BELL SYSTEM TOLL ROUTE

Along this cross-country right of way the newer aerial cable (foreground) supplements the open-wire line, which is still in service. Other types of cable are laid under ground. *See "Trends in Toll Cable Usage," beginning on page 97*

ENGINES FOR DEFENSE

The Danger of Interruptions to Telephone Service Is Further Guarded Against by Numerous Installations of Emergency Power Equipment for Charging Central Office Batteries

By FRED K. ROWE

In a recent mystery novel, two of the characters, discussing the effects of power interruption on the life of a great city, have the following conversation:—

" 'What about the telephone? I suppose it would go too?' The other shook his head. 'That's one of the companies which have had enough foresight to prepare for emergencies. They have a secret power plant of Diesel engines safely hidden away.' "

The book is fiction, but the statement—except for the reference to secrecy—is essentially a fact.

In the report of the American Telephone and Telegraph Company for 1940, President Gifford made the following announcement: "Reserve power equipment was installed or ordered at all important telephone central offices which did not already have it, so as to insure continuity of power supply under all conditions."

Further reference to this increased provision of emergency engine equipment was made in the article "The Bell System and National Defense" which appeared in the February, 1941, issue of this magazine; and a recent article in a trade magazine, commenting on the increased use of engine-driven equipment for emergency sources of power, remarked that "The A. T. & T. Company realizes the likelihood of interruptions so we are seeing scores of emergency Diesel plants being installed by the Bell Telephone System."

What is the emergency equipment that is thus referred to? Briefly, it consists of an engine driving a generator for furnishing power to keep the batteries in the central office charged during an interruption of the commercial power service. Should these batteries be allowed to become discharged, the office could not function, and, while a failure of a telephone office even under normal conditions might be termed a calamity, it takes no great effort to realize the vital importance as a defense measure of making sure that under no condition will there be an interruption of the current required to keep the storage batteries in telephone central offices in a properly charged condition.

Experience has indicated that under normal conditions the large ma-

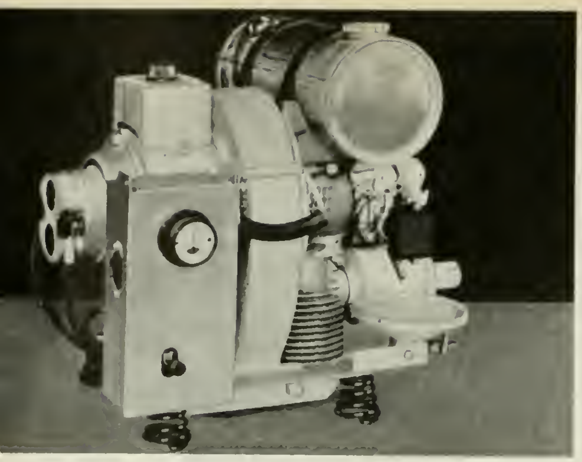


Fig. 1. A 650-watt Portable Gasoline Emergency Set

One of these may serve as a source of emergency power for several closely grouped dial or manual central offices

jority of power failures are of short duration and do not approach the period during which the batteries will continue to carry the office load before they become discharged. Telephone service, however, must be maintained under abnormal as well as normal conditions, and it is these abnormal conditions which determine the need for providing emergency engine equipment. Such abnormal conditions arose, for example, during the unprecedented floods of 1936 and 1937 which made it impossible for days to supply electric power service to such cities as Pittsburgh, Hartford, and Louisville.

For another illustration, there was the short circuit and fire in the Hell Gate power station in January, 1936, which interrupted power in a large part of New York City for several hours. A fire in the Essex power station in December, 1936, resulted in power failure in the central part of Newark, New Jersey, and in some suburbs, for intervals of from five to eight hours. The March, 1938, floods in Southern California, reported to have been the worst in 61 years, resulted in prolonged failures of electric power service in many localities. During the New England hurricane of September, 1938, entire communities were out of power for periods up to three weeks, due to devastation of power lines and crippling of power stations.

Except for a few relatively unimportant and isolated cases, none of these emergencies in the past has resulted in a failure of the central office batteries to continue to carry the load. In instances, however, where no emergency engine equipment was installed, it was necessary to make hurried arrangements for procuring it. This is never a simple task, in view both of the time elements involved and of the demand for similar equipment by others, such as hospitals, whose service also needs protection. Even after locating suitable equipment, such as arc welding sets from local sources and battery charging sets from other telephone companies, there is always a serious transportation problem in the case of large charging sets coming from a distance. Many of these have been sent hundreds of miles—for example, from Milwaukee to Pittsburgh by truck during the dead of winter over ice-bound roads.

There then follows the task of setting up and connecting the sets to the load and of providing suitable shelters. No provision is normally made for the storage of gasoline supplies, and obviously considerable trouble would be experienced in obtaining fuel because gasoline filling stations are almost universally equipped with electrically driven pumps and naturally are inoperative when power lines are not functioning. Because of prompt, skilful and efficient action, there has been no failure of telephone service due to depleted batteries, but there have been many anxious moments for fear that the needed equipment might not be obtained in time to prevent the batteries from being discharged. Another reason for anxiety is that such emergencies require an extraordinary amount of time and effort that are always needed for other work.

Adequate Provision for Emergencies

As a consequence of such experiences in the past, and because national defense requires a telephone service without threat of interruption, the Bell System operating companies have reached the conclusion that adequate provision be made now so that all offices may be readily operated when necessary from emergency sources of power.

Of the 5,200 offices having storage batteries, there are about 4,000 which are of such a size that the batteries can economically be made large enough (generally from one to three days' capacity) so that the office load may be carried on the battery until a small portable engine driven charging set, such as shown in Figure 1, can be brought in and placed in operation to pick up the load. Such a set is small, the one pictured weighing only 71 pounds, so that in general one man can quickly load it into a truck, transport it to the office, and connect it to the battery. Some 200 sets of this general type, ranging in size from 650 to 3,000 watts, are distributed throughout the System, and while this number has so far proven adequate, more than 300 additional sets are being purchased.

The 4,000 offices just mentioned

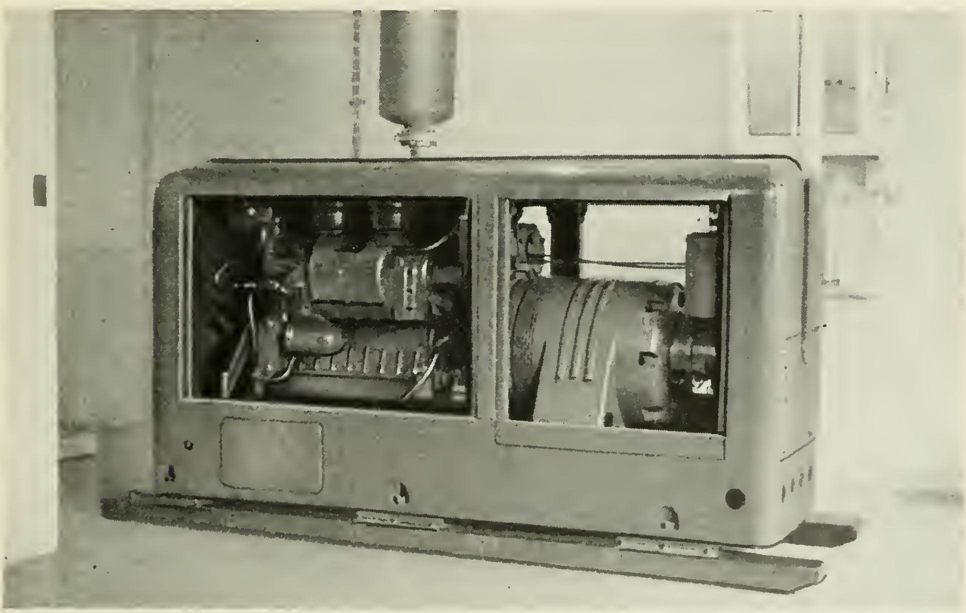


FIG. 2. A 60-KILOWATT STATIONARY DIESEL EMERGENCY SET

A set of this size may be installed to serve two and sometimes three small dial units, and may be used temporarily as a portable set in an emergency

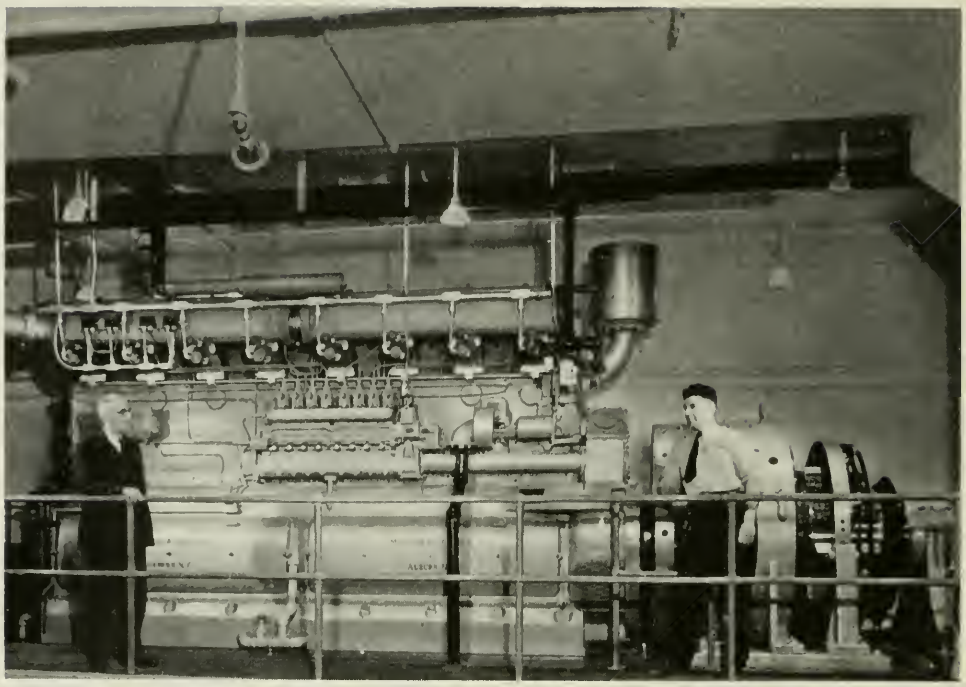


Fig. 3. A 535-kilowatt Stationary Diesel Emergency Set

Including engine, generator, and concrete base, it weighs nearly 100 tons, and has sufficient capacity to supply power to five large dial units and, in addition, to care for essential building services in an emergency

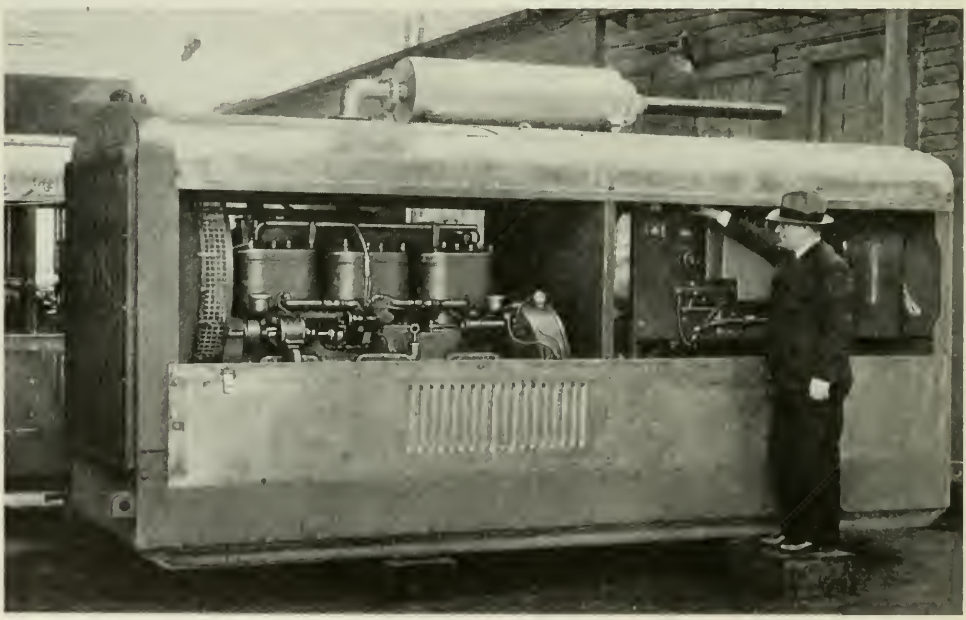


Fig. 4. A 75-kilowatt Portable Gasoline Emergency Set

The Bell System now has more than 50 such sources of emergency power, one of which can be trucked in a few hours to any location where it may be needed consist for the most part of small dial and manual offices and small repeater stations. The remaining 1,200 of the 5,200 common battery offices comprise the larger and more important offices in the System, where it is the general practice to provide not more than two to six hours' reserve in the battery. Of these, 850 are now provided with emergency engine equipment that is permanently installed in the building. The sizes of the units involved range in capacity from about 10 kw to nearly 900 kw, with most of them, however, not exceeding 60 kw. Figure 2 illustrates a typical 60 kw installation, while Figure 3 is typical of the very large units, the one shown being rated at 535 kw. These very large units are all located in large buildings and it has been the general practice to provide them with sufficient capacity to care for limited elevator service, other essential building services such as fire and sump pumps, lighting in operating rooms and test centers, as well as the usual telephone load.

THERE remain about 350 large offices which have been served by two or more independent power services and in which emergency engine equipment has not as yet been installed, but it is expected that the program under way towards providing this equipment will have been largely completed within the next year. For use pending the completion of this program, the System has over 50 large portable engine generator sets in case the commercial power service should be interrupted at any of these offices. Figure 4 illustrates one of the large portable sets. A recent situation in one of the large central western cities threatened to interrupt the electric service, and several of these sets were brought in from other cities as far as 500 miles away.

Automatic Power Supply for Unattended Stations

IN connection with the recent installation of carrier systems on transcontinental routes, it has been found necessary to locate some repeater stations at points which are inaccessible, particularly during the winter season. If storm damage should cripple the power lines supplying these stations, and cause a power failure, the work of restoration would be retarded or hampered in some cases by difficulties of the terrain. Although the storage batteries at these stations are usually large enough to carry the load for one or two days, it is considered undesirable under these conditions for repeater stations to depend on portable sets. Moreover, since they are normally unattended, so that no one is present who could start an engine, it has been necessary to provide engine sets that will start automatically in case of accidents to the electric service. Figure 5 shows one of these sets, which will start to charge the battery when the battery voltage drops to a certain value and will stop when the battery reaches full charge. This cycle, of course, will be repeated if necessary as long as the usual supply of power is unavailable.

THE engines associated with the emergency equipment are in general designed for operation on either gasoline or fuel oil, and are cooled by a radiator and fan, as in the case of an

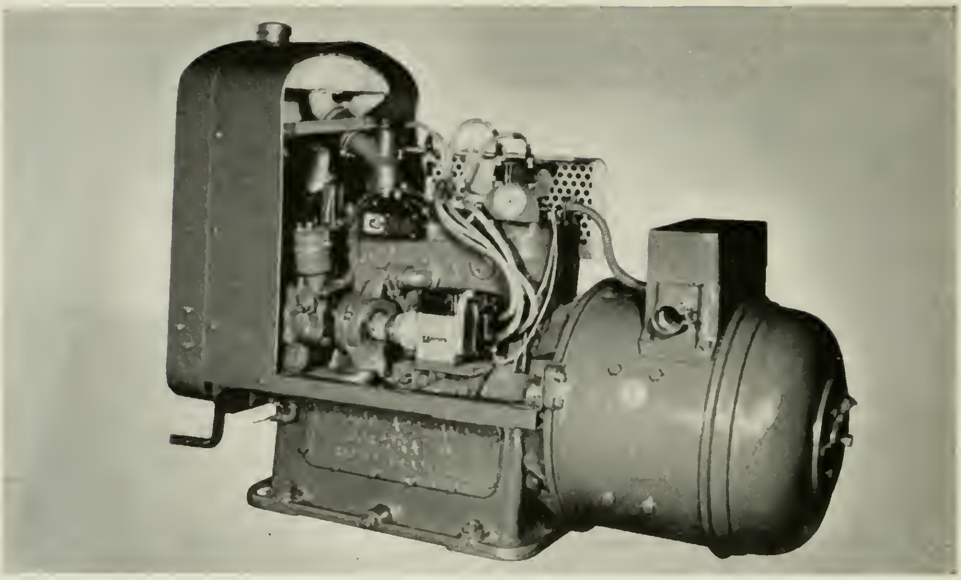


Fig. 5. A 6-kilowatt Automatic Gasoline Emergency Set

Automatic control equipment starts this engine when the battery voltage drops to a predetermined value, and stops it when the battery reaches full charge. The cycle will repeat, without attention, as long as normal power supply is cut off

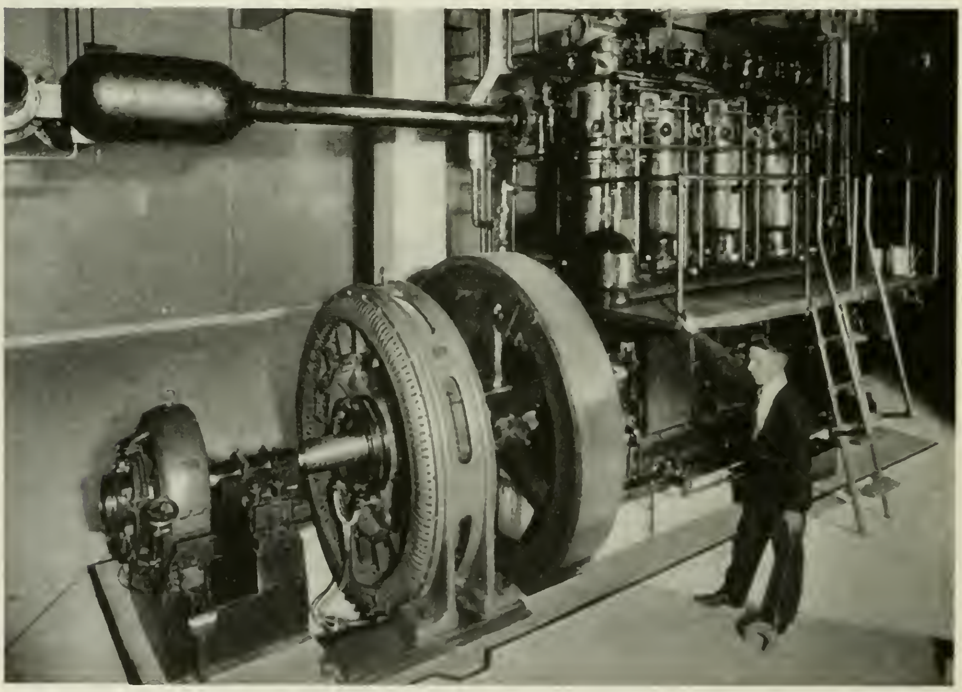


Fig. 6. A 120-kilowatt Gas Emergency Engine of 20 Years Ago

Compare this set with the one shown in Figure 3, which is about the same size as this but has nearly five times the capacity automobile engine. Some of the early Bell System installations, however, utilize gas as fuel and are cooled by city running water. In order that these engines may be independent of all supply services that might be interrupted in times of emergency, consideration is now being given to a program of arranging them for operation on gasoline, with radiator cooling. The student of engine design will be interested in comparing Figure 6, which illustrates one of the older gas engine sets installed about 20 years ago, with Figure 3, which shows an engine of about the same size but having five times the capacity.

AND so, if and when the continued functioning of the central office batteries giving electrical life to telephone facilities is threatened, there will be means readily at hand with which to meet the emergency. To those entrusted with the responsibility of rendering a telephone service "free from . . . delays" this is a reassuring situation.

A COLLEGE COURSE IN TELEPHONE SPEECH

Classes in Public Speaking for Seniors at Rutgers University Now Include Instruction in Extending the Voice and Personality Pleasingly and Effectively by Telephone

By FRANK P. TOWNSEND

Now comes a college course in practical telephone speech, to serve as encouragement to telephone people who for years have been striving in a variety of ways to increase public interest in "good telephone usage."

A four-week course of telephone speech instruction was introduced in April, 1941, as a permanent part of senior year courses in public speaking and debate at Rutgers University, New Brunswick, New Jersey. It is believed to be the first course of its kind in the country, and the fact that it makes use of the "hear your own voice" technique is of special interest in view of production by Western Electric Company of the "Mirrophone" magnetic tape recorder for public exhibition and instruction.

Announcement of the introduction of the course produced considerable publicity in newspapers and in publications circulating among members of college faculties, suggesting an increasing consciousness of the importance of proper use of the telephone, particularly in the business world.

Richard C. Reager, Associate Professor of Public Speaking and Director of Speech and Debate at Rutgers, is responsible for the new course. He is co-author of the text book "Speech Is Easy," Rutgers University Press 1938, which is regarded as one of the most practical volumes on speech instruction.

In common with many colleges and schools, Rutgers has provided instruction in public speaking and debate for a lengthy period. In recent years the use of microphone and loudspeaker has been added to older forms of instruction to help students familiarize themselves with the advantages and restrictions of public address systems, now in common use.

Class room procedure was recently modified successfully by making recordings of students' voices. A student addresses the class. His remarks are heard by loudspeaker, and part is recorded. He then joins the class and hears the record played, taking part in comment and criticism.

"We were immediately convinced of the effectiveness of the 'hear your own voice' technique," Professor Reager states. "For some twenty years I have been speaking at conventions and to groups of business men on the

LISTENING TO A RECORDED CONVERSATION

The two students who conversed by telephone, out of hearing of the class, have rejoined the group, and all are listening not only to what they said but to how they said it. Professor Richard C. Reager is at the extreme right

subject of better speech as an aid to the business man. I have had occasion to mimic some of the common speech faults, and invariably I sense a reaction among my auditors to the effect that 'Of course, *I* never make such mistakes.' Recordings in the class room, where the student hears his voice, thoroughly upset this happy belief! Improvement is rapid, however, as soon as 'mike fright' disappears. Early records are kept for comparison with recordings made toward the end of the course. Thus the student can note his progress.

"In my opinion a great deal of nonsense is taught and written about speech. At Rutgers we approach the subject from a strictly practical viewpoint. We are turning out young men, many of whom will go into business. Good speech is one of the most helpful assets these men can have, especially since their careers are still ahead. Therefore, we are interested only in speech that can be used intelligently. *Speech to be useful and valuable must be practical!*

"It occurred to us that for every occasion when a man speaks from the platform or in the conference room, he takes part in hundreds of telephone conversations. Again, this applies particularly to the younger men. So far as we knew, no school or college offered instruction in use of the telephone—not even schools specializing in speech training. Yet your voice, by telephone, is often your first introduction to some stranger. His first impressions are likely to be determined by how you sound to him in his receiver. No matter what you actually may be like, if you *sound* ill-educated,

RECORDING A CONVERSATION

Two Rutgers seniors converse and Professor Reager monitors as the apparatus in the center makes a record of the conversation. Specially grouped for this picture, the students are actually stationed in separate rooms for regular instruction

slovenly, or uninterested in the other man's affairs, his impression will be unfavorable. Regardless of the logic of it, decisions are made every day (and often important decisions) on nothing more tangible than the thought: 'He seems like a pleasant chap,' or 'I didn't like him!' This led us to believe that instruction in speech for practical daily use is incomplete without training future business men to extend their voices and personalities by telephone in an effective, pleasant manner."

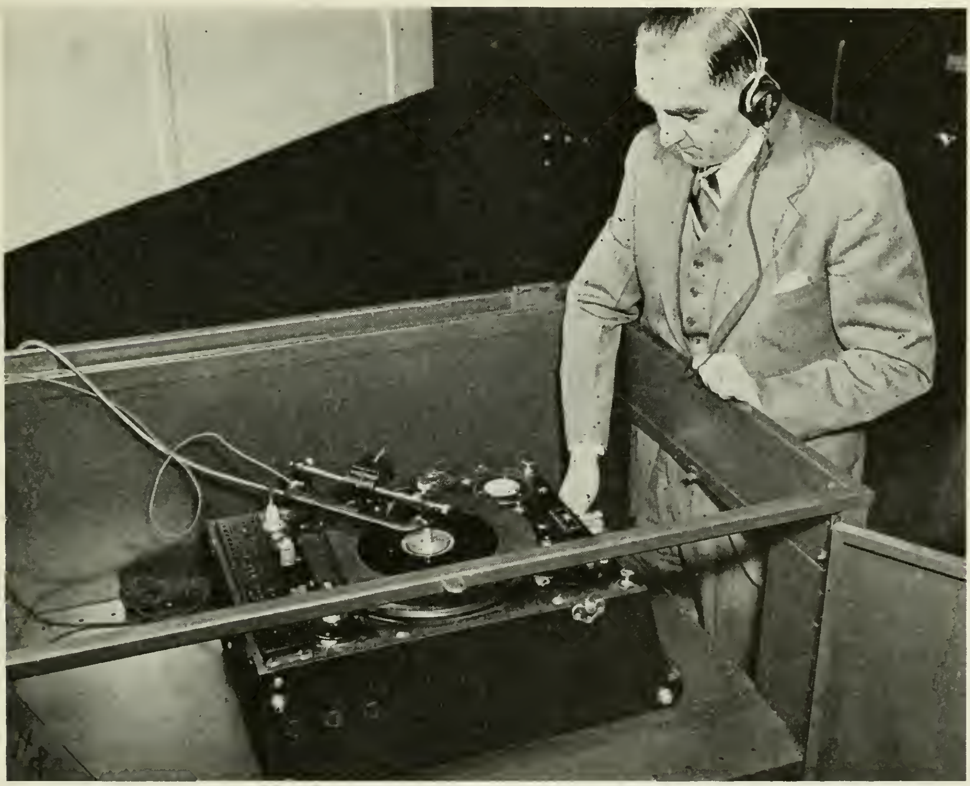
Recording Permits Review

WHEN the new four-week course was introduced, use was made of the recording technique because of its effectiveness in public speech instruction. Two students go to separate telephones which are connected to the equipment. They converse on various topics, such as a detailed business transaction, a campus problem, or perhaps arrange an interview. Their remarks are heard in the class room by loudspeaker, and part is recorded. Then the participants join the class and hear the recordings for comment and criticism.

The equipment used was assembled by Walter K. Dau, Jr., a Junior in Rutgers School of Engineering. It consists of a portable recorder with loudspeaker, and a plug-in microphone for use during public speaking instruction. For recording telephone conversations, the telephones mentioned above may be connected with this equipment. Recording is monitored by headphone. The apparatus is contained in a locking steel cabinet, mounted on rubber-tired wheels, which also serves as storage space for auxiliary equipment, replacement parts and new and used records.

Preliminary experiments made use of non-working telephones, students "conversing" with each other in the class room. Moderate progress was achieved. However, as soon as recordings were introduced there was a marked improvement. Students were in agreement that the "hear your own voice" method provides a "vivid and very personal *feeling*" as to how they sound by telephone.

Even students who had achieved some proficiency in platform delivery discovered immediately that quite different methods are necessary for best results during telephone conversations. It is not only that voices sound changed. On the platform, a speaker can use facial expression, gestures, and even the fact of his physical presence to offset or minimize effects of faulty speech. By telephone, the voice carries the entire burden. It becomes necessary, they learned, to concentrate on what comes out of the dis-



The Recording Instrument

Professor Reager adjusts the input of the recorder as students in distant rooms carry on a telephone conversation tant telephone receiver, and then to adjust voice and manner at the transmitter to obtain the desired effect.

The essentials of good public speaking apply, in general, to telephone speech and its instruction. These include proper use of the vocal mechanism, clarity, prior knowledge if possible of what is to be said, conversation along orderly and logically developed lines, care in producing and maintaining a courteous and friendly effect on the hearer, good vocabulary, unhurried manner. The New York Telephone Company's booklet, "The Voice With a Smile," which was drawn upon freely in preparation of the telephone chapter in Professor Reager's text book, "Speech Is Easy," also serves as background material for class room instruction in telephone usage.

Better Speech—Better Service

The interest of telephone people in "good usage" is based in part on the philosophy that telephone service, regardless of technical excellence, should not be considered as entirely satisfactory unless it is so regarded by the customer. A number of telephone developments resulting from this viewpoint will come to mind, such as operating practices and methods which have been devised not merely to avoid the possibility of confusing customers but to be actually pleasing to them.

A further extension of this thought is the acceptance by telephone companies of responsibility for assisting customers to obtain the most usefulness and value from their service. Efforts are increasingly being made to help eliminate slovenly speech habits and faulty technique, and overcome unconscious mannerisms which may give the effect of discourtesy or inattention at the other end of the line. Booklets are distributed giving practical suggestions, based on experience and observation, for improved usage in business concerns. Some telephone companies maintain a staff of employees to train telephone contact people in business establishments.

These are considered service improvement activities, since anything done by the telephone company which assists a customer to handle his affairs by telephone more efficiently, pleasingly, or satisfactorily is a service improvement to him, just as are better transmission or faster handling of calls.

For some time there has been evidence that these efforts are bearing fruit in increased public consciousness of the importance of good telephone speech. More and more requests come to telephone companies for assistance in training telephone sales forces and other telephone contact employees. The "Hear Your Own Voice" magnetic tape recorders demonstrated in the Bell System exhibits at the New York and San Francisco World's Fairs in 1939 and 1940, and by many Bell companies during "Open House" programs, made thousands of individuals conscious of speech defects of which they had been unaware. The System's sound motion picture, "A New Voice for Mr. X," which portrays the business value of good telephone speech and practice, has made a strong impression upon business men. This impression has been strengthened when the showing of the film is accompanied by setting up the magnetic tape recorder for the audience to experiment with. Instead of resenting criticism or disbelieving it, they appreciate knowledge of faulty usage *when gained by themselves* through hearing their own voices.

Professor Reager's innovation at Rutgers well illustrates this increased public interest, and is perhaps the most significant illustration to date. So far as is known, it is the first organized effort on the part of an institution other than telephone companies to teach proper telephone speech technique and to assign to the subject a degree of importance in practical daily life that ranks it with public speaking and debate.

Application of the essentials of good speech to the 80,000,000 telephone calls handled daily in the Bell Telephone System may be too much to hope for within the foreseeable future, but the new course at Rutgers certainly is a step toward such a goal and forecasts the introduction of similar instruction in schools and colleges generally as something not too visionary.

FIG. 1. EACH DOT REPRESENTS AN INDEPENDENT TELEPHONE COMPANY EXCHANGE

There are 12,000 dots on this map, which was prepared in 1938 by, and is used through the courtesy of, the United States Independent Telephone Association

INDEPENDENT TELEPHONE COMPANIES

Co-operation between These 6,400 Organizations, Serving 20 Per Cent of All Telephones in the Country, and the Bell System Is Vital in Providing a Nation-wide Telephone Service

By H. M. POPE

People living in areas served by Bell telephone companies may not have occasion to know that, in addition to the 24 operating companies included in the Bell System, there are some 6,400 other telephone companies whose management and personnel play a most important part in giving the United States what is often termed "the best telephone service in the world."

These companies are independent of the Bell System, except that there is a physical connection of their lines with the lines of the adjacent Bell company in order to bring about a universal telephone service nationwide in its scope.

Because of this physical connection, these companies are known to Bell System people as "connecting companies." They own and serve about 4,400,000 telephones, or approximately 20 per cent of the more than 22,000,000 telephones in the country; they have 10,000,000 miles of wire; they handle in the neighborhood of 19,000,000 local and toll conversations every day.

That the high standard of telephone service in the United States reflects a high degree of coöperation between the Bell and connecting companies must, of course, be apparent. To it President Gifford of the American Telephone and Telegraph Company paid tribute in his report on the Company's operation for 1940 when he said: "this coöperation is invaluable in marshalling the resources of the entire telephone industry in the interest of national defense."

Without such coöperation, telephones could not be so quickly and readily connected one with another, for obviously there is a most complex operating problem involved in so combining the properties of thousands of companies that anyone anywhere can pick up a telephone and talk to anyone else anywhere else. It is to point out some of the features of this cooperation, which results in a combined network handling about 100,000,000 local and toll conversations a day, that this article has been prepared.

The 6,400 connecting telephone companies are scattered over the entire country, having exchanges in every state except Delaware. A map prepared by the United States Independent Telephone Association in

1938, Figure 1, shows the widespread distribution of 12,000 independent telephone exchanges. In several states the connecting companies serve a larger geographical area than that served by Bell System companies.

CONNECTING companies vary in size from those with only one exchange having not more than 10 telephones to those having more than 100,000 telephones located in a number of exchanges. Some of these companies have their own toll lines connecting several exchanges, while others have no toll lines. There are seven connecting companies having more than 50,000 telephones each, two of which, the Associated Telephone Company, Ltd. (California) and Rochester Telephone Corporation (New York), have more than 100,000 telephones.

Many connecting companies are not financially affiliated with any other company or corporation. Some, however, are members of so-called group companies which own the controlling interests in a number of telephone companies operating in several states. The largest three group companies are General Telephone Corporation, with 532,000 telephones; Telephone Bond and Share Company, with 240,000; and United Utilities Company with 98,000 telephones.

Ohio has a larger number of connecting company telephones than any other state, while Maryland has less than 800. The 10 states having the largest number of connecting company telephones are shown in Figure 2.

State	No. of Connecting Company Telephones As of January 1, 1941
Ohio	322,000
Illinois	312,000
Indiana	278,000
Iowa	247,000
Pennsylvania	223,000
New York	220,000
California	203,000
Missouri	188,000
Wisconsin	170,000
Texas	147,000

FIG. 2

In these ten states there are about 2,310,000 connecting-company telephones

It became apparent to the non-Bell telephone companies prior to 1900 that some form of central organization was needed in order to provide assistance in respect of the many difficult problems frequently encountered in furnishing reliable telephone service. As a result, the National Independent Telephone Association was formed, and later a second organization, the Independent Telephone Association of America, came into being. These two associations were merged in 1915 to become the present United States Independent Telephone Association, the by-laws of which state: "The object for which it is formed is to aid the Independent telephone industry and to furnish to its members information and advice upon all subjects relating to telephony; and to authorize its officers or committees to represent the Independent telephone interests before any commission, executive officer, legislative or regulatory body of the United States or any state."

One of the first activities of the United States Independent Telephone Association was to encourage the formation of state associations to work in coöperation with the national body.

There are now 32 state associations. These provide a clearing house for information of interest to their members through annual meetings, frequent group meetings, through advice on problems of all kinds relating to the industry, and through their relationship with the United States Independent Telephone Association. There have been many evidences of coöperation between the Bell System companies and the connecting telephone companies and their state and national associations. Problems of mutual interest, including those dealing with the interchange of toll messages, frequently are discussed at the state association meetings as well as at meetings of the United States Independent Telephone Association. The national and state associations have been of great value to connecting companies throughout the country.

ANOTHER indication of the important part connecting companies play in the industry is the fact that during 1940 about 94,000,000 interchanged toll messages were originated by customers of connecting companies. The services performed by connecting companies in the handling of so many millions of interchanged toll messages vary considerably, of course. In all cases the connecting company bills and collects the charges for Bell toll messages sent paid or received collect by its customers, and it performs the inward toll operating on all messages that terminate in its exchanges. In some cases the connecting company operators handle to completion (supervise, time, and ticket) toll messages which originate in their exchanges, while in other cases originating messages are routed either to another connecting company or to a Bell exchange for handling. Exchanges in which all originating toll messages are routed to another office for handling are called full tributary exchanges. In some cases a connecting company operator handles to completion certain originating messages, usually those destined to points to which the originating exchange has direct circuits, while the remaining originating messages are routed to another office for handling to completion. These exchanges are called AB or CLR tributaries. The exchanges at which all originating messages are handled are called toll centers.

Handling Interchanged Messages

THE relationships growing out of the exchange of millions of toll messages between connecting companies and Bell companies cover practically every phase of the business. Only through the closest coöperation is it possible to coördinate the efforts of both groups so that a high grade of telephone service will be provided. This involves not only the provision of adequate plant, as to both grade and quantity, but also the use of such traffic operating methods and routings as will achieve speed and accuracy in the handling of the messages to and from all points encountered in nationwide service. Toll messages may originate anywhere and likewise terminate anywhere, and the prompt and efficient handling of the millions of such messages requires carefully thought-out operating methods and practices.

In order to achieve a universally good telephone service on calls be-

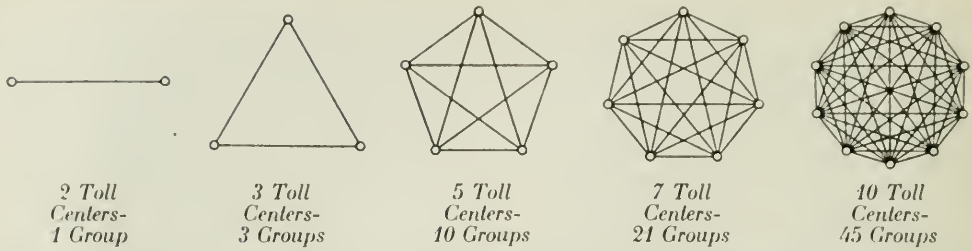


FIG. 3. GROUPS OF TOLL CIRCUITS REQUIRED FOR DIRECT CONNECTIONS BETWEEN VARIOUS NUMBERS OF TOLL CENTERS

tween any two customers, regardless of where they are located or whether they are customers of a Bell company or a connecting company, it is necessary to provide toll circuits in such numbers and so arranged that satisfactory connections may be established quickly. Toll connections may require operators at a number of telephone central offices along the route to connect together toll lines in order to build up the toll circuit between the calling and called customers. These points of connection are referred to as "intermediate switching points" or "switches." Each additional switch introduced in a built-up toll connection increases the time required to establish the connection and reduces somewhat the volume of speech transmitted. The telephone plant must therefore be designed so that the standards of transmission and number of switches required on any call will be such that satisfactory transmission of speech will be provided. The toll calls on which it is most difficult to give a high grade of service are those scattered calls between customers located in remote and widely separated exchanges, because it is difficult to establish such connections and still keep the number of switches to a minimum.

From the standpoint of improved service to the customer, it is desirable, whenever feasible, to provide operating practices that will permit the calling customer to remain at his telephone while the connection is being established. Any improvements in equipment or operating practices that reduce the time of establishing connections or in other ways improve the service to customers are extremely important and are being continually studied.

SINCE 1925 the speed of service of toll calls handled by Bell Companies has been improved from an average of 7.3 minutes to 1.4 minutes at the present time. It has long been recognized that to give an efficient and speedy service requires methods of operating such that an operator anywhere in the country will understand the request of any other operator anywhere else in the country. Obviously, these matters require close coöperation between Bell and connecting companies, and the service today exemplifies such coöperation. The modifications and changes made from time to time in central office equipment, outside plant, and operating practices have permitted the satisfactory handling of toll business which has grown tremendously over the years. The connecting companies have done their share in contributing ideas as to improvement of both equipment and operating technique.

It was early recognized that to provide an adequate number of direct toll circuits from each toll center to every other toll center in the country was impracticable. For example, to connect two toll centers, only one group of circuits would be required; for direct connections for three toll centers, three groups; for five toll centers, 10 groups; for 10 toll centers, 45 groups; for 100 toll centers, 4950 groups; for 1000 toll centers, nearly one-half million groups of toll circuits, and so on. This is indicated diagrammatically in Figure 3.

Another means of establishing toll connections between toll centers might be to provide direct circuit groups from each toll center to only its nearby toll centers, thus providing a network of circuits between all toll centers in the country. Under such an arrangement, a toll connection between distant toll centers could be built up by switches at each intervening toll center. Such a plan would be most impracticable, however, as it would, in many cases, require too many switches to permit establishing a speedy, efficient and economical service.

The General Toll Switching Plan

A GREAT deal of consideration was given to the broad general problem involved in the routing of calls and provision of adequate circuits, which finally led to the development of the fundamental layout of toll plant and routing of toll messages which today is known as the " General Toll Switching Plan." This plan was developed and adopted by the Bell System just before 1930.

It is of interest to note in passing that the Toll Switching Plan has been carefully studied by telephone engineers of the various European telephone organizations. In 1938 the International Telephone Consultative Committee (C.C.I.F.), at its meeting in Oslo, adopted rules and regulations along fundamentally the same lines for international connections within Europe.

The purpose of the plan is to provide systematically a basic plant layout designed for the highest practicable standards of service consistent with economy, including speed and accuracy.

AN important part of the development of the plan was the determination of proper transmission require-

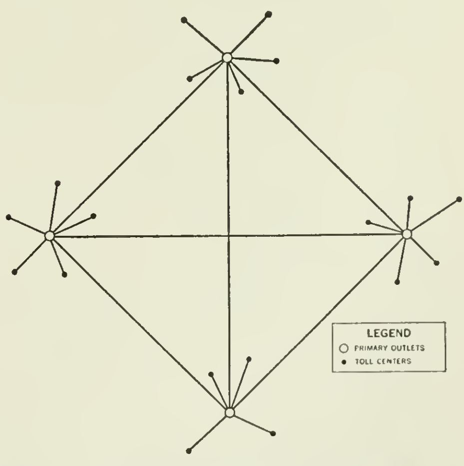


FIG. 4. TOLL CENTERS AND PRIMARY OUTLETS

This diagram shows the operation of the General Toll Switching Plan within a limited area

FIG. 5. THE GENERAL TOLL SWITCHING PLAN

Regional centers and primary outlets in the United States and eastern Canada ments for each connecting link between offices, such that any toll connection established in accordance with the plan would have satisfactory transmission efficiency. All technical measures of the quality of service, including speed, accuracy and transmission, indicate that the difficulty of giving satisfactory service increases rapidly with the number of intermediate switches. The General Toll Switching Plan, therefore, in addition to establishing standards of design that will provide satisfactory transmission, involves the layout of the toll circuits in such a manner as to reduce to a minimum the number of switches required to connect any two telephones. It is obvious that the provision of such circuits and routing of calls must be considered not only from the standpoint of traffic between any two particular points but also from the standpoint of the best over-all arrangement to provide a flexible and economical nation-wide system. The importance of this is emphasized by the rapid growth in the volume of long-haul traffic.

The general features of the Toll Switching Plan, as applied to a limited area, such as a State, required the selection of a minimum number of exchanges as toll centers. The selection was based on a careful study of the existing and probable future development of toll traffic within the area, and the ability of such exchanges to handle the toll operating work from the standpoint of facilities available, including lay-out of toll line plant and other factors. The selection of such exchanges also required a careful analysis in order to arrive at the best distribution of toll centers to handle the traffic speedily and economically. Within this same area a small number of the more important toll centers were selected as "primary outlets." In general, each toll center in the area is directly connected to at least one of these outlets, and each primary outlet is directly connected to the other primary outlets within the area. This makes it possible, as seen in Figure 4, to connect any two toll centers within that part of the area served by the same primary outlet with a maximum of one switch, and within the entire area with a maximum of two switches.

Choosing the Primary Outlets

THE selection of the primary outlets required not only a study of the particular area involved but also careful consideration of its relation to the nation-wide plan. A minimum number of primary outlets in a given area, capable of handling the traffic, is essential, since the number of circuit groups between the primary outlets increases appreciably as the number of primary outlets is increased. This point will be emphasized by again referring to Figure 3 but now considering each of the toll centers shown there as primary outlets. For example, ten groups of circuits are required to interconnect five primary outlets, and 21 groups are required to interconnect seven primary outlets.

The selection of certain exchanges as toll centers, and certain of these as primary outlets, was made from the standpoint of furnishing the highest practicable standards of service consistent with economy, and without regard to the ownership of the exchange involved. This resulted in the selec-

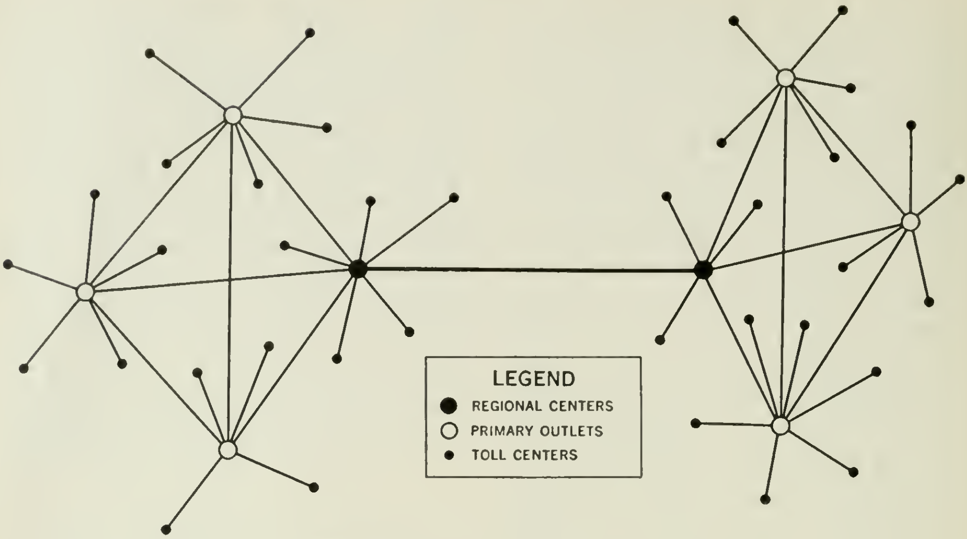


FIG. 6. PRIMARY OUTLETS AND REGIONAL CENTERS
Each primary outlet is directly connected with at least one of the country's eight regional centers

tion of about 2400 toll centers in the United States, of which about 590 are connecting company exchanges, and in the selection of about 140 of the toll centers as primary outlets, of which nine are connecting company exchanges. The distribution of the primary outlets throughout the country is shown in Figure 5.

To facilitate the handling of the longer haul business throughout the country, eight of the primary outlets located in the larger cities have been designated as "regional centers," which are also shown in Figure 5. The method of routing calls between exchanges in different regional areas is illustrated by Figure 6. The plan contemplates that each primary outlet will be connected with at least one regional center and with as many more as is practicable. If the traffic volumes increase sufficiently, then ultimately each regional center may be directly connected to every other regional center in the country. At the present time, through the circuits provided by the plan and other direct circuits, any one of the primary outlets can be connected to another primary outlet served by the same regional center with a maximum of one switch, or can be connected to any other primary outlet in the country with a maximum of two switches.

In addition to the routes provided by the plan for country-wide service, as illustrated in Figure 6, direct circuits or other routings are also provided where the volume of business is sufficient to make it desirable. Figure 7 illustrates such supplementary circuits by dashed lines. The use of such circuits is illustrated in the case of a call from a connecting company customer in Centerview, Missouri, to a telephone in the connecting com-

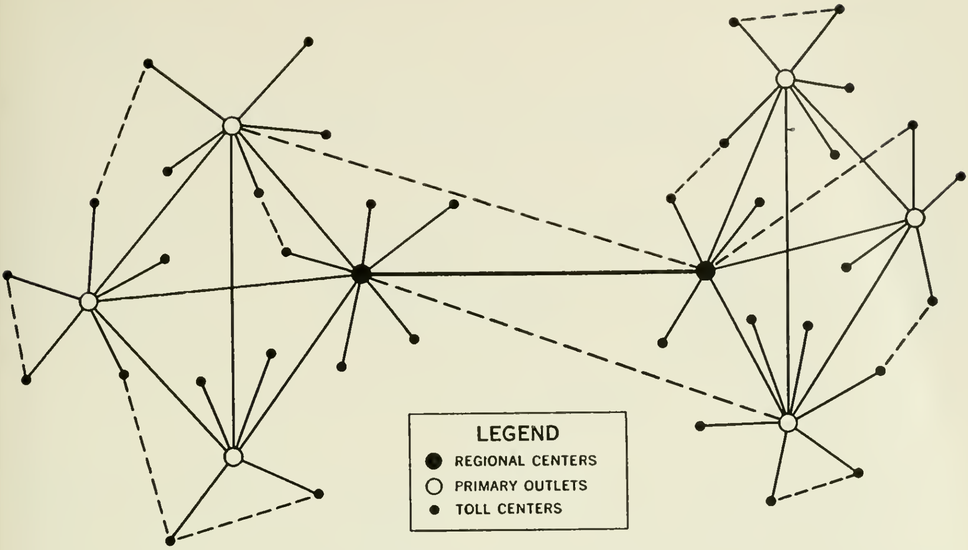


FIG. 7. SUPPLEMENTARY CIRCUITS

In addition to the basic circuits of the General Toll Switching Plan, supplementary circuits (shown by dashed lines) are established when the volume of traffic warrants

pany exchange at Gibsonville, North Carolina, as shown in Figure 8.

The toll circuit groups between regional centers, and in some cases between primary outlets, frequently have a large number of circuits because of the large volumes of traffic involved. More calls per circuit can be operated over a large group of circuits than over a small group. For example, the available conversation time per circuit in a group of ten circuits is almost 22 per cent greater than the available conversation time per circuit in a group of two circuits. This demonstrates why it is frequently more efficient and economical to back-haul the routing of a toll call so that it may be routed via a large group of high grade circuits with good transmission and a fewer number of switches, as is the case shown in Figure 8. All of the circuits between regional centers are furnished by the Bell System. As a result of extensive development work in its Laboratories and through the provision of the highest grade of facilities throughout, it has been possible to reduce the transmission loss to a very low value. This is likewise generally true of the circuits between primary outlets and regional centers.

TOLL calls vary in length, from a few miles to across the continent. The charges for calls also vary, depending not only on distance and length of conversation but also on whether the call is person-to-person or station-to-station and whether week-day rates or night and Sunday rates apply. On calls to and from customers of connecting companies, these companies participate in the furnishing of the service and hence are entitled to a part of the revenue on each such mes-

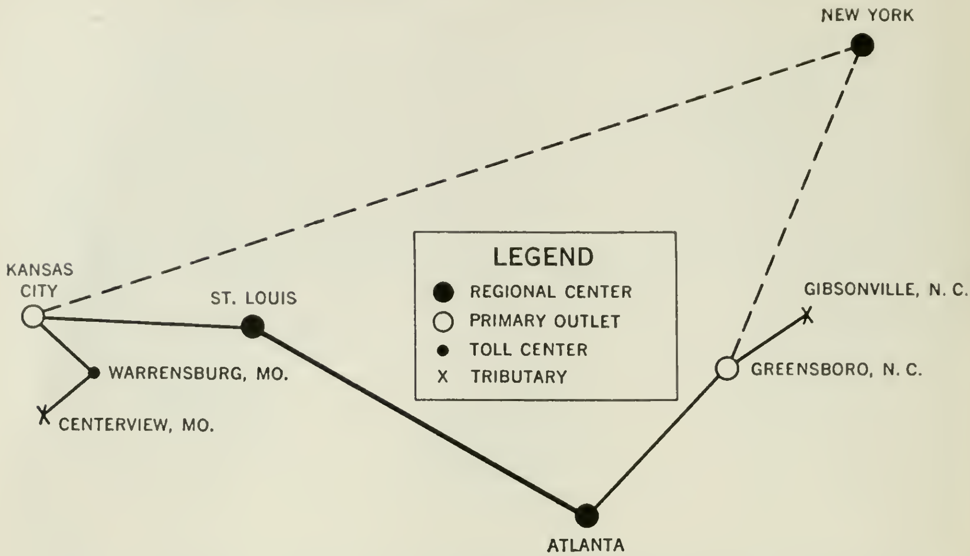


Fig. 8. Back-hauling a Call between Centerview and Gibsonville

The longer way 'round (dashed lines) is the shorter way home in this instance, requiring only two switches—at Kansas City and New York—between terminating toll centers. In the absence of these high-quality direct circuits between Kansas City-New York and New York-Greensboro, the call would be routed via the regional toll centers (solid lines) and would require switches at Kansas City, St. Louis, and Atlanta

sage. The business relationships arising from the vast interchange of toll messages are described in traffic agreements executed between the connecting company and the Bell company with which it connects. The agreements define the responsibilities and duties of each of the companies, and specify the points of connection of the systems and the toll operating that is to be performed by each. The agreements also provide for the basis of division of revenues derived from the interchanged business.

The fine toll service which is enjoyed today didn't just happen, but is the result of careful planning, together with excellent teamwork on the part of hundreds of thousands of employees engaged in the industry. While the Bell System and the connecting companies throughout the country have for years worked together harmoniously to provide this country with the best telephone service in the world, they are now even more determined in their efforts to meet successfully the important problems that will face the industry during the coming days.

TRENDS IN TOLL CABLE USAGE

Telephone Engineering, Scientific Research, and Manufacturing Skill Are Represented in the Wide and Constantly Growing Toll Cable Network Designed to Insure Service Dependability

By ARTHUR F. ROSE

With national defense and dependability of telephone service the keynote at the present time, the importance of the Bell System toll cable network cannot be overestimated.

As early as 1909, when Washington was substantially isolated by an ice storm during President Taft's inauguration, the management of the Bell System realized the need for a more satisfactory form of long telephone circuit than generally used at that time. A large amount of engineering effort was at once devoted to the solution of the problem, and during the lifetime of many engineers still in Bell System service the character of the plant has changed, from one generally subject to the rebuffs of nature to one that sturdily stands through many of her most savage attacks.

Between these extremes is the story of scientific research, manufacturing skill, and pioneer methods of engineering, combining to foil the telephone's ancient enemy—the ice storm—and also to meet the social and economic needs of a growing nation. The sequence of events leading up to our present toll cable network starts almost with the first conception of the telephone and its possible use in business and social activities.

Only a short time after the invention of the telephone in 1876, it became clear that the interconnection of telephones in individual cities would be the initial step in the development of this new device, but for maximum usefulness it would also be necessary to interconnect the telephones in different cities. The first long distance telephone line was a grounded copper circuit about two miles in length between the Walworth Manufacturing Company in Boston and their works in Cambridge. It consisted of copper wire suspended by glass insulators. Up to about 1900, the early long distance telephone circuits in the United States were practically all of this type of construction, although it had soon been found that for the longer circuits the ground return at first used would not give satisfactory results. By the use of metallic (i.e., two-wire instead of grounded) copper circuits, considerable distances were covered and by 1884 a New York-Boston circuit had been established.

The open wire lines, however, soon

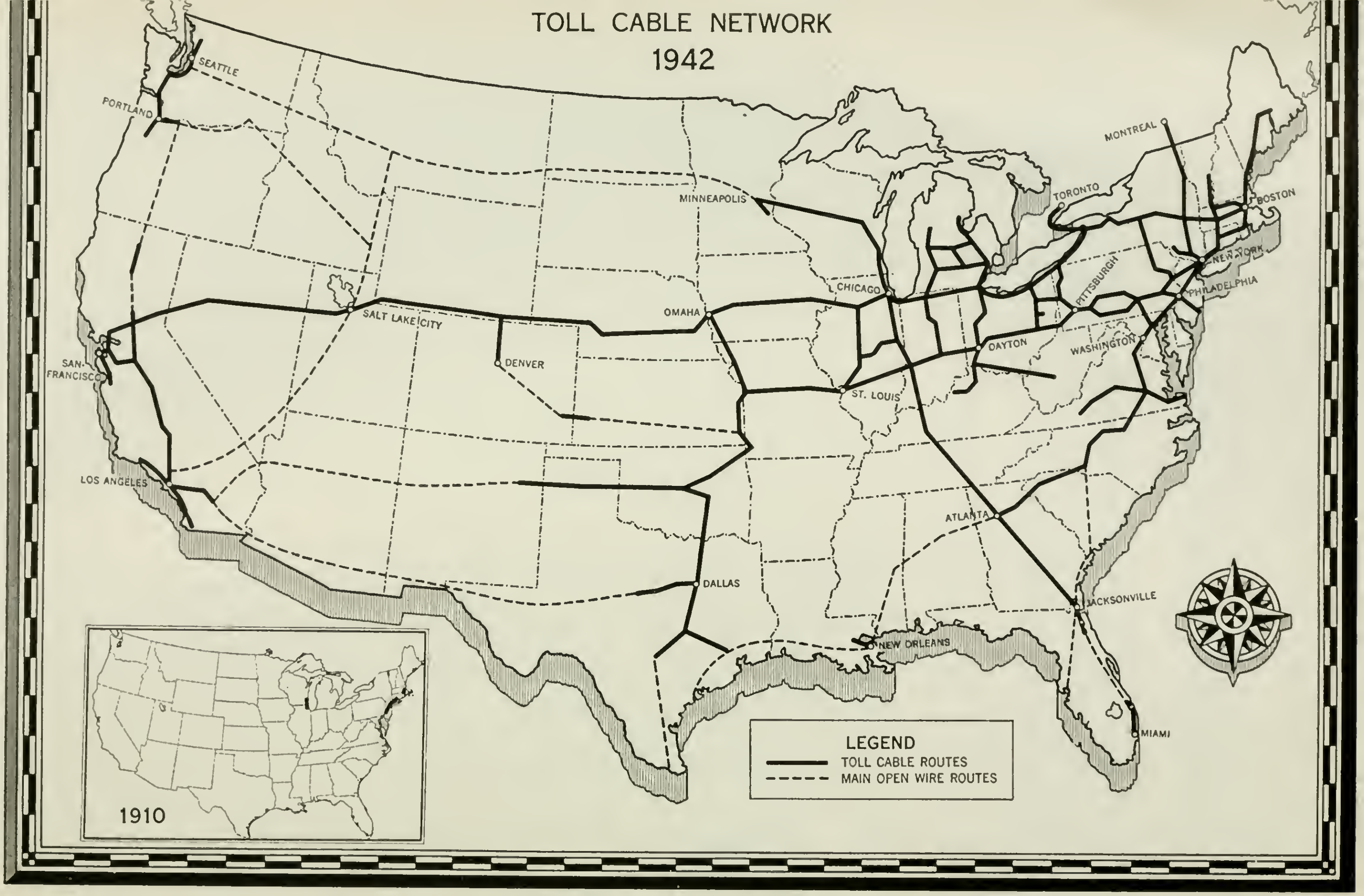


FIG. 1. BELL SYSTEM TOLL LINES—EXISTING AND PLANNED

This is about the way the Bell System's toll network is expected to look on the map by the end of next year. Note the cross-country cable linking the East and the Pacific coast, on sections of which work is now progressing; and contrast the amount of cable shown on the large map with that became inadequate to carry all the toll circuits required and were subject to damage from heavy ice conditions which frequently broke either the wires or the supporting poles and crossarms. Before the turn of the century, the management of the Bell System had come to appreciate the need for improving the reliability of the more important toll circuits between the larger cities, and there was continuous experimentation directed toward finding some way to remove the toll circuits from open-wire type of construction and put them in cable, where a lead sheath protects the circuits from direct action of ice and other hazards. With cable, moreover, it is readily practicable to protect the circuits further by placing them underground whenever this seems desirable and economical. The problem appeared to be almost insurmountable, as the transmission losses were so large that with the types of cables available a few miles of cable transmission was equivalent to 100 miles or more of open wire transmission. For some years after suitable cables had been developed, this higher loss resulted in their being used only in cities, or in very small amounts where they were permitted in the open wire lines under conditions which made such construction imperative. A long toll cable between cities was unheard of.

Extending the Range of Cable

AFTER many discouragements, it was found that under carefully controlled conditions the insertion of inductance at regular intervals along the cable line greatly improved the electrical efficiency of the cable circuits and permitted much longer distances to be spanned with this type of construction. In 1902 a toll cable, the first in the United States to be equipped with these inductances, known as loading, was placed between New York City and Newark, New Jersey, a distance of only about 11 miles, but this historic step was merely the advance guard of a continuing development which gradually but with increasing strength spread across the country. In 1906 cables were placed between New York and New Haven, and New York and Philadelphia; and, spurred on by the critical failure at the time of the Taft inauguration, an underground cable between Boston and Washington, a distance of about 450 miles, was completed by 1913. This cable represented about the practical limit of loaded cable transmission at that time.

The next step in the extension of the application of cables to the toll network required the development of a new tool known as the telephone repeater. The repeater, a device placed at intervals along a telephone line, adds new energy and revives the dying speech currents, sending them along the circuit with renewed vigor. The first crude applications of the telephone repeater were made early in the 20th century on both open wire and cable; but it was not until 1914, when the use of the repeater resulted in a satisfactory transcontinental telephone conversation, that the repeater reached a point in its development where it could be used with assurance as part of plant design.

As soon as it had been proved by the transcontinental experiments that the vacuum tube repeater was satisfactory, it was applied to toll cables and resulted in a rapid expansion of

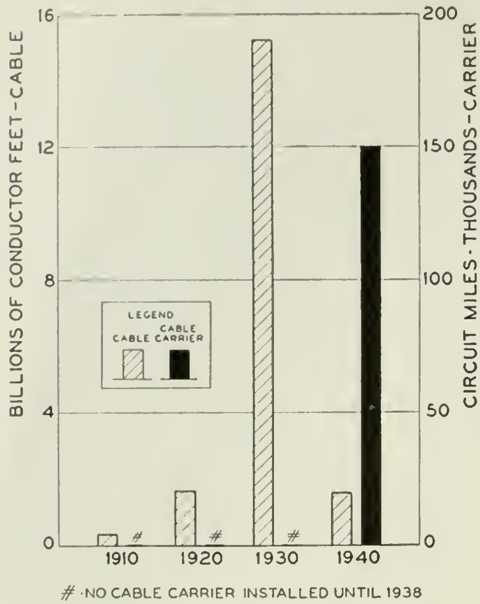


Fig. 2

Production of toll cable, expressed in billions of conductor feet, at four different periods

the toll cable network. The barrier of distance was thus practically removed, and from that time on economic considerations largely controlled the future expansion of the toll cable network. By the end of 1930 the extensions of toll cable covered the entire northeastern quarter of the United States. During the next decade, however, further progress went on at a somewhat slower rate because of the business depression; but at the present time the cable network is again being extended rapidly, with the prospect that by the end of next year the east and west coasts will have been connected by a transcontinental cable. Most of the important cities of the country will then be tied together by toll cables, presenting a tremendous contrast with the picture existing 30 years ago as seen in Figure 1.

The Production of Cable

During the years 1929 and 1930, when the toll cable network was previously expanding at its maximum rate, the toll cable manufacturing plants were called upon to produce tremendous quantities of cable for Bell System toll purposes. As the toll cables vary considerably in size, a quantity representing a product of the number of wires in the cable and the length of the cable in feet has been used as an indication of the manufacturing effort involved in producing the cables. Figure 2 shows the production of toll cable expressed in this way for four past periods. It will be noted from this chart that during 1930 the Western Electric toll cable shipments reached the tremendous high of 15 billion conductor feet in that one year. The toll wire mileage included in the cables installed that year would be sufficient to encircle the globe at the equator more than 100 times.

The next point of interest in connection with Figure 2 is the fact that in 1940 the amount of cable manufactured and shipped by the Western Electric Company and installed by the Bell Telephone Companies was only about one-tenth as much as was shipped in 1930. These surprising totals occurred in the face of a rising demand for circuits; toll messages in 1939–1940 increased at a considerably higher rate than in 1929–30 and therefore theoretically a larger increase in cable demand would have been expected, even allowing for differences in plant margins existing in the two periods. But actually only 1/10 of the previous record shipment of 1930 was ordered by the companies in 1940.

The reason for this was the fact that in the meantime an important change had taken place in the type of cable used for toll purposes, springing out of constant effort to develop cheaper and better ways of providing toll circuits.

THE cables which were put in during the very early years of the cable art, such as the first cable between Boston, New York and Washington, employed large gauge conductors, each wire without its insulation being nearly half as thick as an ordinary lead pencil. With the advent of the telephone repeater, there was no need to employ so much copper and it was much cheaper to use a smaller size conductor. Therefore, the wires in the cables used between 1915 and 1930 were largely composed of 19 gauge conductors, about as thick as the fine lead in an ordinary automatic pencil. This was the cable technique which, with a demand for circuits somewhat smaller than in 1940, resulted in the very large quantity of toll cable shown in Chart 2 for 1930.

During the early 30's, when growth was at a low ebb and few cable extensions were being made, the Bell Laboratories continued actively at their development work, and by the end of the period a new step in the cable art had been taken. This new art still utilized the small gauge conductors of the previous decade, but each pair of wires provided 6 times more circuits than previously. This tremendous increase resulted from the application to cable of the carrier technique which had been utilized for many years on open wire circuits. This naturally affected the amount of cable needed by the Bell Telephone Companies, for even although many more circuit miles were theoretically required in 1940 than in 1930, some were supplied by carrier and much fewer conductor miles were actually needed and installed.

Under the older technique, the largest standard toll cables were approximately 2½ inches in diameter, contained about 300 pairs of wires, and produced about 225 voice channels. Under the carrier technique, 300 pairs can be made to yield 1800 voice channels when completely equipped with carrier systems. To do this, however, the 300 pairs must be divided between two cables, one for transmission in one direction and the other for transmission in the reverse direction. Of course, 1800 circuits would hardly ever be required on a single route, and for this reason most of the cables being installed at the present time consist of a pair of much smaller cables, perhaps 40 or 50 pairs each. Two 50 pair cables are large enough, however, to have an ultimate circuit capacity more than twice as great as one of the 300 pair cables of an earlier day.

Repeaters and Other Equipment

IN connection with the difference in the size of the cable, it is to be borne in mind that the multiplication of the number of circuits per pair of wires in the cable is attained by the addition of new and complicated types of carrier equipment. Under the older technique, the cost of equipment and terminations was already an important part of the total cost of the circuits. With the carrier technique, the equipment and terminations are a still larger proportion of the total cost.

Fig. 3. Exterior of an Auxiliary Repeater Station

Buildings such as these, normally unattended, are located along the routes of cable carrier-system toll lines

Under the carrier technique, several channels are amplified by each repeater, but the repeaters are needed at more frequent intervals along the line. Under the old voice technique, telephone repeaters were placed at 50 to 100 mile spacing, while under the new technique the higher frequencies used require new energy about every 17 miles.

Figure 3 shows an outside view of a typical auxiliary repeater station of the new art. These small buildings are generally about 20 feet square and house as many as 100 repeaters, amplifying 1200 voice channels. The compact manner in which apparatus is fitted into one of these small repeater stations is very interesting and can be readily seen in Figure 4. No space is provided for permanent operating forces, and the building is designed wholly for telephone repeaters, power supply, and control equipment. The maintenance men who take care of these repeater stations are usually located at about every third repeater point, corresponding to the 50 mile spacing of the old voice technique. Remotely operated alarms tell of trouble if any develops, but otherwise the buildings are not visited except occasionally for routine checks.

Along with the development of the small cable and carrier method described above, there has been a corresponding advance in cable installation methods which will have far reaching effects. Previously, cables were installed either aerially on pole lines or underground in conduit, depending on the expected growth, the former method being used on slow growing routes and the latter being justified when 2 or 3 cables could be foreseen in the next 10–20 years. With the new method of installation, it is economically practicable to place cable underground, and therefore obtain greater security, even although one cable represents the ultimate for the route in question.

Plowing Cables into the Ground

This new method involves a single operation of trenching and cable laying, and can be employed on a very large percentage of the toll route mileage involved in our present cable extensions. The engineers of the American Company have developed a plow with a hollow share through which the toll cables are fed directly from the toll cable reels into the furrow cut in the ground as the plow is dragged along by powerful tractors. In the case of the present extension of the transcontinental cable west from Omaha, there are two cables of about 60 pairs each which are being plowed in simultaneously at the rate of several miles a day. Figure 5 shows such a tractor train pulling in cable. In order for this installation, which is to interconnect the east and west coasts by cable, to be completed at the earliest possible moment as a part of our defense activities, plans have been worked out so that the plowing-in can be carried on 24 hours a day, if necessary and weather permitting. This has been accomplished by equipping the tractor trains with lights to enable them to operate at night almost as easily as in the daytime. It is expected that the transcontinental cable will be completed before the end of 1942, and will result in all cable circuits from New York to San Francisco and Los Angeles, for cables are already available from New York to Omaha and from Sacramento to San Francisco and Los Angeles.

The net result of the rapid expansion of the toll cable network is a great addition to the security of the

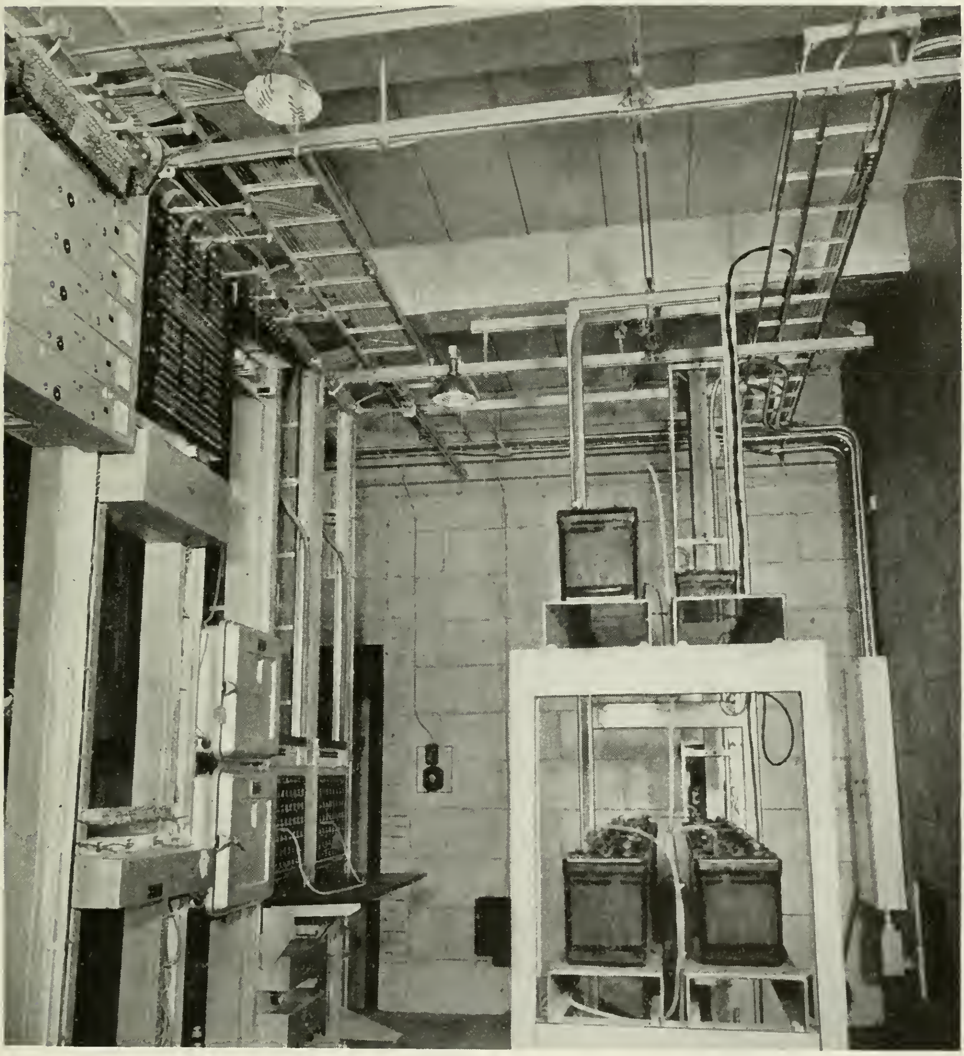


FIG. 4. INTERIOR OF AN AUXILIARY REPEATER STATION

Inside the building shown on the opposite page are compactly arranged the repeaters and associated equipment for amplifying the voice channels transmitted by carrier current

Fig. 5. Plowing Cables into the Ground

Cables from the two reels feed into the furrow through the hollow share of the plow behind the tractor. In heavy going it is not unusual to find two tractors, tandem-fashion, supplying the motive power

toll message plant. The cables, after being plowed in across farm lands,

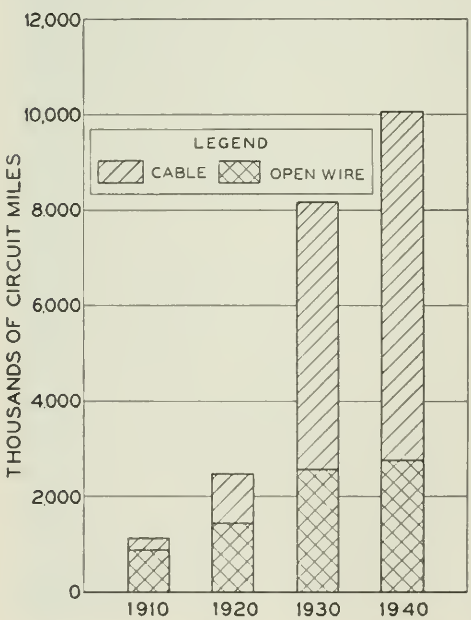


Fig. 6

Relative proportions of toll cable and open wire in the Bell System at four different periods

through swamps, below the bottoms of creeks and rivers, are more free from damage and interruption from storms than their predecessors, many of which were on pole lines and, therefore, exposed to many possibilities of damage. Aerial cables, with their lead sheath protection, were much superior to open wire lines, but were still subject to some hazards, such as small boys using them as targets for their small rifles, or traffic accidents along highways.

As more and more circuits are placed in cable, our long distance services become increasingly dependable. It is interesting to note how steady this trend has been and to what extent the toll circuits of the Bell System are now in comparatively storm-proof plant. The accompanying chart (Figure 6) shows how the long distance circuits, practically entirely exposed to the elements in 1910, have now reached a point where about 75 per cent of the circuit miles used for long distance purposes are in cable.

When one looks at the toll cable map accompanying this article, there still appears to be a large part of the country which is not reached by toll cables. It should be borne in mind, however, that a large portion of the United States is not subject to ice-storm damage and that the older open wire construction is adequate for these parts of the country. Also, through sparsely settled parts of the country, where toll circuit development is low, the open-wire line must necessarily continue to be used because of its lower cost per circuit under such conditions. For these reasons we have not yet attained the ideal of reaching all important towns by means of the cable network, but already substantial progress has been made. By the end of 1942, as a result of a continuing program of cable extension over past years, 82 per cent of our larger cities, those over 50,000 population, will be reached directly by the cable network. Of the remaining percentage not on the cable network, many are in areas not subject to severe storms and therefore comparatively free from service interruptions. The replacement of open wire will continue, of course, and before many more years have passed the prospect is that the other large cities will be connected to the cable network and thus approach closer to the ideal of the Bell System for "a telephone service . . . free . . . from imperfections, errors or delays."

CHEMISTRY BEHIND THE TELEPHONE

The Service of Chemistry to the Telephone Industry Is the Constant Scrutiny and Experimental Reconstitution of the Stuffs That Things Are Made Of

By ROBERT R. WILLIAMS

This is the text of an anniversary radio broadcast made on March 11, 1941, over Station WGY, Schenectady, by the Chemical Director of the Bell Telephone Laboratories.

YESTERDAY was the sixty-fifth anniversary of the first telephone conversation. What the telephone has meant for the comfort of mankind in those intervening years is brought strongly to my mind by an incident of my boyhood. With difficulty I was roused in the small hours of a Kansas morning and told to ride for the doctor while my parents rendered first aid to a desperately sick neighbor. With what heart swellings I set out on the nine mile journey through the night. As, returning, the dawn broke over the hills on the drooping head of my weary horse, the duty had become for me, adventure.

But if, as now, I send my voice out over the telephone on some necessitous midnight errand, the sound waves also have a journey of adventure. Adventure begins just inside the perforated disc into which I speak. For my expelled breath carries not only sound but also moisture which might corrode the delicate moving parts of the transmitter. To prevent this, the most modern instruments are furnished with a thin impregnated silk membrane which detains the moisture but not the sound. Many materials were found to sag in wet weather, and muffled the voice, or they tightened in dry air to give a drum-like reverberation. A new synthetic rubber-like impregnant proved to have the desired properties.

Once through this moisture barrier, the voice must actuate the diaphragm, which is made of a light aluminum alloy and accordingly responds to gentle sounds. Yet it must be rigid, an effect which is produced by precipitation within the metal of an ingredient which is soluble in molten aluminum but which separates as fine particles as the metal cools and is rolled into sheets. The principle is widely used for making alloys which must be both light and strong; for example, aircraft parts.

The diaphragm passes the sound waves on to the transmitter carbon in tiny waves of pressure. The transmitter carbon particles, of the size of sand grains, are hard and shiny to resist abrasion. They also have the somewhat unique property of varying greatly in electrical resistance as they are compressed by the movements of the diaphragm. An electrical current from a battery flows through the carbon grains as one speaks, in a volume which varies momentarily with the sound wave pressure. This device, the microphone, is therefore in a true sense the heart of the telephone, for it converts sound energy into pulsations of electrical current. If the carbon varied greatly in resistance from day to day or from one instrument to another, it would be impossible to reproduce the sounds of modulated speech; or if the carbon grains wore to a powder, frying noises would be mixed in with the speech. Important means to avoid these evils are the selection of low-ash, hard anthracite as raw material and the adjustment of the roasting process to give a carbon of low hydrogen content.

MY voice, now converted into electrical impulses, travels with a speed approaching that of light but not without incidents on its further journey. It might go astray and be lost in the earth or in the framework of the central office building, if it were not securely directed along its proper path. Outdoors its path is guarded by insulating materials. These may be shielded from atmospheric moisture, as in the case of the paper wrappings around each wire of the cables, which in turn are encased in lead sheaths hermetically sealed from end to end. Inside, there is a highly desiccated atmosphere, which in the case of long cables consists of nitrogen under pressure connected to a signal system which sets off an alarm in case the sheath is perforated.

Part of my voice's path may lie underground, where the sheath is subject to corrosion from stray earth currents. Part of it may be supported by poles, on strands of steel. The poles are subject to the attack of wood-rotting organisms of the mushroom family and must be protected by toxic substances, such as creosote, within the cells. Part of the path is usually over wires which are insulated with rubber and exposed to sun and sleet and to tossing tree branches. The rubber must be tough or it will cut through at the insulators under sleet load; it must be protected from the sun by weatherproof braid or it will soon lose its pliability and strength.

WHERE my electrical voice passes through central offices to be connected to the proper party among the many I might call, textile insulations are much used to aid flexible and compact arrangements. There is ample chance for the voice currents to leak away through the internal moisture of the fibres unless the textiles are highly purified of traces of conducting salts. Tarnish films may form at any one of thousands of electrical contacts and my voice may balk at the gap caused by a faint film or be distorted by invisible arcs sputtering through it. All these insulations and conducting or contact materials are safeguarded by chemists who study their initial compositions and the degradations they may undergo from electrolysis or corrosion from dust or atmospheric moisture or impurities. All along its route the channels which carry the electrical counterpart of my voice are subject to slow deteriorative processes which may be likened to the hardening of our arteries as age creeps through our bodies. Much of what the chemist is called upon to do in the telephone industry is to anticipate and to retard their progress.

If my voice has far to go, its feeble currents will be greatly weakened in their travels by dissipation in the line. This effect is reduced by passing these currents through copper coils wound 'round a magnetic core. The action of these loading coils may be likened to a step-up transformer at the terminals of a power line. To be most effective, the core must be very permeable to magnetic lines of force but highly resistant to induced electrical currents. The results are best produced by alloys of iron and nickel so brittle that they can be ground to a fine powder. Each particle is then insulated from its neighbors and the powder pressed into the desired shape to form the core.

If the distance is still greater, my voice must be rejuvenated periodically by passing through an amplifier. This could be done by interposing a receiver and transmitter in the line and, so to speak, make the telephone shout into its own ear. Nowadays, however, it is done by imposing the voice current on a grid past which is flowing a stream of electrons from a hot filament to a plate. When the pulses of the voice current reach their peaks, the grid is positively charged and catches many electrons to reinforce the pulse; as the voice pulses approach their valleys, the grid is negatively charged and repels the electrons. So the voice currents are re-accentuated and go on their way. Their revitalization is essentially due to the reservoir of free electrons which the filament provides. The electrons emanate from a coating on the filament composed of barium and strontium oxides. Its structure and composition give it the quality of a spring-board from which the otherwise bound electrons may leap off into space.

Arrived at the station called, the electrical record of my voice must be retranslated into speech. This is done by passing the voice currents through a coil which lies between a diaphragm of magnetic material and a strong but small permanent magnet. As the voice pulses rise in the coil, they add to the field strength of the permanent magnet and draw the diaphragm toward the magnet; as the pulses fall, they subtract from the magnet's field strength and allow the diaphragm to fall away. The movements of the receiver diaphragm so faithfully reproduce the movements of the transmitter diaphragm against which I spoke that you not only understand my message but you recognize my voice. The nicety of reproduction is greatly aided by nicety of composition, both of the magnet and the diaphragm. Their compositions are different, but each is preponderantly iron plus cobalt. The addition of vanadium in the diaphragm facilitates its manufacture without impairing its sensitivity to the weak voice pulses; the inclusion of molybdenum in the magnet provides a permanent and compact source of magnetic force.

So chemistry serves the telephone as it serves medicine, manufacturing and other callings, by constant scrutiny and experimental reconstitution of the stuffs that things are made of.

FOR THE RECORD

OUR PART IN THE NATION'S DEFENSE PROGRAM: A STATEMENT BY PRESIDENT GIFFORD AT THE ANNUAL MEETING OF STOCKHOLDERS ON APRIL 16

We of the Bell System are concentrating on doing well our part in our country's defense program, which in size and speed is undoubtedly the biggest job ever undertaken by any country. It is not easy, in a few words, to portray to you the magnitude of our task and the diversity of the problems we must face and solve in carrying out our part in that defense program. Perhaps it will help if I try to illustrate by specific instances.

Last September we learned that Camp Edwards, up on Cape Cod, was to have a quota of upwards of 25,000 men. The camp is located between two small towns, and it was up to us to figure out how to furnish adequate service for this big military establishment. We weighed all the possibilities, and the upshot was the decision to build an entirely new central office at Cataumet, not far from the camp. On October 4 the New England Telephone and Telegraph Company broke ground for a brick building of colonial design, to house an initial installation of 30 switchboard operators' positions. Installation started on November 4, and by January 4 the operating force had been trained and everything was in readiness for service —three months to the day after ground was broken. The sequel to this is that already 15 more switchboard positions have been ordered, increasing the capacity of the central office by half, and there is room for still another 15 positions if they are needed.

Another example of the speed with which we can move, and also of the fine spirit of our people, occurred when we were asked to furnish telephone service ahead of schedule for a big ordnance plant which was being constructed not far from St. Louis, Missouri. Crews of the Southwestern Bell Telephone Company got on the job at daybreak on last Thanksgiving morning, ate their Thanksgiving dinners beside the road, and in three days, working from daylight to dark, put in five miles of plowed-in cable and open wire along a heavily traveled highway.

On Sunday, January 26, fire gutted the Administration Building at the Norfolk Naval Base, in the territory of The Chesapeake and Potomac Telephone Company of Virginia, completely interrupting all communication service through the headquarters of the Fifth Naval District. The facilities destroyed included the private branch switchboard, power plant, interior cables and cable records. The alarm was given at 9:30 A.M. By 11 A.M.—and remember that this was a Sunday—about 40 telephone installers, splicers, linemen, engineers and staff men were at the scene with trucks, tools and equipment. Half an hour later, telephone service had been provided over temporary facilities to the offices of the Commandant of the Fifth Naval District and his aides. Two small sections of private branch switchboard had also been obtained locally, and temporary service for other vital telephones at the Base was being given by Sunday afternoon.

By Sunday noon a preliminary survey had been completed, and the local people had Western Electric's Kearny Works on the wire. By ten o'clock that night a complete new 10-position private branch switchboard, weighing five tons, was ready to go. It was packed in a special car which was attached to a passenger express train, and reached Norfolk at 10:30 Monday morning. Western's Hawthorne Works, in Chicago, and its Washington distributing house also shipped a considerable amount of miscellaneous relay equipment and cable for the restoration. When the new equipment arrived on Monday, Chesapeake and Potomac plant men and Western Electric installers were on hand to install it quickly. The Navy coöperated splendidly, our men worked day and night, and service was being given through the new switchboard just 69 hours after the alarm of fire had been given.

THOSE are interesting examples, I think, of what we can and sometimes have to do. I could cite many other illustrations of unusual activities of this kind going on here and there in the Bell System. Even under normal conditions every effort is made to work out and adhere to schedules of construction and installation to meet the requirements laid down by the defense agencies. In order to coöperate quickly and fully with the various government departments, the American Telephone and Telegraph Company has maintained an office in Washington for some years. As soon as the decision has been made to build or enlarge a military or naval establishment or a defense plant, word reaches our representatives there, and is quickly passed on to the operating company in whose territory the project is to take shape; to the Western Electric distributing house serving that company and to Western's headquarters; and to the A. T. & T. staff in New York. The operating company begins at once to survey the kind and amount of work it will have to do and the plant which will be needed, and Western Electric schedules tentatively the probable order for the private branch switchboard, distribution cable, and other items which the project will require. Our staff people here are always available, and are frequently consulted about various aspects of such an undertaking.

As each project becomes more definite, plans for manufacture and construction can proceed with assurance. By the time the order has actually been signed, much preliminary work has been accomplished. We have been quite successful so far in meeting scheduled dates for service to defense projects. Of course, in many cases our Operating Companies and Western Electric have had to work under pressure to do it.

NEW or enlarged Army and Navy camps, bases, aviation fields, and other military establishments, together with Government-owned or financed plants making ordnance, aircraft and other war products where major telephone construction is involved, total about 600. This includes establishments planned, under construction, and completed. We have finished substantial telephone installations at about 200 of these places, and the facilities at the remaining places will be ready when needed. I want to use just one figure to illustrate the size of our job at these 600 establishments: the cables which we have already installed or expect to install in giving service to them will contain a total of more than a million and a quarter miles of wire—and that is enough to wrap around the earth 50 times.

Our part in the nation's defense activities is not by any means confined to the service we have already provided or will provide to these 600 Government establishments. Many thousands of privately-owned industries are making military materials of all sorts, totalling billions of dollars, under direct contracts with the Government. The great activity in all of these military and manufacturing establishments is reflected today throughout the whole industrial and social structure of the country, and is to a great degree the cause of the heavy demands generally for telephone service and equipment. In reality, therefore, a very large part of all our current telephone plant expansion is directly associated with the nation's defense activity and is vital to it.

In addition to manufacturing all the equipment and materials needed by our Operating Companies for this huge construction job, Western Electric is furnishing directly to the Army, Navy, the air services and the Coast Guard, quantities of switchboards, cable, telephones, microphones, radio telephones, field sets, field wire, and other items of communication equipment. Moreover, Western's Specialty Products Division has already received Government orders for highly specialized communication equipment totalling approximately $40,000,000.

These figures are a few days old, and are therefore not complete, for even days make a difference now.

Obviously, where camps, aviation fields, ordnance plants, etc. are located in territories served by independent telephone companies, it is ordinarily they and not we who provide the service and equipment. I should like to emphasize the point made in the Annual Report that the splendid cooperation between these 6400 independent connecting telephone companies and the Bell System is extremely important in marshalling the resources of the entire telephone industry in the interest of national defense.

We have had for some time a group, including representatives of the Bell Telephone Laboratories, Western Electric, and our headquarters' staff, at work on substitutes for such critical materials as aluminum, nickel, zinc, and magnesium, all of which are used in telephone apparatus. We have pledged to the Priorities Division of the Office of Production Management in Washington that we will make every effort to reduce our use of such materials, even at some penalty in cost and effectiveness. It is not a simple matter, but we have already made some real progress and we hope to go further.

More than 200 of the Laboratories' scientists and engineers are engaged in research and development projects for the Army and Navy and for the National Defense Research Committee. Some 60 of the Laboratories' staff are employed in telephone problems which have been directly occasioned by the national defense situation, and another 80 are engaged in fundamental research for which the methods and point of view have been changed because of problems suggested by defense activities.

The Selective Service Act has taken about 700 of our men so far, and about 1,500 who were members of the National Guard and the Army, Navy, and Marine Reserves are now on active duty. Despite these absences on leave, the number of employees in the System, including the Western Electric Company and the Bell Telephone Laboratories, has increased 18,000 since the first of the year and is now about 340,000.

The President of your Company is Chairman of the Industry Advisory Committee of the Defense Communications Board, and ten other members of our headquarters organization are assisting in the work of this Board as members or alternate members of its several committees. Dr. Jewett, a Vice President of this Company and Chairman of the Board of the Bell Telephone Laboratories, is serving as a member of the National Defense Research Committee, and more than a score of the leading scientists and executives at the Laboratories are serving as members or as consultants in the work of its various divisions and sections. Mr. Harrison, A. T. & T. Vice President and Chief Engineer, who has been on leave of absence since last summer on government defense work, has recently been made Chief of the Branch responsible for shipbuilding, construction, and supplies in the Office of Production Management, and a dozen other men from the Bell System have been loaned to the government in connection with the defense program.

Work is going ahead with sections of the new transcontinental telephone cable mentioned in the Annual Report. This cable is being laid underground, starting west from Omaha, where it connects with the eastern cable network. In the meantime, additional equipment is being added to our open-wire lines west of Laramie, Wyoming, which, in conjunction with this cable, will provide another 36 circuits to the Pacific before the end of this year. New wire is also being strung between Oklahoma City and Albuquerque, New Mexico, which, with existing wires over the remainder of the distance and with associated equipment, will provide 32 more circuits to the Coast within the next few weeks. Thus we shall have this year 68 more transcontinental circuits—an increase of about one-third over the already existing 200 circuits. These east-west lines, running in four widely separated main routes across the continent, are, of course, interconnected at a number of points.

While we are working at high pressure to give telephone service to the Army and Navy, and to provide other equipment for the two services, almost every other industry in the United States is also working on defense production, as I said a minute ago. We have our part in that because as others increase the tempo of their efforts they inevitably use the telephone more and use more telephones, for the telephone is an instrument of speed and accuracy in modern affairs. And this means that we have a little part in almost every effort toward national defense. A little part in every effort adds up to pretty large figures.

We have never yet had a net gain of as much as a million telephones in a year —last year's gain of 950,000 was the highest we ever had—but if the present rate of growth should continue throughout the year, we would gain nearly a million and a half telephones—50 per cent more than ever before in one year. In any case, an increase of well over a million looks certain. Long distance calls are running about 25 per cent above a year ago—some days more than 35 per cent. That is a percentage increase in one year which we would normally expect might take place over a period of two or three years. Actually, we are now handling, on the average, more long distance calls every day than we did during the unprecedented peak of traffic which we experienced in September of 1939, when the war broke out in Europe. All of this necessitates additional facilities, and we now expect to spend in 1941 about $400,000,000 for new construction—$110,000,000 more than we spent last year . . .

The speed and vastness of our country's defense program and the importance of the telephone to its success are a challenge to every man and woman in the Bell System, and I am sure that you, as stockholders, would be proud if you could see the spirit and competence with which the entire personnel is meeting that challenge.

DR. CAMPBELL RECEIVES THE EDISON MEDAL

The Edison Medal for 1940 has been awarded by the American Institute of Electrical Engineers to George Ashley Campbell, who retired from the Bell Telephone Laboratories in 1935 after thirty-eight years of Bell Telephone service. The award is "in recognition of his distinction as a scientist and inventor and for his outstanding original contributions to the theory and application of electric circuits and apparatus." Among the eminent engineers and scientists who have been recipients of the medal are Elihu Thomson, George Westinghouse, Alexander Graham Bell, John J. Carty, Michael I. Pupin, Robert A. Millikan, Frank B. Jewett, and Bancroft Gherardi.

In accepting the medal, at the winter convention of the Institute, Mr. Campbell said in part:

"Curiosity is as good an explanation of the Edison Medal award as I could find . . .

"In the Bell System I have found the greatest opportunity for the pursuit of curiosity. It was a fascinating field 40 years ago, and during that interval its expansion has been phenomenal, both quantitatively and qualitatively. What was even more important in my own case was that I became a part of a research and development organization with clear-cut goals, high standards of performance, recognition of the importance of the division of labor, and the advantage of teamwork.

"In the Bell Organization, I was assigned assistants who could do many things with greater dispatch and efficiency and perfection than I could. To some of these assistants I later reported myself, and others have carried on the work into difficulties which I myself could never have surmounted.

"You will see that it is perfectly natural that I am an admirer of that kind of teamwork which represents a division of labor in the intellectual field. At one and the same time it gives a greater opportunity to those whose talents lie within rather narrow fields, and it results in an integrated product greater than the sum of the individual efforts. For reasons I have just explained, I feel that I am the beneficiary of the group method of attacking scientific problems. Without the collaboration of innumerable associates in the Bell System, the contributions you have designated to be mine I probably should not have succeeded in making. It is a distinct pleasure to me to recall these many associations and to testify that those who have been my colleagues over the years are in large part responsible for the honor of receiving the 1940 Edison Medal."

CONTRIBUTORS TO THIS ISSUE

Graduated from Drury College in 1911 with the degree of B.S. and from the University of Pennsylvania in 1914 with the degree of B.S. in E.E., Fred K. Rowe joined the Engineering Department of the A. T. & T. Company in the latter year. After completing the student training course, he was assigned to work on central office and P.B.X. power equipment matters. He was later engaged on manual central office equipment problems, and at present is in charge of the group handling local manual and auxiliary equipment and central office and P.B.X. power plants.

After studies at Princeton and at New College, Oxford University, Frank P. Townsend, Jr., entered newspaper work as a reporter on the Newark, N. J., *Evening News*. In 1926 and 1927 he was successively city editor and managing editor of the Hollywood, Fla., *News*. After a brief period of free-lance advertising and publicity work, he joined the Publicity Department of the New Jersey Bell Telephone Company in 1928. To prepare his article, he interviewed Professor Reager and members of his classes.

Born and educated in England, H. M. Pope gained his first experience in the telephone business with The National Telephone Company, then operating in Great Britain. From 1906 to 1909 he was Engineer in charge of outside plant construction in South Wales. Coming to the United States in 1909, he entered the employ of the New York Telephone Company Plant Engineering Department in New Jersey, where he remained until the war. Early in 1917 he joined the Signal Corps, U. S. Army, and later was in charge of the Signal Corps engineering department for the Eastern Department. Returning to the New York Telephone Company in 1919, he soon was transferred to the Commercial Engineering Department of that company in New York City. In 1921 he became an engineer in the Department of Operation and Engineering of the A. T. & T. Co., and since 1933 has been its General Commercial Problems Engineer.

After graduating from Colorado College with the degree of B.S. in E.E. in 1914, Arthur F. Rose joined the General Engineering Department of the American Telephone and Telegraph Company. Upon completing the student training course for new employees, he was assigned to the development work then under way on the New York-San Francisco route which culminated in the first transcontinental telephone service in 1915. As a result of this initial acquaintance with telephone repeaters, he continued in transmission work dealing particularly with these devices. In 1919, when the General Engineering Department was divided and the O. and E. Department formed, Mr. Rose was assigned to the group which was concerned primarily with the application of repeaters and carrier systems in toll engineering. In 1939 he was transferred to the plant extension section, where he has continued to the present time. He has contributed several articles to the *Bell System Technical Journal* and the Bell Telephone Quarterly, all of them dealing with various aspects of the toll plant.

After receiving the M.S. degree at the University of Chicago in 1908, Robert R. Williams spent eleven years as a chemist in the service of the Philippine Government in Manila and the Federal Government in Washington. He joined the Engineering Department of the Western Electric Company in New York in 1919, where he conducted studies of submarine cable insulation and later of textile insulations for central offices. Paragutta, on the one hand, and purified textiles, on the other, as now extensively used in the Bell System, are outgrowths of the studies inaugurated by him. When the Bell Telephone Laboratories were organized in 1925, he became Chemical Director and has since had general charge of chemical and metallurgical investigations of the manifold materials used in telephone engineering practice. His avocational activity has brought him distinction in another field. Becoming interested in the chemistry of nutritional disease through his contact with beri-beri in the Philippines, he has continued this study throughout his professional career by alliance with various research organizations and with the aid of funds from foundations, notably the Carnegie Corporation. Working at Columbia University and utilizing the time freed by the short working weeks of the depression period, he brought to a successful conclusion, with the aid of a small group of affiliated workers, the isolation, determination of structure, and artificial synthesis of vitamin B_1. The availability of this substance has rendered possible the present program of enrichment of flour and bread under the auspices of the Federal Government and the National Research Council. He has been honored with medals of the American Chemical Society, the Franklin Institute, and the American Association of Manufacturers, and by honorary degrees of D.Sc. from Ottawa and Ohio Wesleyan Universities.

Bell Telephone Magazine

Vol. XX | August, 1941 | No. 3

WESTERN ELECTRIC: TELEPHONE ARSENAL

NEW CHANNELS FOR OLD

EVOLUTION BY DESIGN

PROVIDING THE INFORMATION SERVICE

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."

VOL. XX **AUGUST, 1941** NO. 3

Published for the Bell System by the Information Department of
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York, N. Y.

INSTEAD OF ALUMINUM

Dial telephones go through the assembly line as fast as ever, but the finger wheel is made of steel now—in place of the lighter metal. By substituting less critical materials in many ingenious ways, one Western Electric plant alone is saving an estimated million pounds of aluminum this year, and similar savings are being made at the other W. E. Works, as well as in other vital metals and alloys—as described in the article beginning on the opposite page

WESTERN ELECTRIC: TELEPHONE ARSENAL

The Bell System's "Service of Supply," Experienced in Meeting Emergencies Imposed by Nature's Forces, Is Geared Up to Serve the Nation in This Time of Crisis

By ALVIN von AUW

The following article discusses the part being played in the nation's defense effort by the Western Electric Company, which is the manufacturing, purchasing, and distributing unit of the Bell System. More general statements of the System's rôle in the re-armament program have appeared in three previous issues of this magazine: October, 1940, *the text of a brief radio broadcast by President Walter S. Gifford of the A. T. and T. Company over a nation-wide network on October 14;* February, 1941, *"The Bell System and National Defense"; and* May, 1941, *the statement to stockholders by Mr. Gifford at the annual meeting on April 16.*

In the re-armament program in which this country is so mightily engaged, the Western Electric Company is a full partner. For vital to the nation's defense effort is coordination, which depends, in turn, upon communications. And communications means the telephone. The telephone network has become the nerve system of a democracy on guard against the perils of a world at war. Recent months have seen a demand on the services of the Bell System, and thus on the manufacturing facilities of the Western Electric Company, unprecedented in the history of the telephone. Today the products of Western Electric are moving up to the defense front in an ever-mounting stream.*

Military analogies are apt. In these recent crowded months Western Electric has become the arsenal of telephony. For many years Western Electric has been termed the Bell System's "service of supply," a phrase borrowed from the armed forces. The W. E. organization was established and is maintained to secure the advantages of standardized manufacture and of large-scale centralized purchasing coördinated with nation-wide distributing and equipment installation forces—all in order to supply a communications front stretching the length and breadth of our country. In emergency after emergency this type of organization has demonstrated its advantages. Today, in an "unlimited national emergency," they are once more apparent.

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* So, of course, are the products of other manufacturers of communication equipment, who supply in large part the needs of the country's 6,400 independent Bell-connecting telephone companies. Many of them are also working on defense contracts directly for the armed forces. See "Independent Telephone Companies," Magazine, May, 1941.

PLANNING COMES FIRST

In all Western Electric plants, engineering conferences are a basic preliminary to the production of communication equipment for the nation's defense

Western Electric's defense effort is two-fold. The Company has thrown its full weight of man-power and machines into (1) the manufacture of radio and other communication items for the Army, the Navy, and the Air Corps, and (2) the engineering, manufacture, and installation of telephone equipment ordered through the Bell System operating companies for service in government defense establishments, in vital privately-owned defense plants, in Bell System central offices and cross-country circuits expanding to meet the communications demands of a nation girding itself for any eventuality.

The Bell System laid the groundwork for its defense activities well in advance of the first huge defense appropriations. Telephone company and Western Electric men organized regional defense committees to speed local activities. In New York, the headquarters defense-program group includes a W. E. "coördinator" as one of its important members. To the coördinator's desk has come a mounting stream of teletype "flashes" from the field and from the Bell System representatives in Washington as well: ". . . $25,000,000 NAVAL AIR BASE FOR QUONSETT POINT RHODE ISLAND FOR SERVICE MAY 1 AT LEAST 500 DIAL PBX LINES REQUIRED. . . . TANK ARSENAL SLATED FOR DETROIT 40,000 FEET LEAD COVERED CABLE SHIPMENT REQUIRED AT ONCE. . . . SAN DIEGO CONSOLIDATED

AIRCRAFT 600 PBX LINES BY MAY 1 200 LATER. . . ." Advance information like this, carefully collated, helps the Company to anticipate the later and more specific demands and to make corresponding preparatory adjustments in production programs all along the line.

Cryptic initials "A. S. A. P." (for "as soon as possible") give a staccato touch to many telephone company orders for W. E. material. On corresponding Western Electric invoices, the notation "shipped same day" recurs with gratifying frequency. On specific defense orders, normal "engineer, furnish and install" schedules have been telescoped. Cable reels may roll into army camps when they're little more than a stack of blue-prints in a contractor's shack. Private branch exchanges are often cut into service while the big bulldozers are still making molehills out of mountains, clearing the ground for Uncle Sam's military cities. By the time a camp crackles with its first bursts of practice rifle fire, an entire telephone system will have been installed, and telephones are ringing in headquarters' offices.

Production Quantities Are Vast

WESTERN ELECTRIC's finger on the pulse of the defense situation is the program planning group at headquarters. Twice monthly the group issues a detailed report of progress

THIS IS A FLIER-STRANDER

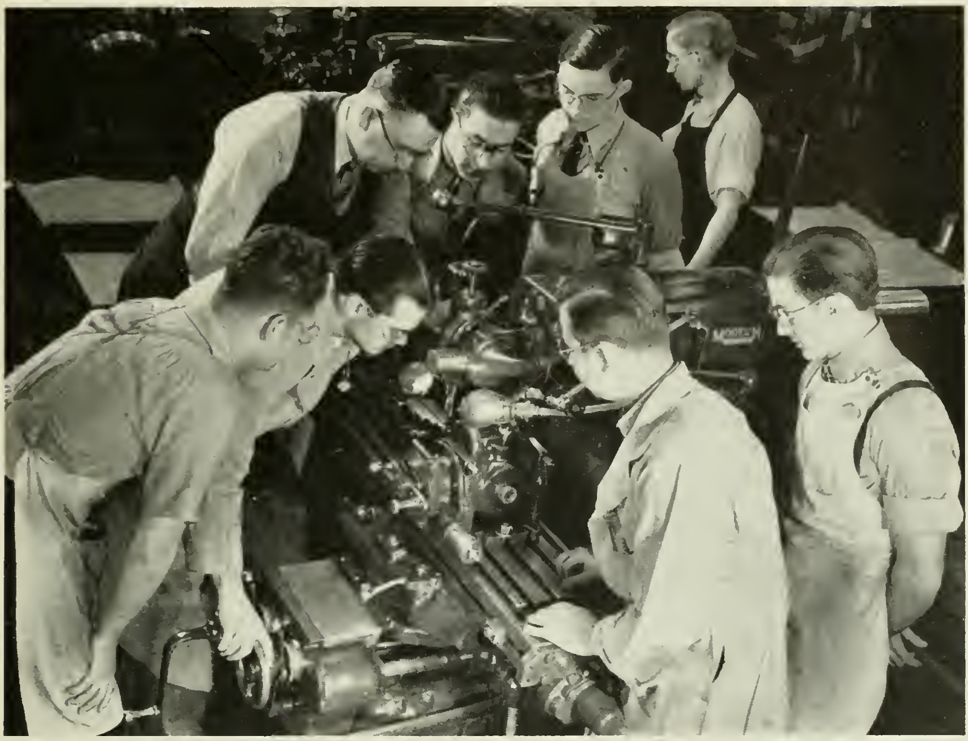
At the rate of 600 feet a minute, 101 separate pairs of wires are drawn from spools through the drilled plate and stranded together—one step in the manufacture of telephone cable along the communications front, together with carefully considered estimates of future requirements. How many telephones are needed in the building of a two-ocean navy, an army of a million and a half, an air force second to none? How much cable? How many PBX's? These reports chart the rapidity with which Western Electric's production, delivery, and equipment installation schedules must be revised in step with the fast expanding defense program. Last October some 153 army, navy, and other defense establishments were projected or a-building. By December 136 more had been added. In February the total reached 777. Today the number is approaching 1,100. To nearly all of these army camps, navy yards, airfields, arsenals, anti-aircraft firing centers, etc., Western Electric will provide telephone equipment in whole or in part—or has already done it.

To do the job, current estimates indicate, will require 9,191,000,000 conductor feet of lead-covered cable, 629 private branch exchanges, 10,000 public telephones, 8000 booths, 3200 teletypewriters — and corresponding totals for other major and miscellaneous items.

But these figures cover only equipment destined for installation in army camps, naval bases, airfields, arsenals, and other government-owned or government-financed defense establishments. They do not take into account equipment required for the Bell Sys-

Field Telephones for the Army

Skilled fingers assemble in mass production the sturdy sets which may handle vital orders and reports in action



LEARNING THE TECHNIQUES OF INDUSTRY
Students in the training department at Hawthorne Works receive some pointers on the operation of a tool-and-die machine

tem's greatly expanded program of new construction. The rapidly growing communications requirements of private industry and of the thousands of America's new homes, as well as the equipment needed to increase the capacity of hundreds of telephone central offices, to add many circuits between the great industrial centers of the land, to link suddenly booming communities to the nation-wide telephone network—all these have placed a demand on the production capacity of Western Electric unmatched in the Company's 72-year history.

ALL the Company's plants are running at exceptionally high annual production rates in almost every line of communications equipment. A check of central office apparatus production shows current annual "going rates" of 116,000 lines of panel, 584,000 lines of step-by-step, 303,000 lines of crossbar. Manual central office equipment is running at the rate of 2,090 switchboard positions per year. Sales of carrier and repeater equipment, items for which there is a heavy demand to supplement the long-distance facilities now serving the nation-wide preparedness program, are expected to reach a total of $22,600,000 for 1941. The loading coil going rate is currently set at 1,227,000; telephone sets at 2,870,000; dials at 1,980,000. Rubber-cov-

Cables for Everywhere

By water, by rail, and over the road these reels of lead-covered cable—already tested, sealed, and packed—will speed to points throughout the country where an expanding telephone service requires them

ered wire is being turned out at the rate of 2,156,000,000 conductor feet per year. Cable shops are working at an annual rate of 48,850,000,000 conductor feet. Much of this lead-sheathed cable is being armored, at an annual rate of more than 5,000 miles a year, for protection against the elements and marauding rodents when buried along underground toll routes.

Another example of advance planning is Western Electric's program of conservation of vital raw materials. For some years, Bell System engineers have been studying materials, both old and new, to assure their most effective use, and today these studies are proving of great value in the light of present problems of supply. In Western Electric plants, less critical materials are now being substituted for metals and alloys vital to airplane and munitions manufacture. Engineers at the Hawthorne Works estimate that the substitution program will effect a saving of more than a million pounds of aluminum in 1941—approximately 62 per cent of the amount this one plant alone would otherwise use. Impressive savings are also being effected at all Western Electric Works with other critical materials as well—nickel, zinc, nickel-steel, magnesium, etc.

In twelve months the Western's man power has increased nearly 50 per cent. Since June of 1940 more than 16,000 new employees have taken their places beside the old, learning from them the tricks of their trade and absorbing the spirit of service. The Western's training programs, too, are bearing fruit, relieving somewhat the acute shortage of machinists and skilled operators which was forecast as a potential defense stumbling-block. Western Electric, like many another vital defense industry, is burning midnight oil: extra shifts in key departments are contributing heavily to the Company's total defense effort.

W. E. in Action

YOU can't tell the story of action on the communications sector with generalizations and statistics alone. You have to go into the front lines. You have to see, for instance, a crew of installers rolling out of improvised bunks in an unheated, unfinished army barracks to complete an elaborate PBX installation before the troops arrive. You have to see the conveyor systems in the Western's 29 distributing houses disgorging material labeled "National Defense." You have to see the men and women and machines of Hawthorne, Kearny, Point Breeze, and the other W. E. plants in action. You have to visit one of Uncle Sam's vast new Army camps.

Take Camp Blanding, for instance, Florida's fifth largest "city," population 45,000. Twelve months ago the uninhabited 55,000-acre tract was given over to palms and pines and an impenetrable thicket.

FOR AN AIR BASE AND TWO ARMY CAMPS

Cable, switchboard sections, and miscellaneous equipment are leaving the loading dock of a Western Electric Distributing House. With a magnifying glass, the words "National Defense" can be seen on every address label

Nearest community to Blanding is Starke, 30 air miles south of Jacksonville. A year ago Starke awoke with a jolt. Twenty-two thousand workmen came to town. In a week cot-space was at a premium. A boom town overnight, Starke went to work in earnest for defense.

On October 26, 1940, the first flag went up over the soldier city. Work crews knocked off for a few minutes to gaze at the banner, then set to again at the double. Early in December the troops began to roll in by train and truck. Based at Blanding today are two full Infantry divisions and a Field Artillery brigade.

To provide communications facilities for the mushrooming military city, the Bell System matched strides with Uncle Sam.

Pine trees hadn't yet given way to barracks when the Southern Bell Telephone and Telegraph Company rushed the first temporary PBX to Blanding. It was set up in the contractor's office, an Army kitchen, and connected with Starke over a two-bracket line rigged by the National Guard. Two weeks later, while carpenters were still hammering away on the rooftop, an 80 line PBX from Western Electric's Jacksonville distributing house was cut into service

A Washington Central Office Expands

Western Electric installers are placing dial switching equipment to care for the Capital's vastly increasing numbers of telephone calls. Many central offices have been greatly enlarged to care for the traffic occasioned by the defense program

ARMY FIELD EXERCISES

A permanently installed dial-type switchboard in the front of the truck is linked to smaller Command Post switchboards ahead and to larger units at the rear. So functionally designed is this equipment that telephone facilities to serve a relatively large sector can be completely set up, including the running of field wire, in a few minutes

in the temporary administration building. Later the contractor called for, and got, 80 more lines.

At September's end, Southern Bell ordered from Western Electric sufficient wire to increase the number of circuits between Jacksonville and Starke from three to nine, the circuits between Starke and Gainesville from two to six. (Circuits between Starke and Jacksonville have since been increased to 22.) Western Electric was also called upon for four positions of number 12 switchboard for the new central office at Starke. Within ten days after the order was dispatched, the switchboard had been engineered and the first shipment had been received. On October 10 a Western Electric installation crew rolled into Starke. On November 18 they rolled out again, the central office installation completed.

Completed is hardly the word, though; for within a few weeks Western Electric men were back on the job to answer the call for three more switchboard positions. Then, later, four more positions were added. And recently the installation of ten additional switchboard positions has brought the total in the new Starke central office to 21.

Meantime, Southern Bell men were burying 43,900 feet of 76-pair cable in the sandy soil between town and camp.

Meantime, too, workmen rushed

A Private Branch Exchange Switchboard

This one serves a naval operating base. Other hundreds of P.B.X.'s, large and small, have gone into camps and bases and into industrial plants from coast to coast

Building TT-2 toward completion. They had a deadline to meet. On December 7, as the camp for the first time echoed to the tread of marching feet, Western Electric installers turned TT-2 into a military nerve center by cutting into service a seven-position, 400-line PBX switchboard.

Since Blanding opened for business, the camp's PBX has been increased to ten positions and its capacity has soared to 1300 lines; cable requirements have lifted radically; public telephones for the convenience of soldiers off duty have been installed.

Blanding, for all its jig-time construction, is not unique. Although one of the largest, it is in point of fact typical of the scores of defense establishments, located at a distance from sizable communications centers, which must be fitted with complete telephone facilities in the interest of national security.

At Corpus Christi

Here's another example.

At Corpus Christi, Texas, close by the Mexican border, there stands a brand-new $44,000,000 assembly-line six months long. Today it is turning out America's most urgent defense weapons: flying men—300 of them a month. It's the world's largest naval air station. Yesterday, it seems, it was a waste of sand dunes and mesquite. With a total acreage of 14,500, Corpus Christi has 29 sepa-

"—WITH THE GREATEST OF EASE"

Conversation with ground stations and with other ships in flight is vital to this pilot of one of the celebrated Army P-40's. Note the throat microphone, which transmits the voice clearly but not motor and other extraneous noises

rate air fields. Twenty-five are practice landing fields scattered over two counties. Only the main base and three auxiliary fields are edged with dormitories and administration buildings, however, so that the huge air campus will have four separate dial PBX systems—an 800-line 701-A PBX with five 605-A positions for the main base, two unattended 100-line 711-A's and a single-position 701-A for the auxiliary fields. Will have? On June 7 all four PBX's went into service simultaneously, six weeks after Western Electric installers put in their first appearance.

Equipment for the main base was ordered April 9, shipped on the 23rd. Installation began on the 28th. Western Electric's two Texas distributing houses established a record, too, by shipping poles, cable, and five positions of manual PBX to provide telephone facilities preliminary to the official dedication of the base last March 12. Moreover, W. E. men have installed six new toll positions in Corpus Christi's central office, an added capacity that in normal times would provide for growth over a period of some years.

Air-base telephone communication is, necessarily, highly versatile. The elaborate crash alarm system at Corpus Christi will send crash boats, ambulances, crash wagons racing to the rescue inside a minute and a half after an accident report is received.

Corpus Christi and Blanding have been cited here in some detail not because they're unusual, but because they aren't:—that is, in reference to military construction which is being accomplished in many places throughout the country. Multiply these two instances by the total defense picture and you have the reason for unprecedented production figures at Hawthorne, Kearny, and Point Breeze, for the accelerated pace of distributing house service, for new installation records.

For the Armed Forces

Corpus Christi and its swarms of canary-colored primary trainers—"yellow perils" in cadet slang—call to mind another Western Electric defense contribution.

Backed by Bell Telephone Laboratories and a quarter century of aviation radio experience, Western Electric, with little or no fanfare, has been turning out radio telephone equipment used by all major United States airlines and hundreds of private fliers. That experience is bearing fruit today. The Specialty Products Division at Kearny has Government orders approaching a total of $100,000,000, a major share of which is for light-weight, low-powered aviation radio equipment for installation in America's rapidly multiplying squadrons of training and fighting planes. The balance of these orders calls for high-powered radio equipment for use on the ground, and also for special telephone, amplifier, and loudspeaking equipment for installation on the new battleships, cruisers, and aircraft carriers that are sliding from the ways in ever increasing numbers. Work on Specialty Products contracts is proceeding at all three Western Electric manufacturing locations, and, in line with the announced policy of the Office of Production Management, millions of dollars in sub-contracts have been let. Thus Western Electric's experience in the manufacture of broadcast transmitters, of radio telephones for use on land, on sea and in the air, and of public address systems and other miscellaneous items fits smoothly into the defense program.

What the future may bring, no one can say with certainty. But as the present danger to democracy becomes more clearly seen—or, perhaps, better comprehended—surely this country's exertions to avert it will be redoubled. More and heavier demands will be made upon the Western Electric Company, as upon all industry: upon its plants and equipment, upon the resourcefulness of its management, and upon the loyalties of its employees. Along with all the other units of the Bell System, the Western Electric Company will continue to contribute in unstinted measure to the provision and maintenance of the country's essential communication service. Western has a job to do for national defense, and to the limit of its resources and capabilities it will keep on doing it.

NEW CHANNELS FOR OLD

To the People of Two Isolated Islands in Chesapeake Bay, a Recently Established Radio Telephone Circuit Brings Contact with the Bell System's Mainland Network

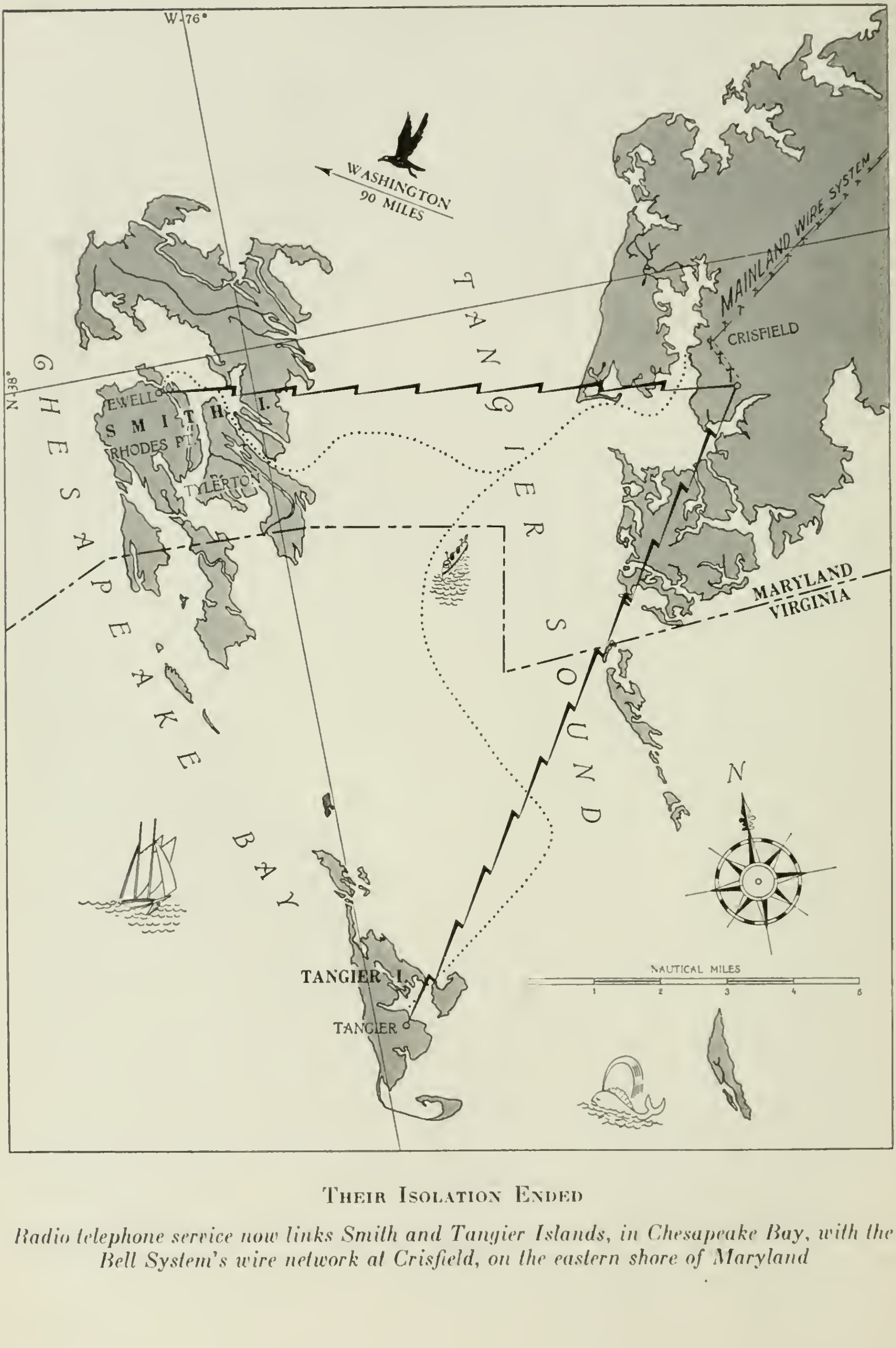
By EUSTACE FLORANCE and AUSTIN BAILEY

In the shallow waters of the Chesapeake Bay, 90 miles or so, as the crow flies, southeast of the dome of the United States Capitol, lie Smith and Tangier Islands. These islands were settled near the end of the seventeenth century, by English from the Colonies. Although these folk and their descendants have always been seafaring, they have had but infrequent contacts with their neighbors on the mainland. They have been fishermen, but the sea could not supply their every need. For two and a half centuries, summer and winter, the men of these islands have fought to keep open a sparse network of boat channels, their only outlet to the town of Crisfield, twelve miles away on Maryland's eastern shore. Through these channels, in sail boats, power boats, and barges flow all those commodities of commerce not taken from the sea that go to support 2,200 souls. Not all of this has been food and material things. Part of it has always been a precious freight of words, written or borne by messenger; words that asked and answered, that sought and gave help or comfort.

Shifting sands, strong winds, or choking ice sometimes blocked these channels; but even when the elements were friendly, the time and exertion required to convey a single word across the Bay was hardly less than would have brought a cargo of lumber or flour.

In recent years, while the islanders spent the seasons oystering and crabbing, caulking boats, or marking channels, others elsewhere explored and devised channels of a vastly different sort. It was inevitable that one of these new channels, dug out of the mystery of electricity by scientists in distant laboratories, should find a swift route above the boat channels to carry this traffic of words across the water barrier in calm or in storm.

The need for swift communication with the two islands had long been obvious. In years like 1936, when Chesapeake Bay froze almost solid, and even ice-breakers could not penetrate Tangier Sound, word spread abroad that aid was sorely needed by the residents of Smith and Tangier Islands. Then the Red Cross and Coast Guard coöperated to send succor to the starving islanders by airplane and parachute. Hazardous



THEIR ISOLATION ENDED

Radio telephone service now links Smith and Tangier Islands, in Chesapeake Bay, with the Bell System's wire network at Crisfield, on the eastern shore of Maryland

HARBOR AT TANGIER

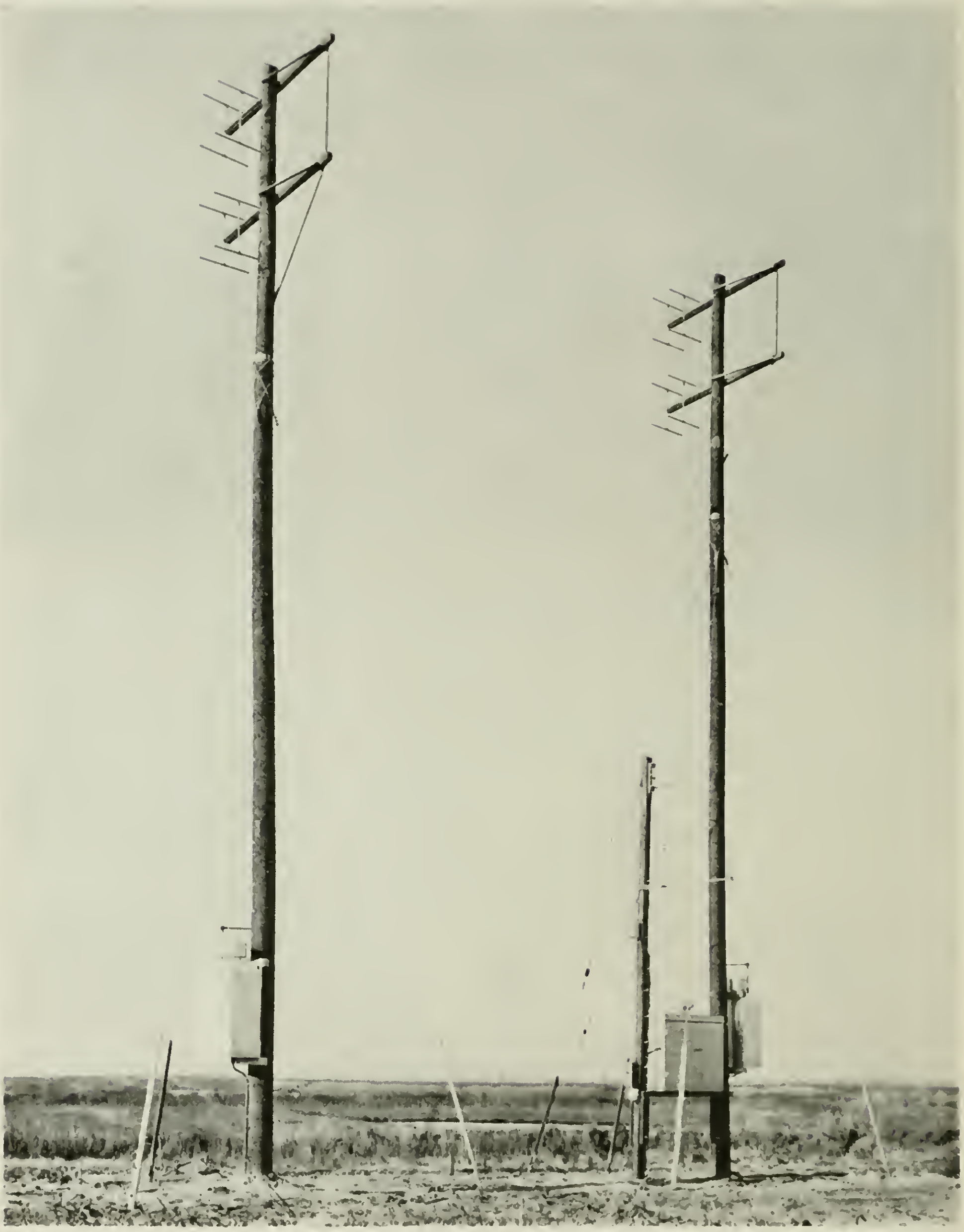
Bell System engineers came ashore here frequently during the past winter. The island was discovered and named by Captain John Smith in 1608

days such as these were not the only occasions when communication was sorely needed; but, of course, it was most essential at such times.

Providing Emergency Service

TELEPHONE connection by submarine cable had often been considered, but both shallow water and extensive oyster dredging would make any cable insecure. This fact led to repeated rejection by telephone engineers of all such cable projects. Progressive developments in the art of radio telephony suggested new approaches to the problem. As soon as suitable radio telephone equipment became available, the local telephone company made provision for at least the emergencies by establishing on the islands portable units for voice communication with the mainland. Restricted though it was, this service proved its worth: when ice threatened to block the channels, emergency calls summoned ice breakers from the U. S. Coast Guard, while other calls sought and secured medical advice or traced the movements of the mail boat and other craft that were over-due. During three months in the winter of 1939–40 alone, more than a hundred emergency calls were completed.

Much development work was necessary, however, to construct a telephone system that would be adequate for general commercial service: radio transmitters, radio receivers, and power supply that would operate continuously, dependably, and automatically with a minimum of supervision. Working together for nearly half a year, engineers of the Chesapeake and Potomac Telephone Companies, the Bell Telephone Laboratories, the Western Electric Company, and the



RADIO TELEPHONE EQUIPMENT ON THE MAINLAND

On these poles is the apparatus for communicating with the islands. Receiving antenna and equipment are on the pole at the left, and at the right are not only transmitting antenna and equipment but an automatically-operating emergency power supply

On Smith Island

This is Main Street in Ewell. Since there are no vehicles larger than hand carts and bicycles here, this narrow "highway" is both safe and picturesque

A. T. and T. Company devised such a system.

Many times during the past winter, often when the passage was coldest and windiest, telephone and Laboratories men visited the islands to direct the installation of equipment and to line up the circuits. As visitors are few on Smith or Tangier, Bell System men soon became known, and each step of the project had its interested audience.

Telephone Service at Last

Last February, with the opening of a reliable radio telephone link which could be used for any messages, these two islands were connected with the nation-wide telephone network of the Bell System through the Crisfield telephone exchange. The radio link equipment consists of radio transmitters and receivers operating at frequencies around 160,000 kilocycles—the highest frequency in Bell System commercial radio telephony today. The channel is controlled from the Crisfield telephone office, and provides a circuit between Crisfield and Smith Island, Crisfield and Tangier Island, and between the two islands through Crisfield. In effect, a forked radio channel has been devised, engineered to cut the tine to one island when operating with the other.

The mainland radio station is in a marsh near Jenkins Creek, just outside the village of Crisfield. Here the equipment is all housed in pole boxes. The radio receiver is on one pole, which is likewise the support for the beam antenna used for receiving. The balance of the radio equipment—largely radio transmitter, control units, and beam transmitting antenna—is supported by another pole about

An Island Telephone Installation

The switch at the right of the instrument on the wall gives access either to the radio telephone circuit to Crisfield or to the local wire circuit for conversation among the islanders

30 feet away from the first. Between this latter pole and a stub pole about 5 feet distant is a platform which supports an emergency power supply generator which will start automatically if there should be an interruption of the regular power.

On the islands other sixty-foot antenna poles, towering over the flat marshlands, disclose from afar the location of the sending and receiving apparatus and wholly automatic gasoline engines which generate the necessary power; all snugly fitted into diminutive huts which gleam white in new paint.

To give the inhabitants on the islands convenient access to the service, four telephones have been provided on each island, strategically placed in village store or dwelling. A flip of a key switches these instruments off the radio connection and onto a magneto line to furnish local talking facilities which run the length of each settlement.

Voices from Afar

Construction and testing completed, the day came for opening of the service. On the fourteenth of February, shortly after nightfall, most Smith Islanders made their way on foot down Main Street in Ewell to the community hall. In the dim light of kerosene lamps, men and boys in rubber boots and heavy clothing and women in shawls awaited, perhaps a little skeptically, the events of the evening. On an improvised stage a pair of telephone men put finishing touches to the installation of a telephone and loudspeaker. The gathering showed polite interest throughout an explanation of the new system; all attention stiffened as the wife of the island's clergyman took her place by the telephone on the stage. A moment later the greetings of Maryland's Chief Executive, speaking from the State Capitol, sounded through the hall.

Those ceremonial congratulations completed, she placed another call, and nodding heads and smiles revealed excited pleasure as the voice of Captain Whitelock—skipper of the mailboat—poured clearly and familiarly from the amplifier: "It's a great thing the telephone people have done for us folks." All knew the Captain's words came from a hospital bed in Baltimore, but few could comprehend how—through aerial, submarine, and underground cable, overland and under the Chesapeake Bay to Crisfield, then out through the air across the water—his voice flashed into the meeting hall. Captain Whitelock has for many years piloted messages into Smith Island ports through the slow channels of the Bay, and it was fitting that he should be among the first to use this new channel of the air to bring his message to those he has served so faithfully.

The following day, with telephone and loudspeaker, Bell System men sailed up to the peaceful boat landing at Tangier, Va., and went to the town hall there to install their equipment. In the early hours of the evening a group of nearly 400 interested people gathered to witness the ceremonies attendant upon the opening of telephone service to the mainland. Although everyone was interested in the explanation of the new telephone system and how it could be used, that interest was intensified when the minister of the island placed a call to the Governor of Virginia, in Richmond. Clearly they all heard the greetings from the Executive Mansion.

To the District Manager of the Chesapeake and Potomac Telephone Company at Salisbury, Md., came recently a letter which was signed by the Mayor, the Treasurer, and the Clerk of the Town of Tangier, Va. In it these gentlemen said, in part:

> "Inquiries come to us from time to time concerning the telephone and its service to the Island. After three months we can truly say its convenience, efficiency, and satisfaction in service are daily being increasingly realized.
>
> "Shakespeare said, 'Some are born great, some achieve greatness and some have it thrust upon them.' Concerning Tangier and the telephone, even before it is needed for emergency service, there is a sense of comparative greatness about it that means progress. . . ."

So science, and the skill and the enterprise of many people—executives and engineers, business men and boat men, installers and others—have lifted the voices of these lonely people out of dependence upon the slow channels of the water and into the swift channels of the air.

EVOLUTION BY DESIGN

The Purposes and Methods of the Bell Telephone Laboratories Are Exemplified in the Continuing Program of Development of Three Plant Items: Drop Wire, Relays, and Receivers

By REGINALD L. JONES

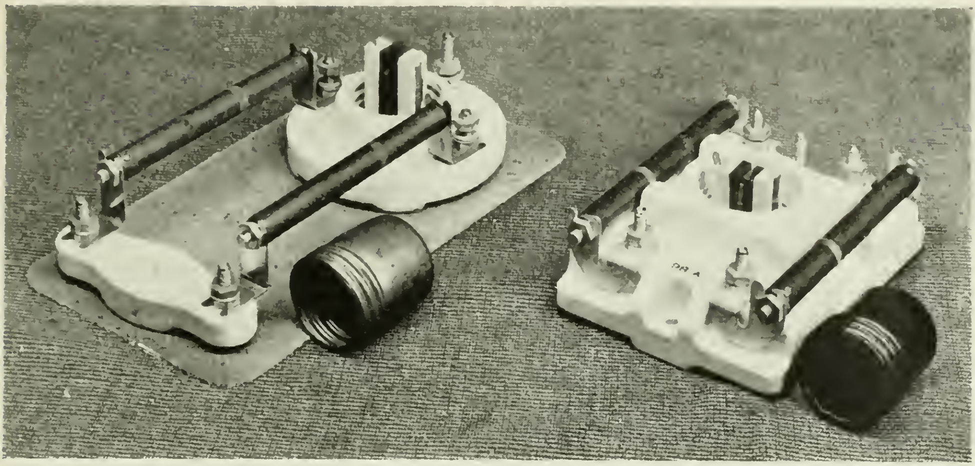
To the telephone subscriber, the "drop wire" which is suspended between his house and the telephone pole line may seem to be of quite ordinary nature. If he should examine it, he would find it to be oval in cross-section, about one-fourth inch in its greater dimension, and to consist merely of two conductors symmetrically imbedded in rubber insulation covered by impregnated cotton braid. The plant man, however, knowing by long experience the many hazards to which drop wire is subjected, recognizes it as a highly specialized product, developed by the Bell Telephone Laboratories with painstaking care to fit its particular purpose.

Of all the parts of the exchange telephone plant, the drop wire occupies the most vulnerable position. It must support itself in the gap between building and pole line, of either cable or open wire, no matter whether the distance be long or short. In many cases, it must pass through trees or other obstructions which may rub against it and finally wear it through. Damaged insulation admits moisture, which corrodes the conductor, thus gradually reducing its strength, and which also causes the subscriber's line to become noisy or perhaps to fail altogether. Because of the addition of new subscribers, changes in residence of old subscribers, and service changes, about four hundred million feet of new drop wire are needed by the Bell System each year. Obviously, low cost is an important requirement.

The Evolution of Drop Wire

The use of drop wire is almost as old as the telephone art itself. Work toward improving its performance has been carried on since the earliest days; but the major improvements have been made during the past fifteen or twenty years, as a result of general advances in chemical and metallurgical processes.

Let us pick up the development about the year 1928. By this time it had become evident, from analyses of field results and by Laboratories tests of the product, that a major source of trouble with the then standard wire was failure of the insulation at the pole and building attachments, between which the wire was suspended.



PROTECTIVE APPARATUS AT SUBSCRIBERS' PREMISES

Near the point where the drop wire enters a building, a protective device is installed to discharge harmlessly any stray current of excess voltage which might accidentally be on the outside telephone wires. The new one-piece porcelain protector at the right is cheaper to make and is better adapted for mounting in homes of modern construction than is the protector of older design

It was known that this was due primarily to the fact that as the rubber aged, it gradually lost part of its elasticity and strength and finally became brittle. Development work was undertaken with two objectives: to design a suspension attachment which would distribute the gripping pressure of the attachments over a wider area of the rubber, and to obtain a rubber having better physical characteristics.

Up to that time, the suspension device had consisted of a porcelain knob attached to a bracket, the wire being looped around the knob and secured by a tie wire. A clamping device was developed in which the wire was laid in a slot with a tapered wedge in such a way that the harder the pull on the wire, the tighter became the gripping action of the wedge. This wedge-type clamp, because of its relatively large gripping area, reduced the unit pressure on the insulation to a satisfactory level. Basically, it is the drop wire clamp in use today, although a number of design improvements have been made since it was first devised.

"Rubber" insulation such as is used on drop wire is a complicated compound of which rubber itself is only one of the constituents. The compound includes sulphur, "mineral rubber," which is an air-blown asphaltic compound, and "mineral fillers" such as whiting and zinc oxide; it also contains organic materials known as antioxidants (to retard aging) and accelerators (to hasten vulcanization). The Laboratories technicians to whom fell the job of securing a better rubber were faced with the essential problem of finding the particular mixture of ingredients which would best meet the requirements of drop wire insulation.

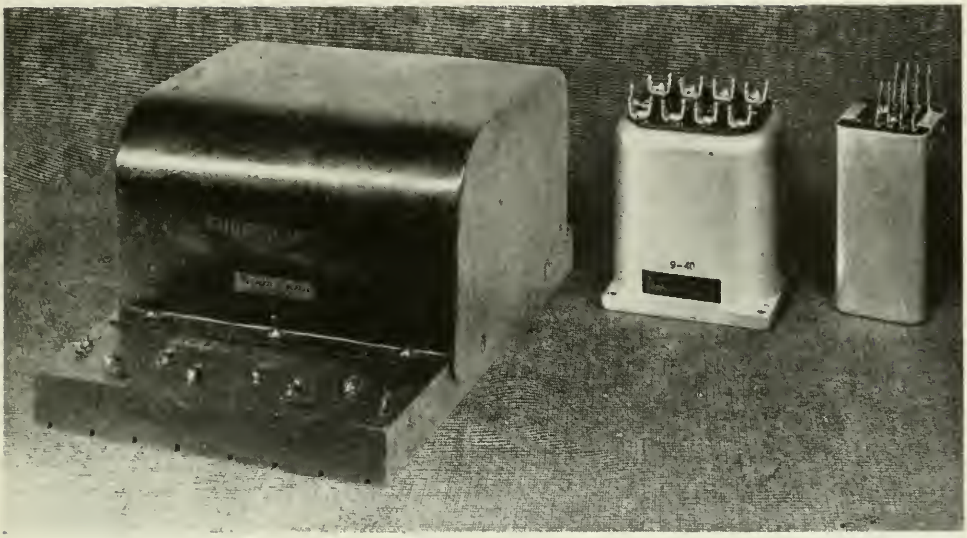
It soon became evident that, as a first step, it would be necessary to devise improved testing techniques for evaluating the relative worths of various mixtures. To replace the tensile strength testing apparatus then available, the Laboratories engineers developed a device for determining the compressive strength of rubber as insulating cover on a conductor. At about the same time, there became available a device known as an "oxygen bomb," in which samples of drop wire insulation could be artificially aged by exposure to oxygen at high pressure and elevated temperature. With these new test tools, and with a large previously acquired knowledge of rubber characteristics, the engineers prepared and tested many kinds of rubber compound. After several years of laboratory work, an insulation was evolved which was much superior to the old from the standpoints of crushing and aging.

During this same interval, the Western Electric Company, in co-operation with Bell Laboratories engineers, developed a new technique for manufacturing drop wire, by means of which the insulation was extruded around the conductors in unvulcanized form and then vulcanized in one continuous operation. This replaced the former method of extruding unvulcanized wire into pans of talc or soapstone and then vulcanizing in the pan. The new manufacturing process was simpler and less expensive than the old; but, together with the better rubber compound, it accentuated a problem which, while troublesome with the older form of wire, had been partly masked by other deficiencies. This problem was the tightness with which the rubber adhered to the conductors.

A good bond between rubber and conductor is essential in order to prevent the conductor from slipping through the insulation at a point of clamping, thus causing the rubber and surrounding braid to take more than their share of the strain, and to break. In the older wire, the bronze conductor was tin coated, primarily to prevent corrosive reaction between the sulphur of the rubber and the copper constituent of the bronze. The adhesion between tin and rubber was strong when the wire was new, but decreased rapidly with age. The Laboratories engineers found that by placing a thin layer of brass, of a closely controlled copper-zinc composition, next to the rubber, good adhesion was secured not only when the wire was new but during service. However, it would not have been satisfactory to deposit the brass directly on the bronze conductor, due to the resulting diffusion of the zinc into the bronze. To overcome this difficulty, and at the same time to afford corrosion protection, a coating of lead alloy was placed over the bronze conductor before the brass coating was applied.

During this same period, the bronze conductor itself received development attention. A new bronze was evolved, containing a larger amount of tin than the older bronze. This bronze was stronger, permitted the size of the conductor to be reduced, and at the same time met the electrical conductivity requirements for drop wire.

The cotton braid covering of drop wire is needed to protect the wire from abrasion, and from sunlight, which would tend to cause cracking of the rubber. To improve its dura-



STEPS IN THE DEVELOPMENT OF "INPUT" TRANSFORMERS

They form part of the repeaters used to amplify the currents at regularly spaced intervals, along telephone toll lines. At the left is the transformer associated with an early type of repeater. The widely used transformer in the center has been superseded recently by the smaller one at the right, which requires less space and is improved electrically

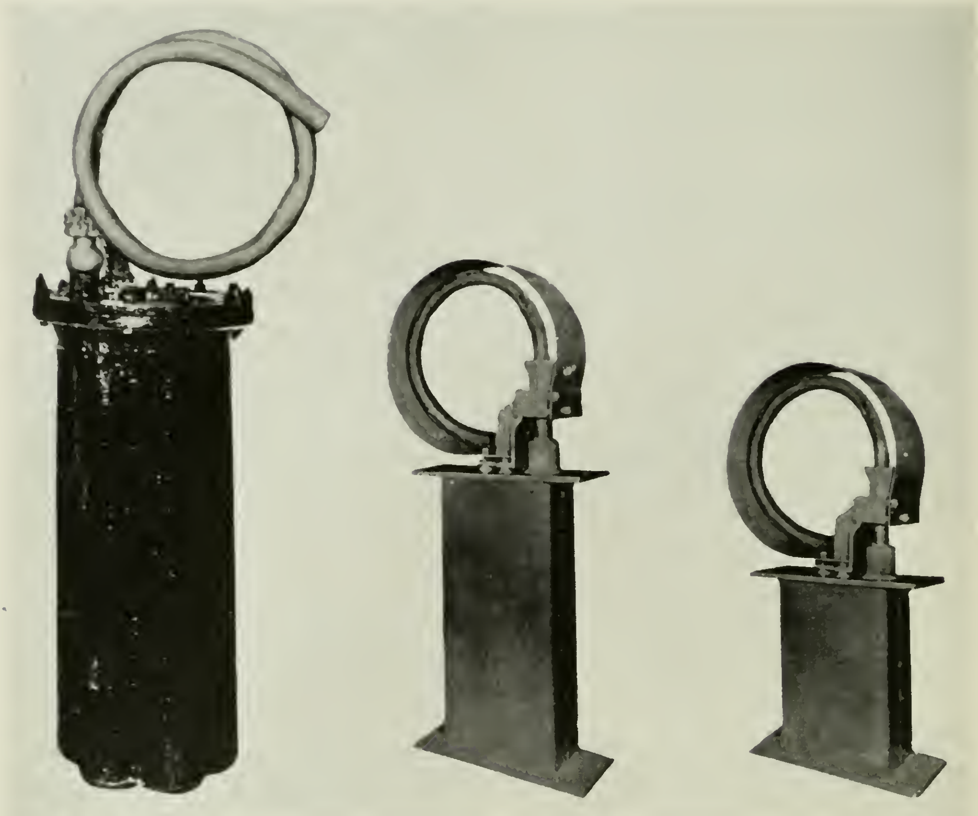
bility and increase the abrasion resistance, the braid is treated with weatherproofing compound. Many of these compounds have been studied. The present treatment involves saturating the braid with a mixture of selected asphalts and waxes, followed by a coating of stearine pitch and, finally, by a coating of ground mica.

The decrease in conductor diameter has made it practicable to use a heavier cotton braid and a correspondingly greater amount of weatherproofing compound than in the older wire, thus further increasing durability and abrasion resistance and at the same time retaining the former cross-sectional size. Retention of size makes it possible for the plant man to use the same "braid stripper" for both new and old wire, avoiding duplication of installation tools.

Thus, during the period from about 1928 to 1938, there was evolved a drop wire which has longer life, better adhesion, and higher abrasion resistance, but costs no more than the wire it replaces. The Laboratories, nevertheless, at outdoor test stations located at San Antonio, at Miami, at Chester, New Jersey, and at the New York headquarters, continue their search for a still better product.

Organized Development Effort

THE development of drop wire is typical of the Laboratories method, in that it utilized and integrated the creative efforts of a number of technicians in various fields of research and engineering. The telephone plant as a whole, with its manifold, interlocking parts, requires a large and highly specialized personnel and ex-

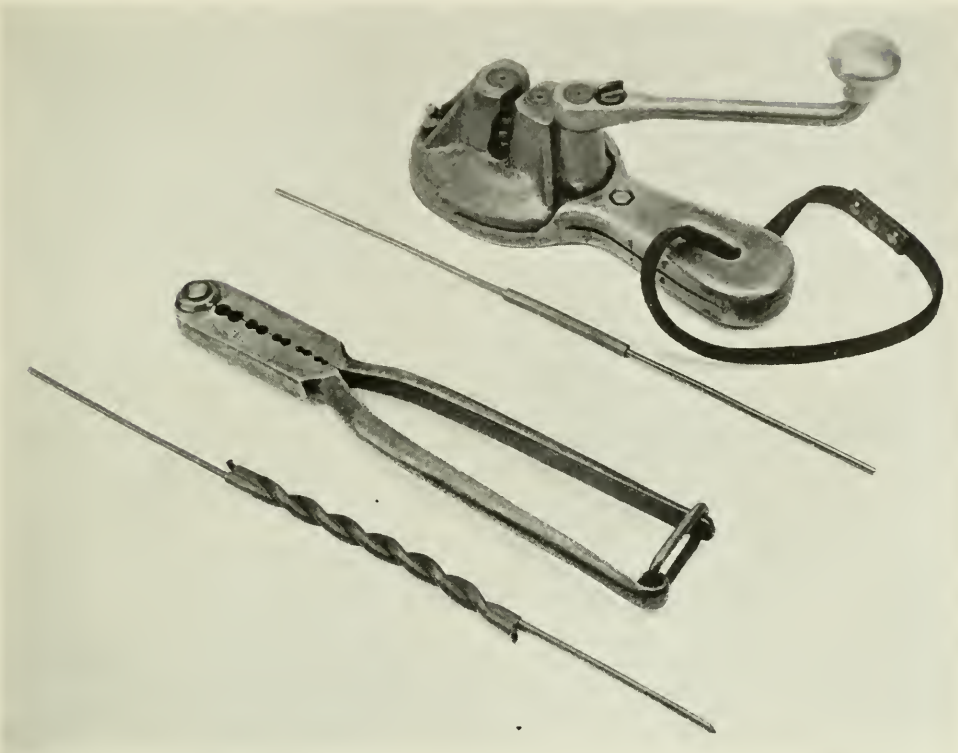


Loading Coil Cases

Each case contains 200 loading coils; each coil consists of many turns of fine wire around a ring-shaped magnetic core. Left, with iron coil cores, made available in 1926, total weight 1750 pounds. Center, with permalloy cores, made available in 1931, total weight 455 pounds. Right, with molybdenum-permalloy cores, made available in 1937, total weight 360 pounds. Loading coils are placed at intervals along a telephone line when it is desired to improve the efficiency of the circuits by "loading." The cases shown here are for use with exchange cable; other types for use on both exchange and toll lines have been similarly improved

tensive facilities to meet its needs for coincident developments. To carry on the necessary work, the Bell Telephone Laboratories employ about 2,000 scientists and engineers; 1,000 draftsmen, laboratory assistants, skilled mechanics, and artisans; and a total personnel of over 4,800.

The Laboratories' headquarters are in New York, in a ten story building occupying an entire city block and containing the multitude of individual laboratories, machine shops, drafting rooms, and paraphernalia necessary for the functioning of an organization of this kind. In addition, auxiliary laboratories for special purposes are located at a number of points in New Jersey, and include an outside plant laboratory at Chester, radio laboratories at Whippany and Holmdel and Deal, and a chemical laboratory



JOINTS IN OPEN-WIRE TELEPHONE LINES

Below are a twisted-sleeve joint and one of the pair of sleeve-twisters used to make it. Before twisting, the sleeve is in the form of straight twin tubes slightly larger than the wire in diameter. Above are the more recently developed rolled-sleeve joint and the rolling tool. The wires are inserted in opposite ends of the sleeve, and the tool is applied at one end of the sleeve and rolled along to the other end by turning the handle. Applying pressure of about one ton, this process reduces the diameter of the sleeve to a tight grip on the wire, as strong as the wire itself and free from corrosion difficulties

at Summit. These are used for development projects which require large amounts of space or special test conditions not available in New York City—as for instance, a study of the effect of wind on open wire lines.

THE technical forces of the Laboratories are organized in three general departments: Systems, Apparatus, and Research. The Systems Development Department formulates circuits and assemblies to serve both switching and transmission needs of the Bell System plant, and prepares switchboard and central office equipment specifications for manufacture and installation. The Apparatus Development Department designs and specifies most of the items of apparatus and material used at subscribers' stations, in central offices, and in the outside plant. The Research Department conducts fundamental studies in physics and chemistry, emphasizing particularly the branches of science underlying communication phenomena and materials.

By careful planning, the work of each department is coördinated within itself and with that of other departments. An important phase of this is the continuous dissemination, to each group, of knowledge concerning the new materials, processes, apparatus, and circuits which are being worked on by other groups. This is done by conferences of key engineers, by the circulation of technical memoranda, by lectures in the Laboratories auditorium, by articles in the *Bell Laboratories Record,* and, perhaps most importantly, by the day-to-day contacts which result from the centralized association of a large group of people all skilled in the technical aspects of the telephone art and the sciences which underlie it.

A case in point is the development for telephone use of certain oxide mixtures which have the characteristic that their resistance to electric current decreases rapidly with increase in temperature. Basic laboratory studies led to the conclusion that such mixtures could be usefully employed to meet several immediate needs of the telephone art and that probably they could be adapted advantageously to other needs.

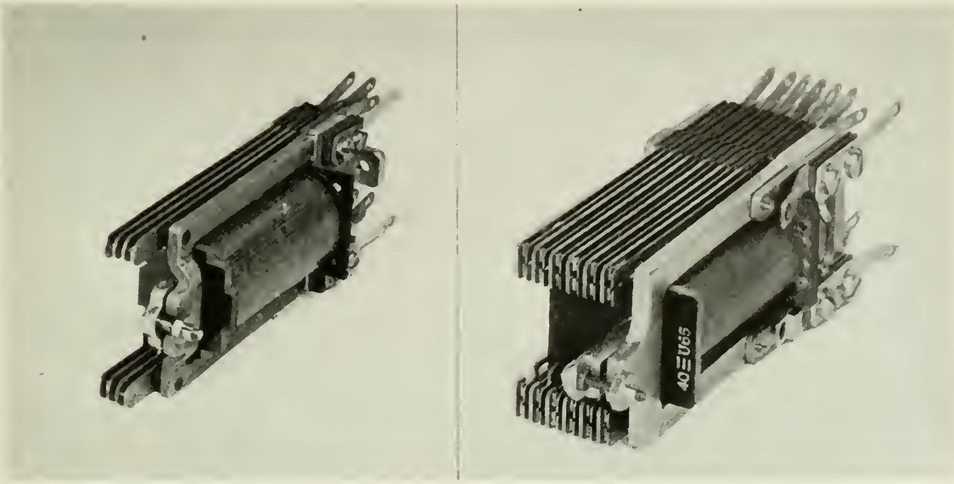
By means of lectures held in the Laboratories auditorium, the technical staff was made familiar with the theoretical possibilities of the mixtures and the applications in prospect up to that point. A new tool, the "thermistor," thus became a part of the working capital of the Laboratories engineer. Within a short time, thermistors were being developed for such diverse purposes as controlling the operation of a supervisory relay in a toll trunk circuit, keeping constant the amount of output power of a cable carrier repeater with changes in input power, and stabilizing the transmission loss of a telephone cable circuit with changes in cable temperature.

With these Bell System resources for laboratory study, analysis, and experiment in mind, let us further examine in broad outline the recent development histories of two familiar telephone parts which, like drop wire, have been in use since earliest days.

The Telephone Relay

In a telephone central office, whether local or toll, large or small, there are many contrivances for establishing the connections and guiding the voice currents to their destination. Each has reached its present form as a result of a large amount of development effort. We shall focus our attention on one: the relay, which is the automatic switching device of the telephone network. About ninety million relays are in use in the Bell System. In some types of dial system, as many as five hundred relays may come into play in completing a connection between two subscribers, and ten or more of these relays may remain in action until the subscribers hang up. Many relays are called upon to operate millions of times during their service lives. Reliability of performance, small size, and low cost are paramount design objectives.

The basic relay parts are an electromagnet and a switch operated by this magnet. The magnet is made of a wire-wound iron core and a movable



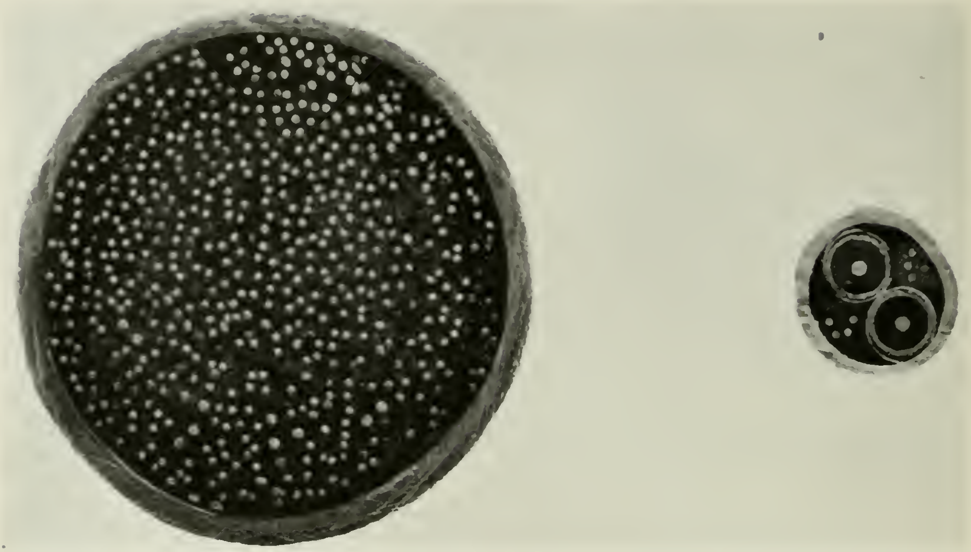
TELEPHONE RELAYS

The most recently developed type of relay, at the right, is more powerful than the older type shown at the left, will operate a larger number of contact springs, and embodies other improvements in design, as discussed in the accompanying text

iron piece called the armature. The winding is arranged for connection to a control, such as an operator's key, the dial of a telephone set, or another relay. The armature is usually hinged at one end, with its other end free to move toward the core in response to the magnetic force generated by a current in the winding. The armature, in turn, operates the switch which, in most relays, consists of a number of reed-like contact springs mechanically coupled to the armature and moved by it to make or break the desired electrical circuits. Each spring is about one-fourth inch wide and two inches long, and has a small contact point welded near one end. The distance over which a spring moves is about one-sixteenth inch.

THE wire of the magnet spool is coated with enamel or silk; but still more insulation is needed for such purposes as separating the winding from the core, spacing the terminal wires from the rest of the winding, and affording mechanical protection. For these purposes, early designs of relay employed materials such as bookbinder's cloth and ordinary paper similar to writing paper. A source of trouble with relays has been gradual corrosion of the wire, which finally causes the winding to open. Intensive laboratory study indicated that this corrosion was due chiefly to impurities in the insulating materials. One by one these impurities have been eliminated by the development of insulating materials better suited to the purpose. The most recent step in this phase of relay development has been the substitution of thin sheets of cellulose acetate for the paper insulation of former times.

In order to retard corrosion, the paper insulation of the older relays was impregnated with wax. Particles of the wax, seeping from the winding,



Two Types of Modern Telephone Cable

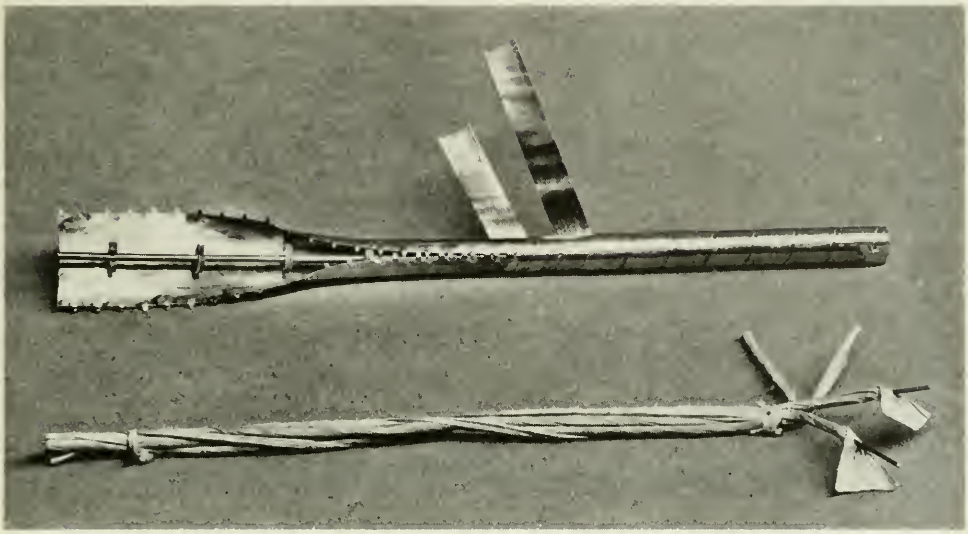
A quadded toll cable, left, and one form of the recently developed coaxial cable, shown in cross section, about actual size. The quadded cable contains approximately 150 "quads" of paper-insulated wires. The coaxial cable contains two copper conductors, each held centrally in a copper tube surrounded by helically-wound steel tape, and also two quads for circuit supervisory purposes. Both cables have about the same message capacity. Structural details are shown on the opposite page

would in some cases be deposited on the moving parts of the relay, causing the armature to stick. With cellulose acetate insulation, wax treatment was discontinued, and sticking became a less serious problem.

Insulation made of cellulose acetate has an additional advantage: it is better adapted than paper to manufacturing processes using automatic coil winding machinery. The new insulating material has made practicable several major advances in manufacturing technique, and these have reduced the cost and improved the uniformity of the product.

The most vital part of the relay, and at the same time one of the most vulnerable, is the tiny projecting contact welded to the contact spring. The shape of this contact and the metal of which it is made are of great importance in determining the relay's reliability, and have been the subject of almost continuous laboratory study. Extensive investigations have been made of the behavior of contacts of various metals and shapes when subjected to mechanical action and to erosion of an electric spark, the amount and effect of tarnish, the pressure required for good contact, and the effect of foreign particles.

Silver, tungsten, platinum, rhodium, iridium, gold, and palladium, and their alloys, all find use as relay contacts. Years of experience have shown that precious metals are better than base metals for contact purposes. For



COMPONENTS OF CABLES

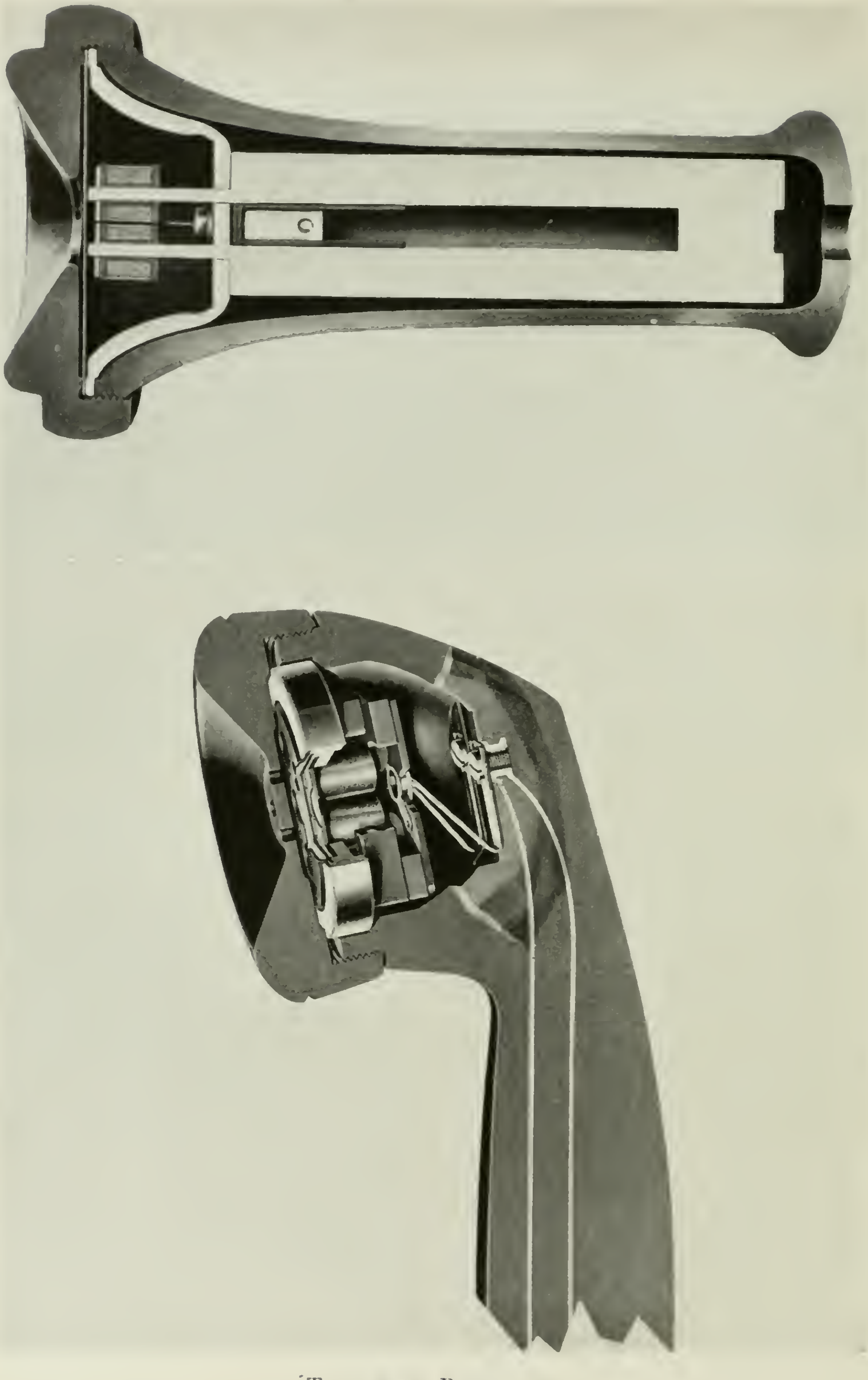
At the top is shown one of the two coaxial conductors pictured in the cable at the right on the opposite page. The central wire is held in place by insulating discs and enclosed in a copper tube which is wound about by two steel tapes, and is enclosed, with its twin and two sets of quads, in a lead sheath. Below is a quad, composed of four copper wires, each wrapped in paper insulation and then twisted together. Coaxial cable is cheaper per mile to make than the quadded cable shown opposite, but requires more expensive terminal equipment

many kinds of relay, silver or palladium is the most satisfactory. As regards shape, the older contact, with its pin-head contour, has been replaced by one in the form of a tiny bar about one-sixteenth inch long and one-sixtyfourth inch high. The bar of one spring is mounted horizontally and the bar of its companion spring vertically, so that the two contacts, when touching each other, are in the form of a cross.

FOREIGN particles have been a frequent source of relay trouble. The air is full of minute objects: drops of moisture, bits of hair, soot and coal, metallic particles, fibers of cotton, silk, and wool. With the thousands of relays in a central office, it is not surprising that at times one of these floating particles should lodge on a contact surface and prevent proper closing of the contacts.

To diminish troubles from this source, individual covers have been used to keep the dust away, the contacts have been mounted in vertical planes to minimize accumulation of dust by settling, and air filtering equipment has been used in some cases. A recent improvement which is very effective is a relay spring having double contacts.

The advantage of twin contacts over the former single contact can be illustrated by an extreme example of atmosphere wherein dust particles are so dense that at every thousandth operation a contact, when pressed against its mate, will close over a piece of dust or lint, and thus fail to



Telephone Receivers

The desk-stand receiver, above, has been largely superseded by the hand-set receiver below. Differences between them are described in the text on the opposite page operate. If now the contact on each spring is split into two independent members, the chance of a particle falling between the second set of contacts will also be one in a thousand; but the likelihood of two particles of dust falling at the same time, one between each of the sets of contacts, will be one-thousandth as large, or one in a million. Field experience has indicated that with the twin contact arrangement, as used in practice where the two contacts are not independent, the improvement in reliability of operation is about ten-fold.

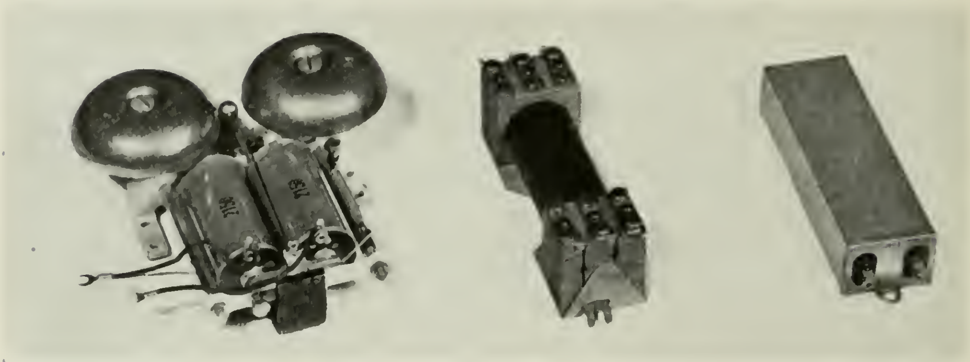
RELAY springs must be properly dimensioned and mounted. Otherwise, when they close they may bounce apart and flutter back and forth for a few thousandths of a second. The consequent "chattering" of the contacts results in excessive contact wear, and may cause false switching operations. Studies of spring shape and mounting have been an important phase of Laboratories' design. As part of this work, high speed motion picture apparatus developed by the Laboratories has been utilized to photograph in "slow motion" the rapidly moving relay parts.

Another objective in development studies has been the improvement of the electrical and mechanical efficiencies of the relay so that a smaller operating current is required and the load on the central office battery is reduced. In recent years, this phase of the work has received added emphasis as the number of circuits controlled by a relay has increased, due to advances that have been made in automatic switching systems. In relays of more recent design, the cores of the windings are somewhat larger, the shape and material of the magnet are altered, and the armature hinge is improved, in order to increase the pulling power. By these means, sufficient power has been added not only to permit the use of more springs but to increase the pressure per spring and also the distance over which the armature and springs move. The greater pressure has served to increase the reliability of operation. The greater swing provides surplus movement which is utilized to take up wear on the contacts and so to increase service life.

Thus the development of the telephone relay goes forward: contact materials and shapes, elimination of chatter, protection from dust and dirt, improved magnetic structures, better windings—all are being studied by the Laboratories in the constant effort to provide more efficient and trouble-free telephone apparatus.

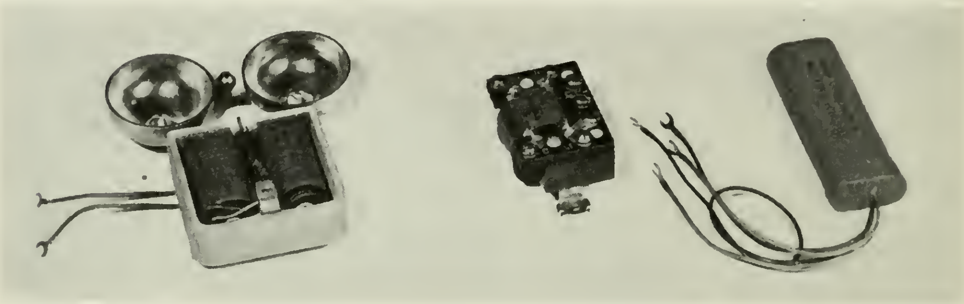
The Telephone Receiver

IN Bell's original telephone, the sound waves of the voice caused a piece of magnetic material to vibrate in the field of an electromagnet, and thus to generate in the coil of the magnet a varying current. At the receiving end of the circuit, this current passed through a similar coil and caused another piece of magnetic material to vibrate, reproducing the original sound waves. In the earliest commercial telephone receivers, the electromagnet was replaced by a permanent magnet, the coil was placed around an iron pole-piece attached to the end of the permanent magnet, and the vibrating piece of magnetic material was a disc of iron.



Apparatus in the Telephone Set

Above are the ringer, induction coil, and condenser used in a telephone of older design. Below are the improved ringer, induction coil, and condenser for the latest type of telephone



This same general arrangement for converting electrical energy into sound energy has continued in use throughout the development of the telephone, and is found today in the many millions of telephone receivers in service in this country and throughout the world. However, although the operating principle has not changed, many improvements in receiver design have been made as the years have gone by. Up to about 1927, these improvements were of such nature as not to alter radically the instrument's general external appearance. The hang-up receiver of the desk stand of that time bore a resemblance to the receiver of earlier days, although it was ten times as efficient. With the advent of the hand set, in which the transmitter and receiver are mounted as a handle-like unit, both the appearance and the internal design were radically changed.

The extent of the change in internal design is indicated by the fact that the receiver unit of the hand set weighs only about three ounces, as compared with ten for the unit of the desk stand.

Until about four years ago, the telephone receiver was so designed that its diaphragm was clamped rigidly around its edge by the receiver cap. This arrangement produced a vibrating element which was most efficient at its natural period of vibration.

The thickness and diameter of the diaphragm were so proportioned as to place the maximum efficiency at about 1,000 cycles per second (two octaves above middle C on the piano). This placed the greatest response of the receiver at a tonal pitch in the middle of the voice range. While emphasis on sounds in this range was helpful in producing loudness, the naturalness of voice reproduction was of course somewhat impaired.

In the meantime, receivers and loud speakers for high-quality speech reproduction, such as those of public address and broadcasting systems, had been developed by the Laboratories to a point where they operated with satisfactory loudness without diaphragm vibration at its natural frequency. The designs were relatively complicated, however, and extensive development work was required to adapt the principles involved to the small receiver unit of a telephone set. The more important features of these high quality systems were incorporated in a Bell System hand set placed in production about 1937.

In the improved receiver, the permanent magnet is made of an alloy of cobalt, molybdenum, and iron, instead of the former cobalt-iron alloy; the pole-pieces are of permalloy instead of silicon steel; and the diaphragm is made of permendur instead of magnetic iron. By proper design of the dimensions of the air spaces in front of the diaphragm and behind it, and of the openings connecting these spaces with the ear and with the housing of the receiver, and by using better magnetic materials, with a consequent increase in efficiency, it has been practicable to obtain a naturalness of speech reproduction far beyond that of previous receivers and with no material decrease in loudness.

Thus, the telephone receiver, relying for its operation on the same basic principle conceived by Alexander Graham Bell, has over the course of the years been greatly improved in efficiency and in quality of sound reproduction, and at the same time has been reduced in size and weight.

These development histories are illustrative of the manner in which Bell Telephone Laboratories perform their function of designing telephone equipment to meet Bell System needs. Drawing upon field experience and ideas, as reported to them by the American Telephone and Telegraph Company and the associated telephone companies, and upon observations and ideas of their own specialized technicians, the Laboratories constantly survey each over-all operating mechanism and each component part, no matter how small, and continuously bring into being new and improved kinds of apparatus for telephony and its related arts of electrical communication.

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THE FIRST TELEPHONE DIRECTORY EVER PUBLISHED

In the early years of the telephone, subscribers were listed by name only, and each operator at the switchboard was by way of being an Information operator

PROVIDING THE INFORMATION SERVICE

Specially Developed Equipment, and Operating Practices Adapted to Local Requirements, Have Brought About a Pleasing Service Supplemental to the Regularly Published Directories

By FRED C. BAURENFEIND

She responds to your call with a pleasant "Information"—to your call and to three million others which are handled daily by over ten thousand employees engaged in furnishing Information service throughout the Bell System. If you live in a small community, perhaps you recognize her voice, for frequently she alone is responsible for handling the calls which reach Information. In the larger cities, she may be one of as many as five hundred operators required every day to give this service. In either case, she takes her responsibilities seriously, and is anxious to serve to the best of her ability those who consult her. She is interested in her job, for in it there is variety—a variety of calls and requests which keep her abreast of the happenings in her community.

There is the housewife who likes to shop by telephone, for instance, and wants the telephone number of the new grocery store on the corner; the young lady, home from school, who wants to telephone for an appointment with a certain hairdresser recommended by her roommate but whose number she has been unable to find in her directory; the young man who is trying to locate the telephone number of that good-looking girl he met at a party the night before. There are calls for the telephone numbers of hotels, airports, and railroad terminals from visitors in town; calls for the telephone numbers of prominent people; the urgent request for an ambulance, or the call from a youngster who is in some difficulty and asks the assistance of Information in obtaining the telephone number of the family doctor. There are requests for telephone numbers from salesmen, professional men, and business executives who find the services of the Information operator invaluable in their day-to-day telephone communications with their customers and associates.

Then, of course, there is always the unusual situation in which the operator's experience and good judgment play an important part—as, for example, the cleaning matron who finds herself locked in the building and wants to know how to get out. Another customer wants to know the telephone number of some one in the dead flower business (he means artificial flowers), another wants advice on some domestic problem. There is also the appeal from the elderly person who is ill and unable to take Buster, her dog, for his usual walk in the park. Can the operator suggest anything? Fortunately, yes, for a search of her records reveals the existence of a "dog walking service," the telephone number of which is suggested to the calling customer—and Buster once again is happy and well taken care of.

While the Information operator obviously cannot supply the answers to all questions which are asked of her, she is usually able to do so better than nine times out of ten and, on the average, in about half a minute. Considering the fact that she frequently has but very meager details with which to search her records, that on about one-fourth of the calls she handles customers are unable to supply a definite name to associate with the telephone number desired, that there are unusual situations which must be coped with, and that there are still a great many people who do not have telephones, it is not difficult to account for that tenth time when she is unable to be of assistance or must admit of a limit to her fund of information.

In the Early Days

In the early days of the telephone, calls were placed by name instead of by number. While telephone directories were published as early as 1878, they were merely lists of subscribers to the service and, except as they perhaps encouraged the use of the telephone and stimulated a demand for the service, they had no directional telephone value. The handling of telephone calls by name was a very personal service, but as the number of telephones in service increased in the larger towns and cities, the abandonment of this practice was inevitable. Telephone growth, however, was not the only reason for changing to number designations. Evidence of another consideration is expressed in the following excerpt from a paper on "The Telephone System of Today" which was presented in Boston on November 24, 1903, at a meeting of The Insurance Society of New York:

"When the telephone central stations were first established, the names and positions on the switchboard of the subscribers were known to operators with strong memories; an epidemic of measles occurred in Lowell, Massachusetts, and Dr. Moses Greeley Parker, a member of the Board of Directors, viewed with alarm, from his standpoint as a physician, the possible condition of affairs if more than two of the four operators should be taken with the measles, and proposed that the subscribers should be numbered.

"His associates demurred, as they were of the opinion that the subscribers would give up their telephones sooner than submit to the indignity of being known by number, but in view of the contingency of the service being paralyzed they finally yielded, and to the surprise of all, the new arrangement was cheerfully accepted by the subscribers, who appreciated the improvement in service which resulted from the change."

With the introduction of number designations, telephone directories of course began to show customers' numbers. When local operators were relieved of the responsibility of remem-

A MODERN INFORMATION BUREAU EQUIPPED WITH FREQUENTLY REPRINTED RECORDS

Pictured here is one of the largest information bureaus of this type in the Bell System. The arrangement of operators' positions, the accessibility of records, and the privacy afforded individual operators conduce to the furnishing of an Information service which is pleasing to customers

bering the names of all their customers, and their locations on the switchboard, they were able to concentrate on the numbers of new customers whose telephones were connected between directory issues, and usually were able to supply these numbers from memory. As the business continued to grow, however, this added responsibility became too much for the local operator, and finally the Information specialist came into being.

From its early beginnings, the provision of Information service has been the subject of the study and development which are characteristic of the Bell System's approach to the task of rendering a pleasing and efficient service to its customers. Staff engineers at the System's headquarters in New York, as well as the men and women in the operating telephone companies who are directly concerned with the conducting of the business day by day, have constantly under review the various phases of this important specialized service—the training of Information operators, the design of equipment, the adequacy of records, and other aspects of the job—so that it shall contribute its share to a telephone service which is not only the best in the world but shall continue to be the best that it is possible to render.

Information Records

There are, as a consequence, several types of Information records in use throughout the System today, each one designed to fit the needs of the particular locality in which it is used. In the smaller exchanges, Information records may consist of a customers' directory and a long-hand list of new telephones connected after that directory went to press. Many refinements have been incorporated in the arrangement of these basic records for use by Information operators in such localities. In the larger cities, however, either frequently reprinted book records or rotary file records are the types more commonly used. The former is a book record of telephone listings which, as its name implies, is reprinted at frequent intervals, while the latter is a record maintained in a specially designed circular file.

Customers' listings in Information records may be arranged in two different ways. The first is an alphabetical arrangement, in which customers are listed in the same manner as in the telephone directory. The second is a street address arrangement, in which the listings appear numerically under the proper street name. If there are two or more listings at the same address, these are shown in their proper alphabetical order.

All Information Bureaus are equipped with alphabetical records, and in many of the larger cities both alphabetical and street address records are provided. Under certain conditions, the provision of street address as well as alphabetical records makes it possible for the operator to conduct a more rapid search for the number requested than she could if only the latter were available. This is particularly true on calls involving common names. In one of the larger cities, for example, there are 15 columns of "Smith" in the telephone directory. On a call for the telephone number of a person by that name at a given address, it is obvious that a search of the alphabetical record is apt to be a lengthy one unless the person calling knows the first name or initials, while the search of the street address record probably would reveal more quickly the number desired. Also, on calls involving an indefinite name, or when the name is unknown but the person calling knows the business and address of the person whose telephone number is wanted, the street address record enables the operator to conduct an effective search for the number which otherwise might not be possible.

In cities using frequently reprinted book records, both the alphabetical and street address records are brought up to date and reprinted at frequent intervals. Between printing intervals, the alphabetical record is supplemented with a printed alphabetical list known as the "daily addendum." This list is placed on the Information switchboard early each morning, and contains all the new and changed listings which have occurred from the time the alphabetical record went to press up to the close of business the previous day. In some cities, where experience has indicated the need for even more up-to-date information,

ROTARY RECORDS ARE USED IN THIS MODERN INFORMATION BUREAU

The staggered positions of the desks, and the floor racks between pairs of girls, make all records readily available to each operator in this moderate-sized Information bureau

"new telephone" files are maintained from current connections, so that if a calling person indicates the telephone number desired is one connected "this morning," the operator is usually able to obtain it for him.

Prior to the introduction of frequently reprinted records, in some cities the alphabetical record used by Information was the regular customer directory, which was supplemented by a bi-weekly alphabetical addendum and a daily alphabetical addendum. The street address record was supplemented in some cases by a bi-weekly address addendum, but was reprinted only as frequently as the customer directory. This arrangement of records adversely affected the time interval involved in locating telephone listings, because operators frequently found it necessary to consult one or more of their addenda records to obtain the information desired. This was particularly true with increasing obsolescence of the customers' directory. In one large city it was found that for every 1,000 calls handled, the operators were obliged to consult over 1,800 records under this plan, while with frequently reprinted records this number was reduced to less than 1,300.

Use of Rotary Files

ROTARY file records, both alphabetical and street address, differ from frequently reprinted records chiefly in that they are contained in rotary files instead of books, and in the method of maintenance. The rotary file consists of a stand on which rotating drums are mounted, and fastened

An Information Position

The operator is using one of the frequently reprinted records provided for her individual use. In the racks are current directories for other frequently called localities, which are also within reach of operators at adjacent and opposite positions

in segments of these drums are frames which carry the listings. The stand may have one or two drums, giving either a one-tier or two-tier rotary. Rotary files are placed on the switchboard in a manner which makes them easily accessible to the operators who use them. When an order is received for the connection of a new telephone, inserts containing the new customer's listing are prepared by the clerical force at the Information center. When advice is received that the telephone has been installed, these inserts are placed in their proper positions among the other listings in each of the rotary files. When a telephone is disconnected, the inserts showing the listing of the customer involved are removed from the files.

Information Equipment

Information operators work in groups or teams, except in some of the smaller localities where one operator, or sometimes one operator who combines Information with some other type of operating, is sufficient

FREQUENTLY REPRINTED RECORDS

Note that the open directory is five columns wide. Directly above it is a ready-reference list of the local numbers most frequently requested. At the left is the key panel used in operating the position

to care for the needs of the community. The size of these teams will vary, depending upon the volume of traffic to be handled and the kind of equipment in use. From the standpoint of team arrangement, there are two types of equipment in use throughout the System at the present time.

The first and original type is arranged to provide for terminating directly on the operator's position the Information trunks from the central offices served by an Information Bureau. Associated with each trunk is a lamp signal which lights whenever that trunk has been selected on a call for Information, and the operator selects the trunk on which she wishes to answer by manually operating an answering key which is provided for each incoming trunk. This kind of equipment is generally used in the smaller Information Bureaus, where the volume of traffic does not require the use of large teams of operators. The trunks can be multipled to as many positions as are needed to handle the traffic during the busiest period of the day.

When the volume of traffic is such that more trunks are required than can be terminated on one position, two or more groups of positions and a corresponding number of teams of operators must be used. This, in effect, divides up a large information bureau into two or more small ones, and is not a desirable arrangement, particularly in the larger cities em-

Rotary Files in Use

The upper tiers of the files here pictured carry the alphabetical list and the lower tiers the street-address list

ploying hundreds of Information operators, for it develops certain inefficiencies in operating and tends to affect adversely the speed of service. The introduction of call distributing, the second type of equipment developed for use in the larger cities, remedied this situation.

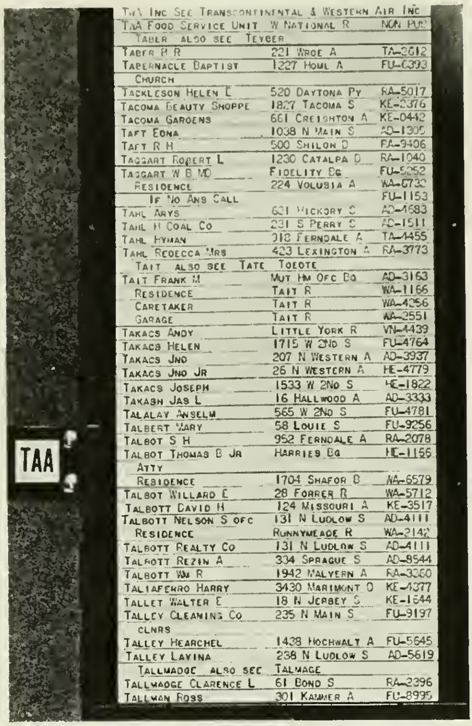
Call distributing equipment is arranged to distribute calls to idle operators.* With this arrangement, incoming trunks are not wired directly to operators' positions. Instead, each trunk is connected to a position-selecting switch which performs the function of associating an incoming call

* "Idle" meaning in this instance simply operators who are not engaged at the moment in actually responding to inquiries and who are therefore free to accept new ones.

with any one of a number of Information positions. Each switch is provided with terminals for use in establishing "paths" to 40 Information positions, if desired, and in response to an incoming call the switch will automatically test these terminals until it finds a path to a position at which an operator is idle, waiting for a call. When the position has been selected in this manner, the operator receives a signal indicating that there is a call on her position to be answered, and is in immediate communication with the calling customer without further action on her part. Position-selecting switches are arranged so that as many as 120 can be used for terminating incoming trunks in a single group, and the calls received over these trunks can be distributed, if necessary, to a team of 40 operators. In addition, the design of call-distributing equipment practically insures that incoming calls will receive attention at the Information Bureau in the order that they are received.

The Information Operator

WHILE improved methods and equipment provide the means, it is the operator who is responsible for giving the service; and if full benefit is to be derived from new developments, it is important that care be taken in the selection and training of Information operators. A student operator selected for Information must be a good speller, of course; she should know the general geography of the community in which she is engaged; and she should be familiar with the different racial names of its inhabitants. Resourcefulness is a character-



TWA Inc See Transcontinental & Western Air Inc		
TWA Food Service Unit	W National R	NON PUB
Tabler also see Teyber		
Taber B R	221 Wroe A	TA-2612
Tabernacle Baptist	1227 Homl A	FU-6393
Church		
Tackleson Helen E	520 Daytona Py	RA-5017
Tacoma Beauty Shoppe	1827 Tacoma S	KE-2376
Tacoma Gardens	661 Creighton A	KE-0442
Taft Edna	1038 N Main S	AD-1305
Taft R H	500 Shiloh D	RA-9406
Taggart Robert L	1230 Catalpa D	RA-1040
Taggart W B MD	Fidelity Bg	FU-5252
Residence	224 Volusia A	WA-6732
If No Ans Call		FU-1153
Tahl Arys	631 Hickory S	AD-4683
Tahl H Coal Co	231 S Perry S	AD-1511
Tahl Hyman	318 Ferndale A	TA-4455
Tahl Rebecca Mrs	423 Lexington A	RA-3773
Tait also see Tate Tobote		
Tait Frank M	Mut Hm Ofc Bg	AD-3163
Residence	Tait R	WA-1166
Caretaker	Tait R	WA-4256
Garage	Tait R	WA-2551
Takacs Andy	Little York R	VN-4439
Takacs Helen	1715 W 2Nd S	FU-4764
Takacs Jno	207 N Western A	AD-3937
Takacs Jno Jr	26 N Western A	HE-4779
Takacs Joseph	1533 W 2Nd S	HE-1822
Takash Jas L	16 Hallwood A	AD-3333
Talalay Anselm	565 W 2Nd S	FU-4781
Talbert Mary	58 Louie S	FU-9256
Talbot S H	952 Ferndale A	RA-2078
Talbot Thomas B Jr	Harries Bg	HE-1156
Atty		
Residence	1704 Shafor B	WA-6579
Talbot Willard E	28 Forrer R	WA-5712
Talbott David H	124 Missouri A	KE-3517
Talbott Nelson S ofc	131 N Ludlow S	AD-4111
Residence	Runnymeade R	WA-2142
Talbott Realty Co	131 N Ludlow S	AD-4111
Talbott Rezin A	334 Sprague S	AD-8544
Talbott Wm R	1942 Malvern A	RA-3360
Taliaferro Harry	3430 Marimont D	KE-4377
Tallet Walter E	18 N Jersey S	KE-1644
Talley Cleaning Co	235 N Main S	FU-9197
clnrs		
Talley Hearchel	1438 Hochwalt A	FU-5645
Talley Lavina	238 N Ludlow S	AD-5619
Tallmadge also see Talmage		
Tallmadge Clarence L	61 Bond S	RA-2396
Tallman Ross	301 Kammer A	FU-8995

A SECTION OF ROTARY FILE

This is a section of one of the files shown of the opposite page, indicating how the individual listings may be inserted or removed to keep the files up to date

istic which is important in the Information operator if she really is to be helpful to those who come to her for assistance.

The Information operator's initial training period may take up to two weeks. During this period she is given what might be termed a "tailor-made" course of instruction—a course designed to prepare her for the specific work performed in the bureau to which she is assigned and to assist her in becoming a productive operator through instruction to fit her individual needs. During this initial training period she will learn how to make effective use of her records, the

Another Recent Development in Information-bureau Equipment

This type of information desk has been developed for use in localities where relatively few records are required. In all other respects its operation is the same as the other modern information equipment pictured on the preceding pages

normal limits of search which have been found to be most productive, how to handle emergency calls, and many other fundamentals of the job. She will learn that customers are not always listed exactly as asked for by the person calling, and that she must acquire the habit of making suitable suggestions which occur to her as she searches in her records for requested information. She will learn that there are several ways in which the more common names can be spelled which she must be aware of if she expects to make intelligent use of her records. Some examples of these are Petersen, Peterson—Smith, Smyth, Smit—Cohen, Cohan, Coen, Cone, Kohn.

The initial training period is only the beginning of the Information operator's education; for in this branch of the service, as in others, training is a continuing activity and experience a big factor in the development of proficiency. With experience, she will become familiar with the more frequently called business firms, and will find she is often able to give out their numbers from memory, thereby expediting her report to the person asking. She will learn to associate trade names which are not listed in the directory with the manufacturers or distributors of these products. She will become more proficient in the handling of her records, and will instinctively know which record to use in beginning a search to locate a listing in the shortest possible time. These are only a few of the things experience will develop in an operator, all of which go a long way towards making the service more complete and efficient.

To make the service more pleasing,

operators have been encouraged to use a natural, courteous tone of voice in their contacts with customers. They are given considerable latitude in the choice of operating phrases to fit particular situations, and the degree of liberality which is permitted in this connection has been effective in promoting an atmosphere of personal service.

Information Trends

THE effect of introducing improved methods and equipment in Information has been reflected in a substantial reduction in the average interval of time required to handle an Information call. In some of the larger cities, this interval has been cut almost in half. There is evidence, however, that this situation has encouraged the use of Information service to a point where some customers are using it as a first source of reference, rather than as the secondary source for which it is intended. In 1940, over half the Information calls handled in the Bell System were for telephones correctly listed in the directory, and as the volume of these calls increases, major problems are created. A great deal of thought is given to making the thirty million directories printed each year as satisfactory to customers as possible,* and it is considered not unreasonable to expect customers to refer to them before calling upon Information for assistance.

The purpose of Information is to provide customers with telephone numbers which do not appear in the current directory, and to assist telephone users who may be having difficulty in locating people they wish to call. In the fulfillment of this purpose, it is the desire of all those charged with the responsibility of the service to do the job thoroughly, efficiently, and in a manner which will merit the approval of those customers who have occasion to seek the assistance of Information.

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* See "Making Telephone Directories Better," BELL TELEPHONE MAGAZINE, February, 1941.

TELEPHONE STATISTICS OF THE WORLD

The High Development of Facilities and the Frequency of Use of the Service in This Country, as Contrasted with the Rest of the World, Are Revealed in This Annual Survey

By KNUD FICK

THE latest issue of "Telephone and Telegraph Statistics of the World" illustrates in detail and in summary form, in its eight pages of charts and tables, the statistical situation in respect of wire communication throughout the world as of January 1, 1940. As in former years, this survey has been undertaken by the Chief Statistician's Division of the American Telephone and Telegraph Company, with the coöperation of the government administrations and the private companies which own and operate the various component parts of the world's vast network of telephone and telegraph facilities. In the compilation of the present edition of this bulletin, however, it proved impossible to obtain authentic statistics covering developments during 1939 for many of the foreign countries now involved in the war. But the latest statistics previously available are included for such countries, so that the tables and charts in the bulletin, which are reprinted here, are substantially accurate and representative of the status of world telephone facilities at the beginning of 1940.

As of that date, there were 42,642,252 telephones in service throughout the world, half of them—20,830,950—in the United States and about a third—15,765,994—in Europe. Connecting with these 42,642,252 telephones were 179,110,000 miles of exchange and long distance wire conductors, again with about one half—95,150,000 miles—in the Unitd States and one third—60,611,000 miles—in Europe. The indicated net gain in telephones during 1939 was 1,551,905, or 3.8 per cent, while the world's telephone wire increased by 4,562,000 conductor miles, a gain of 2.6 per cent. The relative telephone development of the United States can be seen from the following brief comparison:

	Telephones		Telephone Wire		
	Number	Per 100 Pop.	Miles	Per 100 Pop.	Per Telephone
United States	20,830,950	15.85	95,150,000	72.41	4.57
Rest of World	21,811,302	1.07	83,960,000	4.13	3.85
Total World	42,642,252	1.97	179,110,000	8.27	4.20

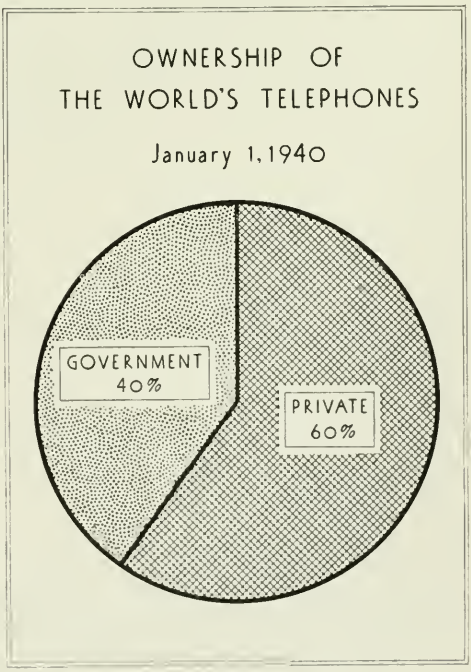
At the beginning of 1914, just before the first World War, a similar statement of this country's relative position would have shown:

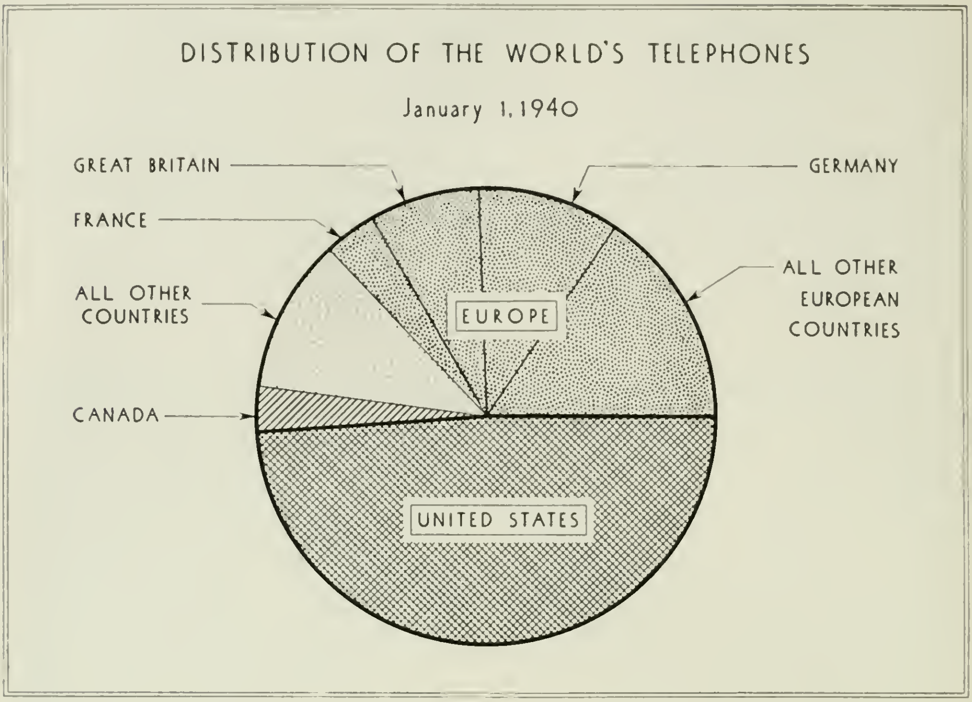
	Telephones		Telephone Wire		
	Number	Per 100 Pop.	Miles	Per 100 Pop.	Per Telephone
United States	9,542,017	9.68	22,137,000	22.46	2.32
Rest of World	5,346,533	0.32	15,201,000	0.92	2.84
Total World	14,888,550	0.85	37,338,000	2.14	2.51

At the present time (i.e., the middle of 1941), it may be estimated that there are at least 45,000,000 telephones in service throughout the world, slightly over half of them being in the United States, indicating that the world's telephones have about trebled since the first World War. The world's telephone wire mileage is now five times greater than it was in 1914. In less than 28 years, the United States alone has added some 13 million telephones and nearly 80 million miles of wire to its telephone network.

At the beginning of 1940, nearly 24 million—or 56 per cent—of the world's telephones were of the dial type, including 10,350,864 dial telephones in this country. More than half of the world's dial telephones were placed in service during the decade from 1930 to 1940, the gain in dial installations having been slightly greater than net telephone gain during this period.

Three-fifths of all the telephones in the world are operated under private enterprise. It is interesting in this connection to compare the telephone development in the largest private (or predominantly private) systems (United States, Canada, Italy and Denmark) with that in the largest wholly government operated systems (Germany, Great Britain, France and Japan). Private initiative has produced an average of 12 telephones per 100 people in the former countries, or three times the telephone development in the largest four telephone systems operating under government auspices. The bulk (nearly 81 per cent) of the world's 17,072,092 government-operated telephones are





in Europe, whereas 99 per cent of all the telephones in the Western Hemisphere are in private hands.

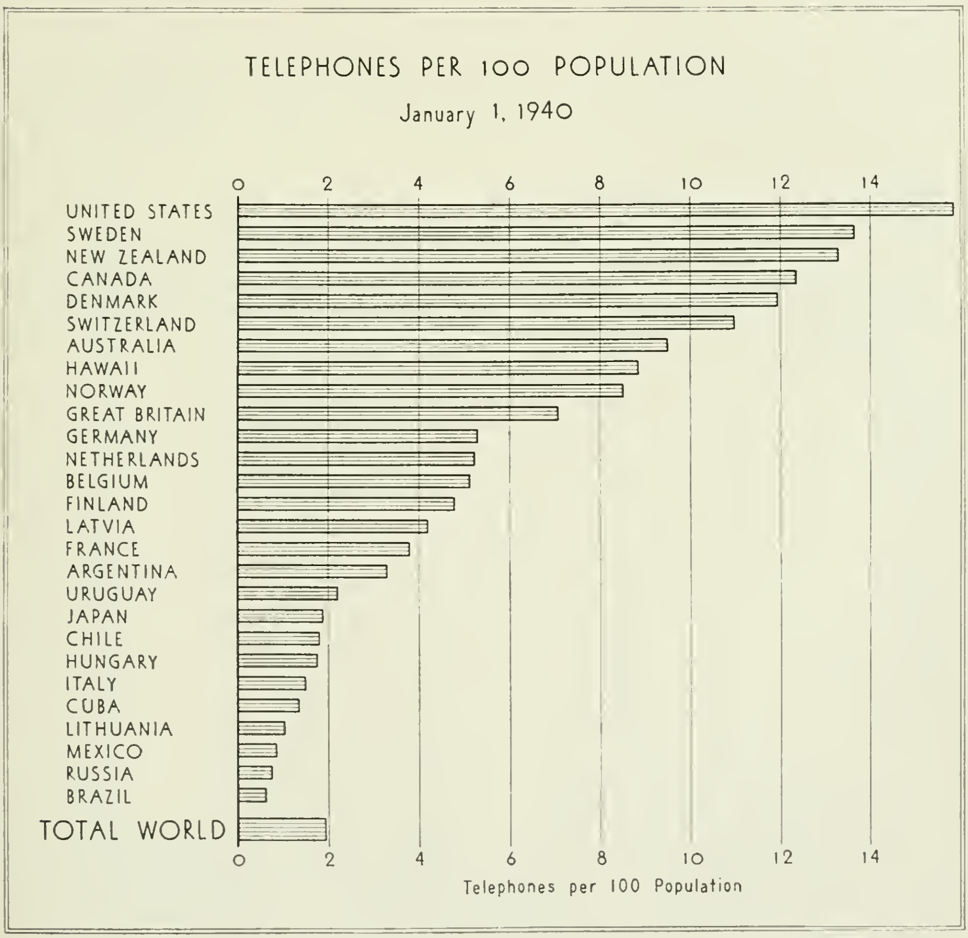
During 1939, more than 30 billion local and long distance telephone calls were completed in the United States and it has been estimated, from records covering the majority of foreign telephone systems, that some 60 billion calls were completed throughout the world at large, or about 28 telephone conversations per capita. For the United States alone, however, the per capita calling rate was 231.5, which means that there were only about 15 calls per capita outside the United States.

It will be seen from the various tables and charts reproduced herewith that the United States—with nearly one half of the world's telephones on January 1, 1940, but with only six per cent of its population—has retained its supremacy as the world's leading country in the field of voice communication.

In point of absolute size, the next largest national telephone system is that of the German Reich (including Austria and Sudetenland). On June 30, 1939, this embraced 4,226,504 telephones interconnected by some 18 million miles of wire, these facilities representing some 10 per cent of the respective world totals. The over-all German telephone development, however, was equivalent to only 5.28 telephones per 100 people, which is a little less than one half the average telephone development of the smaller communities and rural areas in the United States. At the beginning of 1940, there was, in fact, an average of

11.33 telephones for every 100 people in American communities with a population of 50,000 or less. This is a relative telephone development better than that to be found in the vast majority of cities, even the great national capitals, abroad. In most of the larger German cities, for example, there were fewer than 10 telephones for every 100 people, the exception being Berlin, where the 599,911 telephones on March 31, 1939, corresponded to somewhat less than 14 per cent of the population.

The second largest network of telephone facilities abroad is that of Great Britain and Northern Ireland, embracing on March 31, 1940, 3,375,902 telephones and over 16 million miles of telephone wire. This corresponded to 7.06 telephones and 34.10 miles of telephone wire per 100 population. Operated as a branch of the British Post Office (except for three small systems serving the City of Hull and the Islands of Guernsey and Jersey), the British telephone system is the best developed system among the larger European countries. The British system handles some 2,255,000,-

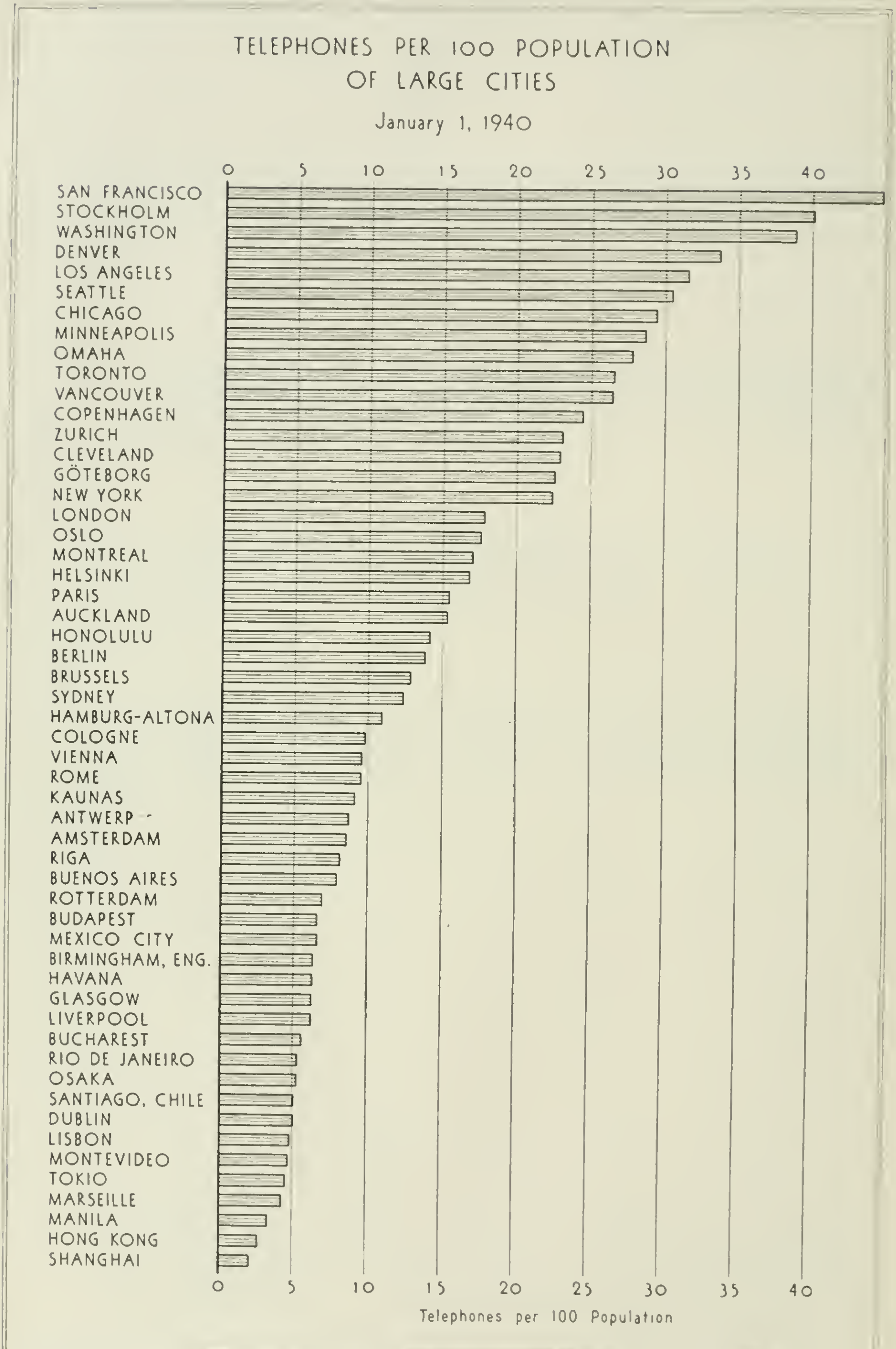


TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES, JANUARY 1, 1940

Countries	Number of Telephones: Government Systems	Private Companies	Total	Per Cent of Total World	Telephones Per 100 Population
NORTH AMERICA:					
United States	—	20,830,950	20,830,950	48.85%	15.85
Canada	212,619	1,184,653	1,397,272	3.28%	12.35
Central America	13,799	18,881	32,680	.08%	0.39
Mexico	1,337	174,263	175,600	.41%	0.88
West Indies—					
Cuba	610	56,462	57,072	.13%	1.33
Puerto Rico	531	16,227	16,758	.04%	0.90
Other Places in the West Indies	9,785	19,502	29,287	.07%	0.36
Other Places in North America	—	19,108	19,108	.04%	4.87
Total	238,681	22,320,046	22,558,727	52.90%	12.16
SOUTH AMERICA:					
Argentina	—	434,017	434,017	1.02%	3.30
Bolivia	—	2,611	2,611	.006%	0.08
Brazil	1,291	271,437	272,728	.64%	0.62
Chile	—	84,151	84,151	.20%	1.80
Colombia	8,900	32,787	41,687	.10%	0.47
Ecuador	4,600	3,050	7,650	.02%	0.27
Paraguay	—	3,658	3,658	.01%	0.38
Peru	—	37,286	32,286	.07%	0.48
Uruguay†	34,810	11,846	46,656	.11%	2.20
Venezuela	740	27,910	28,650	.07%	0.80
Other Places in South America†	3,018	—	3,018	.007%	0.54
Total	53,359	903,753	957,112	2.25%	1.05
EUROPE:					
Belgium	430,000	—	430,000	1.01%	5.12
Bulgaria	31,225	—	31,225	.07%	0.48
Denmark	17,813	441,944	459,757	1.08%	11.95
Eire#	45,513	—	45,513	.11%	1.54
Finland†	7,720	177,736	185,456	.43%	4.79
France†	1,589,595	—	1,589,595	3.73%	3.79
Germany*	4,226,504	—	4,226,504	9.91%	5.28
Great Britain and No. Ireland#	3,375,902	—	3,375,902	7.92%	7.06
Greece	5,967	48,437	54,404	.13%	0.76
Hungary	178,325	790	179,115	.42%	1.76

Italy*	—	650,000	650,000	1.52%	1.49
Latvia##	83,650	—	83,650	.20%	4.20
Lithuania†	26,591	—	26,591	.06%	1.03
Netherlands	460,000	—	460,000	1.08%	5.22
Norway*	153,000	97,000	250,000	.59%	8.52
Portugal	20,366	52,506	72,872	.17%	0.94
Roumania	—	102,268	102,268	.24%	0.51
Russia¶	1,272,500	—	1,272,500	2.98%	0.75
Spain	—	300,000	300,000	.70%	1.18
Sweden	863,102	1,697	864,799	2.03%	13.64
Switzerland	462,013	—	462,013	1.08%	10.99
Yugoslavia	72,000	—	72,000	.17%	0.45
Other Places in Europe	437,253	134,577	571,830	1.34%	1.11
Total	13,759,039	2,006,955	15,765,994	36.97%	2.74
ASIA:					
British India##	31,878	51,500	83,378	.20%	0.02
China	45,000	115,000	160,000	.37%	0.04
Japan##	1,367,958	—	1,367,958	3.21%	1.89
Other Places in Asia	211,129	99,034	310,163	.73%	0.15
Total	1,655,965	265,534	1,921,499	4.51%	0.18
AFRICA:					
Egypt	67,983	—	67,983	.16%	0.30
Union of South Africa#	220,288	—	220,288	.52%	2.13
Other Places in Africa	140,968	1,460	142,428	.33%	0.11
Total	429,239	1,460	430,699	1.01%	0.27
OCEANIA:					
Australia*	661,996	—	661,996	1.55%	9.51
Hawaii	—	37,154	37,154	.09%	8.78
Netherlands Indies	48,321	4,492	52,813	.12%	0.08
New Zealand#	217,869	—	217,869	.51%	13.28
Philippine Islands	2,410	30,386	32,796	.08%	0.20
Other Places in Oceania	5,213	380	5,593	.01%	0.25
Total	935,809	72,412	1,008,221	2.36%	1.03
TOTAL WORLD	17,072,092	25,570,160	42,642,252§	100.00%	1.97

† January 1, 1939. ## March 31, 1939. * June 30, 1939. # March 31, 1940.
¶ U.S.S.R., including Siberia and Associated Republics, January 1, 1939.
§ Approximately 56% of this total are automatic or "dial" telephones, including 10,351,000 "dial" telephones in the United States.


TELEPHONES PER 100 POPULATION
OF LARGE CITIES
January 1, 1940
0 5 10 15 20 25 30 35 40
SAN FRANCISCO
STOCKHOLM
WASHINGTON
DENVER
LOS ANGELES
SEATTLE
CHICAGO
MINNEAPOLIS
OMAHA
TORONTO
VANCOUVER
COPENHAGEN
ZURICH
CLEVELAND
GÖTEBORG
NEW YORK
LONDON
OSLO
MONTREAL
HELSINKI
PARIS
AUCKLAND
HONOLULU
BERLIN
BRUSSELS
SYDNEY
HAMBURG-ALTONA
COLOGNE
VIENNA
ROME
KAUNAS
ANTWERP
AMSTERDAM
RIGA
BUENOS AIRES
ROTTERDAM
BUDAPEST
MEXICO CITY
BIRMINGHAM, ENG.
HAVANA
GLASGOW
LIVERPOOL
BUCHAREST
RIO DE JANEIRO
OSAKA
SANTIAGO, CHILE
DUBLIN
LISBON
MONTEVIDEO
TOKIO
MARSEILLE
MANILA
HONG KONG
SHANGHAI
0 5 10 15 20 25 30 35 40
Telephones per 100 Population

000 telephone messages per year, an average per capita telephone usage (47.4 messages in 1938) which is still considerably below either the Scandinavian or North American calling rates. The telephone development of British cities is similar to that found in Germany and France, averaging around 8 or 9 telephones per 100 people. London, however, had 17.81 telephones for every 100 inhabitants of the city and county of London proper, although Greater London, with nearly nine million people and well over one million telephones, averaged less than 13 telephones per 100 inhabitants.

THE French telephone system, operated by the Government Administration of Posts, Telegraphs and Telephones, had 1,589,595 telephones on January 1, 1939, or less than 4 per 100 population, with a wire mileage of 14.35 per 100 population. Although no less than 28 per cent of all French telephones are to be found in Paris, the telephone development of the French capital was only 15.45 per 100 inhabitants; other French cities are considerably less developed telephonically. The average French citizen uses the telephone only some 23 times during the year, or just about one tenth as much as the use in the United States.

The three countries of Canada, Japan, and Soviet Russia all had approximately the same number of telephones (1,397,272, 1,367,958 and 1,272,500, respectively). But Canada, where all but about 15 per cent of the telephones are owned and operated by private companies, had a development equivalent to 12.35 telephones per 100 population, which was six times better than that of Japan and 16 times better than that of Russia. Both of the latter countries operate their telephone systems as a function of the Government.

IN proportion to their respective populations, the telephonically best developed territories—*outside* the North American continent—are the three Scandinavian countries and Switzerland, in Europe; Australia; Hawaii; and New Zealand. In all of these, the number of telephones in service corresponded to between 8 and 13 per cent of the population. In Denmark and Hawaii, all or nearly all of the telephone facilities are privately operated. In Norway, over one third are under private operation, and Sweden gained her position of telephonic preëminence in Europe during the period when the telephone system was still largely in private hands. Australia's and New Zealand's large cities have telephone developments of from 10 to 20 telephones per 100 inhabitants, and the larger cities in Scandinavia and Switzerland likewise are fairly well provided with telephone facilities. Stockholm, an exceptional instance, had 40.16 telephones for every 100 of its 460,000 inhabitants.

LEAVING Russia out of the computation, Europe covers nearly two million square miles, as compared with three million in the United States, but Europe's population of 400 million is three times that of the United States. Considering the fact, then, that Europe is, on the average, about four

TELEPHONE DEVELOPMENT OF LARGE CITIES, JANUARY 1, 1910

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones Per 100 Population
ARGENTINA:			
Buenos Aires	3,400,000	268,956	7.91
AUSTRALIA:†			
Adelaide	321,000	35,935	11.19
Brisbane	326,000	35,805	10.98
Melbourne	1,036,000	135,518	13.08
Sydney	1,289,000	159,825	12.40
BELGIUM:††			
Antwerp	560,000	48,696	8.70
Brussels	991,000	127,639	12.88
Liege	433,000	29,885	6.90
BRAZIL:			
Rio de Janeiro	1,940,000	103,797	5.35
CANADA:			
Montreal	1,095,000	187,158	17.09
Ottawa	203,200	40,829	20.09
Toronto	807,900	214,782	26.59
Vancouver	292,000	77,362	26.49
CHILE:			
Santiago	860,000	44,487	5.17
CHINA:			
Hong Kong	850,000	22,606	2.66
Shanghai≠	3,750,000	79,554	2.12
CUBA:			
Havana	725,000	45,651	6.30
DENMARK:			
Copenhagen	900,000	220,202	24.47
EIRE:#			
Dublin	488,000	24,893	5.10
FINLAND:†			
Helsinki	305,000	51,328	16.83
FRANCE:†			
Bordeaux	260,000	23,311	8.97
Lille	200,000	18,566	9.28
Milan	1,206,000	109,168	9.05
Naples	920,000	31,373	3.41
Rome	1,280,000	122,442	9.57
Venice	284,000	10,209	3.59
JAPAN:##			
Kobe	989,000	46,265	4.68
Kyoto	1,160,000	51,457	4.44
Nagoya	1,224,000	46,122	3.77
Osaka	3,321,000	176,697	5.32
Tokio	6,458,000	290,510	4.50
LATVIA:##			
Riga	391,000	31,795	8.13
LITHUANIA:†			
Kaunas	110,000	10,124	9.20
MEXICO:			
Mexico City	1,450,000	95,673	6.60
NETHERLANDS:†			
Amsterdam	794,000	67,927	8.56
Haarlem	174,000	14,474	8.32
Rotterdam	635,000	44,145	6.95
The Hague	540,000	57,635	10.67
NEW ZEALAND:			
Auckland	215,000	33,012	15.35
Wellington	160,000	32,083	20.05
NORWAY:*			
Oslo	417,000	73,786	17.69
PHILIPPINE ISLANDS:			
Manila	770,000	25,715	3.34
PORTUGAL:			
Lisbon	710,000	33,902	4.78
ROUMANIA:			
Bucharest	910,000	50,347	5.53

Lyon	650,000	39,369	6.06
Marseille	915,000	38,801	4.24
Paris	2,830,000	437,139	15.45
GERMANY:# #			
Berlin	4,339,000	599,911	13.83
Breslau	623,000	48,203	7.74
Cologne	771,000	75,393	9.78
Dresden	821,000	75,569	9.21
Dortmund	585,000	28,945	4.95
Essen	672,000	36,743	5.47
Frankfort-on-Main	647,000	68,112	10.52
Hamburg-Altona	1,724,000	188,861	10.96
Leipzig	767,000	73,959	9.64
Munich	866,000	97,215	11.23
Vienna	1,874,000	180,165	9.61
GREAT BRITAIN & NO. IRELAND:# #			
Belfast	415,000	23,336	5.62
Birmingham	1,259,000	79,847	6.34
Bristol	450,000	31,376	6.97
Edinburgh	465,000	47,066	10.12
Glasgow	1,150,000	72,359	6.29
Hull#	361,000	25,354	7.02
Leeds	568,000	36,825	6.48
Liverpool	1,265,000	79,228	6.26
London— (City and County of London)	4,028,000	717,468	17.81
Manchester	1,015,000	68,191	6.72
Newcastle	482,000	28,167	5.84
Sheffield	522,000	28,776	5.51
HAWAII:			
Honolulu	179,000	25,408	14.19
HUNGARY:†			
Budapest	1,635,000	107,906	6.60
Szeged	141,000	2,635	1.87
ITALY:†			
Bologna	315,000	14,738	4.68
SWEDEN:			
Göteborg	281,000	63,585	22.63
Malmö	155,000	29,862	19.27
Stockholm	460,000	184,722	40.16
SWITZERLAND:			
Basel	165,000	38,916	23.59
Bern	125,000	31,662	25.33
Geneva	125,000	30,950	24.76
Zurich	320,000	73,914	23.10
URUGUAY:†			
Montevideo	705,000	33,447	4.74
UNITED STATES: (See Note)			
New York	7,442,000	1,669,904	22.44
Chicago	3,390,000	997,174	29.42
Los Angeles	1,444,000	456,564	31.62
Cleveland	1,153,900	264,560	22.93
Total 6 Exchange Areas with over 1,000,000 Population	17,245,900	4,191,428	24.30
Milwaukee	748,700	162,758	21.74
San Francisco	648,800	290,990	44.85
Washington	654,000	254,042	38.84
Minneapolis	541,000	155,362	28.72
Total 13 Exchange Areas with 500,000 to 1,000,000 Population	8,922,900	2,265,558	25.39
Seattle	422,000	128,613	30.48
Denver	321,500	108,244	33.67
Omaha	246,600	68,452	27.76
Hartford	242,700	67,685	27.89
Total 30 Exchange Areas with 200,000 to 500,000 Population	9,503,500	2,210,282	23.26
Total 49 Exchange Areas with over 200,000 Population	35,672,300	8,667,268	24.30

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.

* June 30, 1939.
≠ International Settlement and French Concession.
March 31, 1939.
†† February 28, 1938.
∓ March 31, 1940.
† January 1, 1939.

TELEPHONE CONVERSATIONS AND TELEGRAMS, YEAR 1939

				Per Cent of Total Wire Communications		Wire Communications Per Capita		
Country	Number of Telephone Conversations	Number of Telegrams	Total Number of Wire Communications	Telephone Conversations	Telegrams	Telephone Conversations	Telegrams	Total
Australia	637,000,000	17,998,000	654,998,000	97.3	2.7	91.9	2.6	94.5
Belgium†	320,000,000	5,900,000	325,900,000	98.2	1.8	38.5	0.7	39.2
Canada	2,774,000,000	11,629,000	2,785,629,000	99.6	0.4	246.3	1.0	247.3
Denmark	726,000,000	1,748,000	727,748,000	99.8	0.2	189.5	0.5	190.0
Finland†	309,000,000	811,000	309,811,000	99.7	0.3	80.3	0.2	80.5
France†	972,000,000	27,524,000	999,524,000	97.2	2.8	23.2	0.6	23.8
Germany†	3,640,000,000	21,701,000	3,661,701,000	99.4	0.6	45.8	0.3	46.1
Gt. Britain & No. Ireland†	2,255,000,000	59,484,000	2,314,484,000	97.4	2.6	47.4	1.3	48.7
Hungary†	187,000,000	2,439,000	189,439,000	98.7	1.3	19.5	0.3	19.8
Japan†	5,339,000,000	68,475,000	5,407,475,000	98.7	1.3	74.2	0.9	75.1
Netherlands†	468,000,000	3,588,000	471,588,000	99.2	0.8	53.9	0.4	54.3
Norway†	281,000,000	3,489,000	284,489,000	98.8	1.2	96.1	1.2	97.3
Sweden	1,195,000,000	4,641,000	1,199,641,000	99.6	0.4	189.0	0.7	189.7
Switzerland	335,000,000	2,039,000	337,039,000	99.4	0.6	79.8	0.5	80.3
Union of South Africa	317,000,000	6,863,000	323,863,000	97.9	2.1	30.9	0.7	31.6
United States	30,300,000,000	195,000,000	30,495,000,000	99.4	0.6	231.5	1.5	233.0

NOTE: Telephone conversations represent completed local and toll or long distance messages. Telegrams include inland and outgoing international messages.

† Year 1938.

and a half times as densely populated as the United States, one would expect a more uniform development of telephone service in European communities outside the largest cities than would be the case in similar American areas, where the much sparser average settlement would seemingly make the provision of adequate telephone facilities a more difficult problem. According to the latest available information, however, the greatest discrepancy in the telephone development of Europe as compared with that in the United States occurs in non-metropolitan areas; viz.:

	Telephones per 100 Population		
	Europe	United States	Ratio of U. S. to Europe
Cities with a population of over 1,000,000	10.1	24.3	2.4 to 1
500,000–1,000,000	8.9	25.4	2.9 to 1
200,000– 500,000	6.8	23.3	3.4 to 1
Total metropolitan areas	8.9	24.3	2.7 to 1
Rural areas and communities with less than 200,000 population	2.4	12.7	5.3 to 1
Total	3.6	15.9	4.4 to 1

In relation to population, the large cities of the United States have generally from two to four times as many telephone facilities as European cities, while our smaller cities and rural areas have over five times the telephone facilities of similar communities in Europe.

FOR THE RECORD

DIRECT RADIO TELEPHONE CIRCUITS TO PORTUGAL AND PANAMA ESTABLISHED

A DIRECT radio telephone circuit between New York and Lisbon, Portugal, was opened on June 25. Previous to the opening of this circuit, calls from the United States to Portugal had passed over the New York-Madrid radio telephone circuit, completing their journey to Portugal over long distance wire lines. The service linking Bell and Bell-connecting telephones in this country with those in Portugal is operated between the American Telephone and Telegraph Company's short wave stations in New Jersey and the Portuguese Marconi Company's radio telephone stations near Lisbon.

A direct radio telephone service between New York and Panama City was opened on July 11. This system provides one circuit initially, with facilities for a second as soon as it is needed. Calls between the United States and Panama and the Canal Zone have more than doubled during the past year. Since 1933, telephone service with Panama has been operated between the A. T. & T. Company's short-wave radio telephone stations near Miami and the radio telephone stations of the Tropical Radio Telegraph Company in Panama Viejo. The new radio circuit operates between the Tropical stations and stations of the A. T. & T. Company in New Jersey.

PROGRESS IS RAPID ON TRANSCONTINENTAL TELEPHONE CABLE

WORK goes forward rapidly on the Bell System's new $20,000,000 transcontinental telephone cable between Omaha, Neb., and Sacramento, Cal., which is to link the eastern and Pacific Coast cable networks, and by the end of July about 500 miles of the twin underground cables had been plowed in by three tractor trains at work along different sections of the route. (See "Trends in Toll Cable Usage," MAGAZINE, May, 1941). About 30 of the approximately 100 repeater-station buildings along the line have already been completed, and the installation of repeaters and of circuit balancing apparatus is under way in more than a score of them.

The two cables are laid side by side in a furrow plowed usually about 30 inches deep. The cables feed off their reels and into the ground through an aperture in the plow share, and the entire operation is completed at one time as the train is drawn along by powerful tractors. While the speed of one of these trains naturally depends on the character of the ground, under particularly favorable conditions one train covered seventeen miles in one week.

The circuits in one of the twin cables will carry words bound eastward, while those in the other will carry the westbound halves of conversations. For the most part, the cables are manufactured and laid in lengths of about 3,000 feet, and gangs are now engaged in splicing the lengths together and conducting tests. Gas pressure is maintained in the cables during the laying operation, and the pressure is tested after each length is in place, to determine that no opening in the lead sheath has occurred during the plowing in. For protection, the route follows a carefully selected right-of-way which avoids highways.

The new cable will supplement several transcontinental lines which consist in part of open wire. According to present plans, from 50 to 70 circuits will be put into service in the completed section between Laramie, Wyo., and Omaha before the end of this year. When the rest of the cable is finished, next year, there will be about 100 circuits to link the eastern and western cable networks at Omaha and Sacramento respectively, and an additional 20 or more to take care of traffic between Denver and the east. This will be an increase of about 50 per cent over the number of circuits provided by existing transcontinental lines. It is expected that ultimately this one cable alone will furnish some 600 telephone circuits, or about triple the present number of transcontinental circuits. Channels will also be provided for radio network transmission and for telegraph and teletypewriter purposes.

CONTRIBUTORS TO THIS ISSUE

A 1937 graduate of Wesleyan University, Alvin von Auw stayed on at the University to take his M.A. in 1938. Until April of 1939 he served as managing editor of *Listeners Digest*, a national magazine featuring condensed versions of notable radio broadcasts. When *Scribner's Commentator* took over the *Listeners Digest* formula, Mr. von Auw became radio editor of the combined publication. He joined Western Electric's Public Relations Department in July of 1939, and has since 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 written a series of articles for Western Electric's employee papers, designed to keep the Company's employees informed on the extent of the Western's contribution to the Bell System's and the nation's defense efforts.

Entering Harvard in 1916, Eustace Florance left college in 1917 to serve as a First Lieutenant and Captain of Infantry in several southern cantonments until the middle of 1919. In 1921 he joined the Chesapeake and Potomac Telephone Companies in Washington, where he was engaged in commercial engineering work. In 1926 he was appointed Division Commercial Supervisor of the Washington Division, and in 1929 General Commercial Manager of the Chesapeake and Potomac Telephone Company of Baltimore City, serving the State of Maryland. In May of 1936 he returned to Washington, headquarters of the companies, as General Information Manager.

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 several articles to the *Bell System Technical Journal, Bell Laboratories Record,* and Bell Telephone Quarterly, all dealing with various aspects of radio telephony.

After graduating from the Massachusetts Institute of Technology with the degrees of B.S. in E.E. in 1909, M.S. in 1910, and Sc.D. in 1911, Reginald L. Jones became a member of the research staff of the Western Electric Company, engaged in study of the fundamental characteristics of telephone transmitters and receivers and of mechanical telephone repeaters. In 1914 he was placed in charge of the Transmission Research Department, organizing and directing early studies of the nature of speech and hearing; development studies of improved transmitters, receivers, and loud speakers; and transmission engineering of telephone systems. In 1917–18 he was a Captain in the Signal Corps Reserves, assigned to research work for the Army and Navy relating to acoustic instruments and submarine signaling. In 1923 he was placed in charge of the Inspection Engineering Department, newly organized to establish a scientific basis for inspection operations in factory and field. When the Bell Telephone Laboratories was organized, in 1925, Dr. Jones continued in this work in the new organization. In 1927 the Outside Plant Development Department was added to his responsibilities. He organized the first laboratories devoted exclusively to the development and specification of materials and constructions used in the outside plant of the Bell System. In 1928 he became Director of Apparatus Development. This department is responsible for investigation and design of most of the apparatus and materials used by the Bell System. He is a representative of the telephone group on the Standards Council of the American Standards Association, and is the Bell System representative on the Aviation Communications Sub-committee of the Defense Communications Board. He is a member of the Bell System Committee on Critical Materials, and is chairman of the Benefit Committee of the Bell Telephone Laboratories.

Upon graduation from Brown University with the B.S. degree in 1922, Fred C. Baurenfeind joined the New York Telephone Company, and in the next several years filled a number of assignments in the traffic field organization in New York City. In 1930 he was appointed District Traffic Superintendent of the Washington Heights district; in 1932, after a brief period during which he was in charge of traffic instruction work for men in dial panel operation, he became District Traffic Superintendent for Information bureaus in Manhattan, with a personnel of about 1,000; and in 1938 he was made Traffic Superintendent of the Circle dial-toll district. Last November he was transferred to the Department of Operation and Engineering of the A. T. and T. Company, where, in the Traffic Division, he is engaged on local and auxiliary service matters—which include, among others, the Information service.

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. His present discussion of what statistical analysis reveals about the world telephone situation is his seventh annual contribution to the Magazine and its predecessor on this topic.

BELL TELEPHONE MAGAZINE

VOL. XX | NOVEMBER, 1941 | NO. 4

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.*"

VOL. XX NOVEMBER, 1941 NO. 4

Published for the Bell System by the Information Department of
American Telephone and Telegraph Company
195 Broadway, New York, N. Y.

MODERN PIONEERING

This is one of the huge tractor trains which is plowing the twin transcontinental telephone cables into the ground along the route from Omaha, Neb., to Sacramento, Cal., to link the eastern and Pacific toll cable networks. See "Engineering the Transcontinental Telephone Cable," in this issue.

TELEPHONES AND DEFENSE

AS this country gears up more and more to the achievement of a condition of impregnable defense, a fast, dependable, nation-wide telephone service is of incalculable importance: in the creation of Army camps and Navy bases and the training of great numbers of men; in the building of huge factories and the operation of plants both new and long established; in the transportation and distribution of raw materials and finished products; in the administration of the vast new and special activities of the Federal Government—in all the innumerable consequences of the hurried transformation of a whole people from a state of peace to one "short of war." To keep pace with the present unexampled demand for telephone service is the grave responsibility of Bell and independent telephone companies, whose interconnected lines, and manufacturing facilities as well, are being called on as never before in the maintenance of the time-schedule of defense.

How the Bell System is meeting its responsibility is best told by the line gangs who are placing wire and cable at top speed, by the installers who are putting in telephones and switchboards in unprecedented numbers, by the operators who are handling more calls than ever before, by the heightened tempo at the Bell Laboratories, by the day-and-night shifts at Western Electric's great factories.

Parts of that story have also been told in this MAGAZINE. In the issue of February, 1941, "The Bell System and National Defense" gave a summary of how the System had risen to the situation by the first of this year. "Engines for Defense," in the May issue, told of one aspect of the preparations for an emergency. "Western Electric: Telephone Arsenal," last August, reported how the System's manufacturing and supply organization is keeping pace with the demand for communication equipment to meet requirements of both civilian needs and our armed forces. Two briefer statements by President Walter S. Gifford of the American Telephone and Telegraph Company (in the issues of October, 1940, and May, 1941) were recapitulations. In the following pages of this issue appear three articles which bring sharply into the foreground the extent to which the Bell System is contributing to the defense program. "An Operating Telephone Company's Part in National Defense," which begins below, has been written especially to supplement the articles just named. "Providing Substitutes for 'Critical' Telephone Materials," and "The Present Situation and the Present Outlook," which follow, are statements recently prepared for the information of employees and already given some circulation in the Bell System; they are included here as contributing materially to the perspective of the whole picture.

AN OPERATING TELEPHONE COMPANY'S PART IN NATIONAL DEFENSE

Furnishing Service Quickly to New Army and Navy Establishments, Defense Plants, Boom Towns, and Expanding Industry Creates Problems Which Can Be Met Only by Extraordinary Exertions

By HERVEY ROBERTS

Of the 24 operating companies of the Bell System, the Southwestern Bell Telephone Company is, whether in point of area served, telephones owned, or number of employees, neither the largest nor the smallest. In the territories of the other Bell companies there may be more camps, more men in training, more defense plants, more mushroom towns—or there may be fewer. All of these companies are meeting the demands for communication which national defense is creating in their areas. This article, which narrates the intense activity of the Southwestern Bell arising out of the country's defense program, may be regarded as representative of the way in which all the System companies are responding to the present emergency.

When more than a billion dollars is suddenly poured into one section of the country for Army camps, navy bases, air fields, shipbuilding yards, chemical and steel plants, airplane factories, and all the miscellany of a national defense emergency; when thousands of workmen and their families swarm to cities where defense building is going on; when towns double their population in a few weeks, and tar-paper shacks and old chicken sheds are snatched for houses; when ordinary business zooms from the additional pay checks and the clamor for supplies; and when, on top of all that, two of the country's four Armies start practicing for the largest peacetime maneuvers in the history of the United States . . . well, normal ways of living and doing business are likely to go by the board. And just incidentally, it's likely to present some problems to the telephone company furnishing service in that area.

That is exactly what has been going on in the territory of the Southwestern Bell Telephone Company during the

ROOM FOR EXPANSION

Behind the protection of the temporary walls, service is rendered as usual in the central office at Victoria, Tex., as work starts on a two-story addition made necessary by the creation of an Army air field near by

last year or more. Of course, much the same thing is taking place in other parts of the country; there are larger defense factories in the East, and bigger Army maneuvers in the South. But Southwestern Bell territory—Missouri, Arkansas, Kansas, Oklahoma, Texas, and a bit of Illinois—furnishes a good cross section of the defense effort because to some extent it is getting in on practically everything.

Southwestern newspaper headlines for months have been reporting daily additions to defense activity: a $30,000,000 TNT plant at Weldon Springs, Mo.; a $5,000,000 shipyard at Houston built in 100 days; the largest air base in the world, built at Corpus Christi for the Navy; more than a score of Army camps, new and enlarged; airplane factories and air fields; chemical plants and munition dumps . . . the list runs on and on.

And each in its way has offered a challenge to the telephone forces.

JUST as a sample, at Freeport, Tex., a $10,000,000 addition was made to a magnesium plant. Result: the number of workers at the plant jumped from 550 to 2000—a fair-sized increase for one factory in a town of 2600. And that's not all. When building began, nearly 5000 construction workers poured into Freeport—nearly twice the town's normal population. So strained were living accom-

Lines in a Hurry

Telephone service is one of the first requirements of the contractor building a defense project—in this case Camp Robinson, Ark. Permanent facilities come later, when requirements for the camp itself are definitely known

modations that some of these men had to stay in Houston, and drive 125 miles a day to and from work.

Even more spectacular, a small-arms munition plant employing 8000 workers is now in operation at Lake City, Mo., which early last spring had a population of 30! And these are just two examples.

This tremendous expansion, plus the acute need for speed, has faced the telephone industry with some major problems—just as it has, of course, many other industries. For when factories costing millions start rising in the middle of flats previously inhabited by sea gulls, and Army camps spring up among the scrub oaks and armadillos, the job of rushing in telephone facilities is by no means simple. It can be done, and it is being done. But it has taken some fast action.

Action through System

Still, the problems are somewhat similar to those raised by storms and floods, and it has been possible to solve them with methods used to meet such "normal" emergencies. The Southwestern Company bases its system upon a series of special committees similar to those formed for emergency storm restoration. At the top is a General Defense Committee for the company as a whole, composed of the General Sales Manager as chairman, the General Commercial Engineer, the General Plant Supervisor, the General Plant Extension Engineer, and the General Traffic Engineer. As chairman, the General Sales Manager also acts as chief liaison man in the company's dealings with Government officials on defense projects.

While these are the regular appointed members, actually the committee is a flexible and informal group, and anyone in the general departments may be called upon to sit in on specific jobs. The idea is to get the work done as smoothly and as quickly as possible. Similar committees are organized in each of the company's four areas, which correspond in general to state lines except that Arkansas and most of Missouri are combined in one area.

The committees cover a wide range of activities. One of their most important tasks is to keep informed of the new defense projects that enter the picture, including where each new project is to be and when it is to start. Unless such information is received in plenty of time, the company may find it difficult to be ready when the inevitable rush begins. The Army, which is supervising much of the defense industry expansion, has been very cooperative in providing this information as soon as it is available.

The committees also watch such things as force adjustment, to make sure that enough plant men, engineers, and operators will be available for the new jobs. They work closely with the Army and Navy, and, in the case of the general committee, with the American Telephone and Telegraph Company and with neighboring Associated Companies. With the wholehearted coöperation of the Western Electric Company, they have proved themselves adept at seeing that, no matter how urgent a new order may be, needed supplies can be provided for the job without delay.

A SERVICE ORDER

Not all the telephone work for defense is done in the field. This is the order written for telephone service for the new plant of the Beech Aircraft Company at Wichita, Kan.

LET us assume that word is received that a new airplane plant is going up in the country outside of Tulsa, Okla. There will also be a housing project, financed by the government, to take care of the workers. Perhaps there are only a few rural lines in the neighborhood.

The Oklahoma people go to work immediately, both at Tulsa and at state headquarters at Oklahoma City, even before official notification is received that the plant and houses will be built. On the basis of all the information they can gather, they decide approximately what telephone facilities will be needed for the construction contractors, for the plant itself, and for the people who will live in the new houses. Past experience has proved a trustworthy guide, and it is highly probable that the advance estimate will come out very close to what will be actually needed.

The advance figure on the amount of material and labor that seems necessary is telephoned to St. Louis, where approval is obtained—over night, if necessary—for ordering the material. The order is placed, and Western Electric gets under way at once. By the time the new plant is ready for the work, the material is usually ready for delivery. The formal estimate, upon which normally every move must depend, may not be submitted for approval until the work is well started.

What amount to double jobs are almost standard now for defense expansion. First comes a small manual PBX for the contractor, and other activities involved in construction, plus, perhaps, teletypewriter service. Then, as the building nears completion, a dial PBX is installed to serve the communication needs of the plant itself.

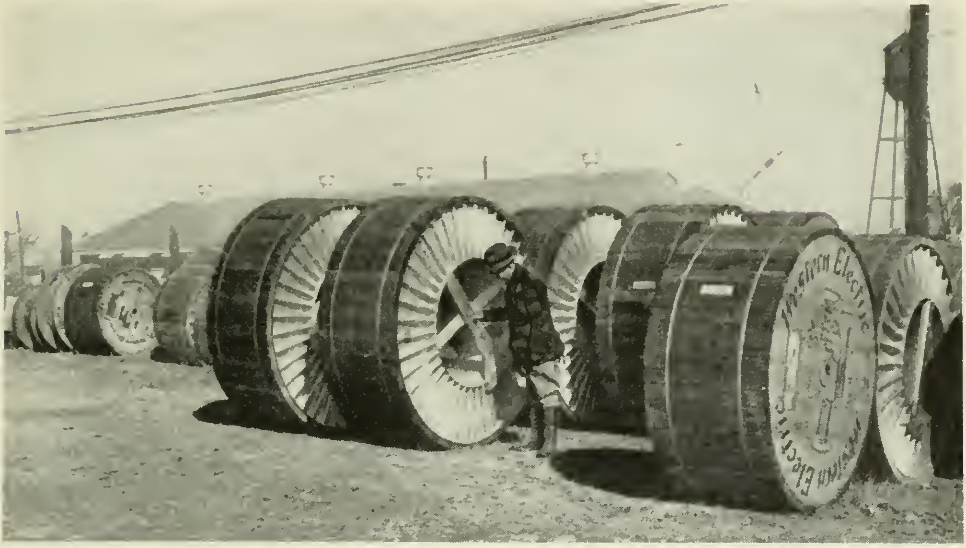
Naturally, this putting in and taking out of PBX's has kept the Plant Department fairly busy. But on top of that, nearly every defense job has also meant a big outside construction program. Most of the defense plants, as well as the Army establishments, are located outside city limits, and many of them have housing projects associated with them. The combination requires new facilities in territory perhaps five or ten miles from the central office. In many instances it is necessary to string open wire circuits for the contractor's immediate needs, following along with a permanent cable later.

But other things happen to the telephone company, too. Victoria, Tex., where an advanced air training field is being built for the Army Air Corps, is a good example. Weeks before work started on the field, the number of local calls at Victoria began shooting up, while the volume of long distance calls went out of sight. Naturally, there would be even greater traffic when the field was completed, to say nothing of the volume contributed by the new families that were certain to be drawn into town.

When Victoria was converted to a common battery system, only five years ago, it had eight toll and six local positions. On April 1 of this year there were eleven toll and eight local, and the activity at the field had just started. Careful estimates indicated that by May 24 a four-position toll table would have to be added; by October another local and two more toll positions; and by July of next year two more local and two more toll, or a total of 30 positions as compared to the original 14.

One trouble was that 19 positions jammed the operating room. The last one literally touched the rear wall of the building. Not another jack could be squeezed in—much less eleven more positions. So the end of the building was knocked out, and 28 more feet added to both stories. This allowed room for all the estimated new positions, with space for more if they are needed. Incidentally, the operating force at Victoria has increased from 33 a year ago to 54 at present.

At Grand Prairie, Tex., the changes were relatively even greater. Three years ago Grand Prairie was cut in as an agency office, with a two-position switchboard. Things went along quietly for two years. Then last summer North American Aviation started building a huge new airplane plant which will employ 10,000 persons by



CABLES FOR DEFENSE

A Southwestern Bell cable splicing foreman inspects the reels in the storage yard at Camp Robinson

the end of this year. A housing project brought additional activity, while a Naval Reserve airfield, next door to the factory, took on new life as a primary training field for the Navy. Local calls and telephone installations rose in a flood. Long distance calls jumped from 50 a day to 800, with far more in prospect. The operator hurriedly moved her residence to another house; part of the telephone equipment was moved to her former bedroom, a wall was torn out so that the kitchen could be added to the operating room, and five new switchboard positions were put in—just as a starter. Now chief operator, she has twelve girls working for her, and more must soon be added.

Such force increases have brought problems for the Traffic Department in their train. You don't expect to find enough trained operators in a small town to permit doubling and quadrupling the force in a few weeks. Part of the need can be filled by transfers, but in addition it has been necessary to train new girls at some of the smaller places.

THESE localized shortages of operators, however, have proved one thing again: that the Bell spirit sticks even after telephone people leave the service. Just as former operators frequently volunteer to help in time of storm or flood, quite a few are now coming to the "tight" offices and saying, "I know you're short-handed, and I'll be glad to help until you can pull out of the hole." In many cases these girls are wives of the men who have come in to build or work at the new defense plants. The girls may have worked for Michigan Bell or Pacific Tel. . . . but as far as they're concerned the Southwestern is part of the family, and they want to lend a hand.

Service for the Camps

But defense industries are just one aspect of the telephone's new job. There are also Army camps and airfields to serve, to say nothing of the world-record Naval Air Base at Corpus Christi, which 18 months ago was a stretch of sand dunes and mesquite. The new additions vary considerably in size, from 1000-man reception centers to full-fledged camps for 35,000 to 40,000 troops such as Fort Leonard Wood in Missouri. But the story of one is pretty much the story of all, so let's take Camp Wolters, a medium-sized infantry replacement center at Mineral Wells, Tex., as typical.

Last fall Camp Wolters was nothing but 8000 acres of pasture and scrub. But when the contractor got under way last November, the camp popped into being like a field of mushrooms. Using the system that is standardized on these camp projects, bulldozers first scraped off the scrub, and then pushed the hills casually into the valleys. To give you an idea of the way these bulldozers work, at one period it was planned to set some 30-foot poles across a low spot. The contractor suggested waiting until the next morning, as during the night the bulldozers were going to push a hill into that hollow, and the dirt would cover the tops of the poles. That's a long way from a man with a shovel!

As soon as the camp site was leveled, a railroad spur was rushed in, a hard-surfaced main road and a system of streets was started, and the buildings themselves began springing up. By March the camp was partly garrisoned and troops were in training.

When work first started, the usual request was made to furnish telephone service for the contractor: two 80-line PBX's and a number of circuits to Mineral Wells. The material was ordered November 12, the first switchboard was working November 18, and the second was in by the 22nd.

The switchboard for the camp itself was ordered January 7, and was in service February 12—three weeks before schedule. Ahead of schedule or not, the board was put to work immediately.

Meanwhile, telephone construction gangs were brought in from as far away as Houston, until finally 32 crews were on the job. These included two oversized cable gangs, one of which had 13 men. Thanks to the number of men, and the coöperation they received all the way up the line, these gangs did a little record-breaking of their own. Some toll circuits to Abilene, which normally would have taken 100 to 120 days to put in, were up and working in 20 days. On the local end, a 50-pair cable was run in from Mineral Wells for the contractor, and later, when the Army's requirements were definitely known, a 200-pair cable went in for the camp's permanent facilities. It was in use two days before the date set by the Army.

While all this sounds smooth enough, there were a few minor interruptions, some more amusing than serious. The contractors were jumping so fast that in a couple of cases they literally moved their shacks out from under their telephones, leaving the instruments lying on the ground. And the ubiquitous mud, chief enemy of camp construction all over the country, insisted upon bogging down telephone trucks as well as everyone else's.

Bad as the mud was, though, the crews at Minerals Wells had an easy time compared with gangs putting in some toll circuits to Camp Wallace, a coast artillery replacement center near Galveston.

Four miles of this toll lead runs through a typical Gulf Coast swamp—a swamp that's bad enough normally, but that had become soupy muck through weeks of steady rain. It was too thin for trucks, and too thick for boats. So three teams of mules were hired, three wagons were stripped down to wheels, axles, and poles, and the necessary crossarms and hardware were hauled in. So bad was the mud that 12 crossarms were a full load for a team, and even then the mules would play out. They would lie down to rest, and the men would have to hold their coats under the mules' noses to keep them from drowning! To get in the wire, the reels were set up on the highway, and one strand would be hitched to a mule. Then the mule would drag that one wire through the bog, the reel unwinding as he pulled.

Just to complicate matters, at one point the gangs ran into a few mosquitoes . . . a few thousand, that is. The men were already wearing boots,

"GENERAL MUD" TAKES A HAND

Caterpillar traction, and caterpillar mount for the cable reel, helped to get cable in on schedule at Fort Leonard Wood, Mo.

slickers, and gloves, but to protect their faces they made hoods of slicker cloth, cutting holes to see and breathe. It was probably the weirdest-looking construction gang on record, but it was better than being eaten alive.

Mud didn't cause all the chuckles, though. One day at expanding Fort Riley, Kan., a building contractor rushed in and said he had cut a telephone cable. There was no sign of trouble, and he was so assured, but he insisted he knew a telephone cable when he saw it. Investigation showed it was a telephone cable all right—a piece of underground that had been abandoned back in World War days!

The prize story also goes to Fort Riley. Shortly after the selectees had started coming into the fort, a long distance call came through for a private named approximately John Smith, outfit unknown. As there were then about 5000 regular and selectee troops on the reservation, the operator asked for further identification. She got it thus: "He's blond, has curly hair, and one gold tooth."

It hardly seems fair to neglect the story of the air bases, both Army and Navy, in Southwestern Bell territory, because this region is one of the major air training centers of the country. Besides the Corpus Christi base, it contains the Randolph-Kelly-Brooks Field group, the "West Point of the Air," at San Antonio, and more than a score of other military air training fields, exclusive of the regular Army air posts. But the telephone jobs at these fields have been similar to those already described, and further comment would be mere repetition.

Building lines and installing telephone equipment isn't the only way in which Southwestern Bell has helped the Army, however. Unorthodox arrangements have been worked out to enable them to meet unusual conditions. For instance, a number of small PBX boards have been rearranged for use as portable switchboards in the field, some of them mounted in Army trucks. Some of these boards, used for specific situations during maneuvers, are designed to juggle magneto and common battery circuits in a manner that would never be needed under ordinary circumstances. In one case, Plant men assigned to help the Army during maneuvers designed a system whereby teletypewriters could be made to operate over field wire laid on the ground, with its insulation wet from constant rain.

Less obvious, but no less important, was some specialized training for the Army. Faced with all their new and enlarged camps needing communications service, and with a sudden addition of hundreds of new men to the Signal Corps, the Army last year forehandedly started expanding the group of instructors who are now teaching the new Signal Corps men their jobs. The communications companies were asked to help in certain phases, and all last fall the Southwestern Bell conducted classes in teletype operation, PBX maintenance, station installation, and central office work. In a number of camps, experienced operators have been assigned to teach soldiers how to operate switchboards.

Service during Maneuvers

The maneuvers mentioned earlier are an entirely different phase of the

Right at Home

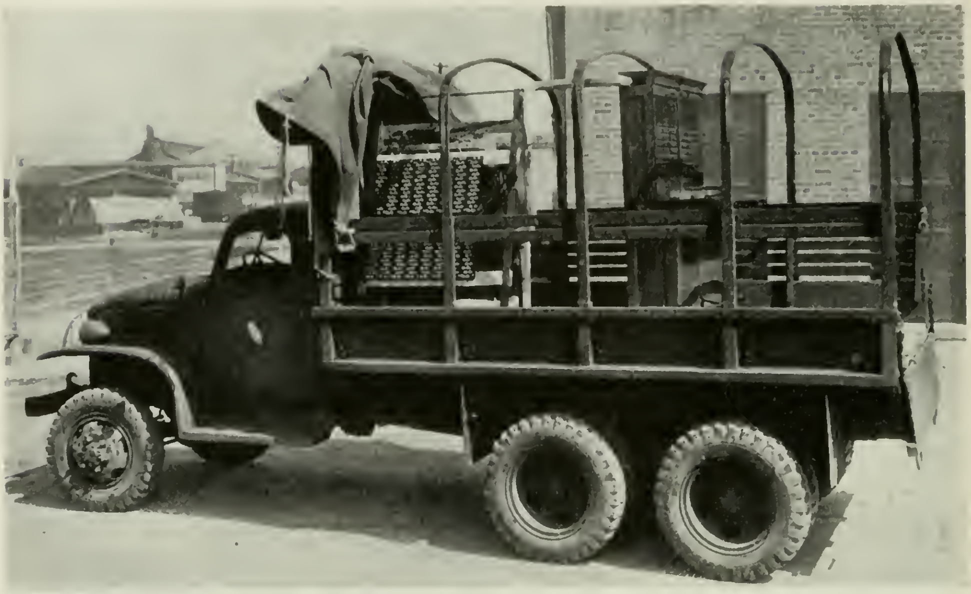
The Post Signal Officer, going over plans for the switchboard at Camp Funston with Western Electric installers, was a facilities engineer with the Southwestern Bell Company until he donned khaki

telephone company's defense job. They involve many of the regular defense activity problems, such as rush orders for major construction, but they also add a few of their own.

In the last year there have been three maneuvers in Southwestern territory: one in East Texas last fall, a Second Army action in Arkansas this August, and Third Army maneuvers that started in West Texas the first part of August, and then moved to Southeast Texas and Louisiana the latter part of the month. These last two were preliminaries to joint maneuvers, largely in Southern Bell territory, during which the Second Army defended against the invading Third.

Both for tactical reasons and to avoid disrupting civilian life as much as possible, the Armies chose the most sparsely-settled sections of the areas for their practice. For these objectives the country chosen was excellent: enough stretches of mesquite in Texas, and cypress swamps and pine hills in Arkansas, so that only a few towns need be involved. But from a communications standpoint it wasn't so good. Most telephone lines stay away from hill and swamp areas.

The Army, of course, handled the actual operation of its communications, using its own switchboards, soldier operators, and Signal Corps men. It also strung hundreds of miles of field wire between different units. But the backbone of its communications network was the regular com-



PORTABLE CENTRAL OFFICE
Southwestern Bell men helped the Signal Corps to mount this magneto switchboard in an Army truck

mercial lines; for, rather than run lines between units which might be many miles apart and frequently on the move, the Army leased toll circuits between the two nearest towns, and ran its own lines from the unit headquarters to Southwestern Bell lines.

Naturally, the Army requirements had to be superimposed upon those for regular civilian usage, with as little disturbance of the latter as possible. Moreover, non-Army telephone usage was certain to increase, rather than decrease, during the maneuver period. General business was certain to boom (El Dorado, Ark., had one million-and-a-half-dollar payday that practically cleaned out the stores), and long distance was sure to jump as merchants frantically tried to replenish stocks. On top of that, several hundred thousand soldiers, and hundreds of visitors, were going to be making calls, to say nothing of the first-class service that would be needed by newspaper and radio men covering the activities. Obviously, facilities normally adequate for the maneuver areas would be hopelessly swamped.

THE Army, however, has always proved very considerate, and as soon as its plans were developed, they supplied a fairly complete picture of what could be expected. Weeks before the troops moved in, the Southwestern Bell was able to swing into action. Construction crews from Oklahoma and Kansas were brought into Arkansas to help the local forces there, and gangs from different parts of Texas were concentrated in the Texas maneuvers areas. In both cases, special groups of Plant, Traffic, and Commercial men were assigned to devote their entire time to the Army "for the duration."

The biggest construction job had to be done in a section running roughly from Gurdon, Ark., to El Dorado and the Louisiana line. In this area more than 1700 miles of new lines were strung; circuits were rearranged, and 26 new carrier terminals were installed. New positions were added to the switchboards in Gurdon, Prescott, Camden, and other towns, some of which are served by independent telephone companies. Western Electric poured in supplies literally by the carload: 4500 crossarms, 50,000 insulators, 45,000 locust pins; two and a half tons of tie wire, more than a quarter of a million pounds of line wire.

The construction gangs had their troubles. Temperatures reached 100 and higher every day they were on the job, and shirts became so soaked with perspiration that they shorted circuits temporarily as the men worked among the wires. And to make things worse, there was an epidemic of chiggers. Things weren't nearly so bad on the similar job in Texas. There the worst trouble was that the cows developed a taste for insulation, and would eat it off the field wires.

Despite heat and chiggers, the crews made remarkable time. Using truck-mounted borers to dig pole holes, and hiring mule teams to pull whole cross-arms of wires at once, some of the grouped gangs averaged three miles a day.

Meanwhile, representatives of the

ARMY MESSAGE CENTER

Hidden in the woods during maneuvers, this 35th Division post included telegraph facilities in the trailer at the left, a teletypewriter in the center, and a telephone switchboard mounted in the truck at the right

PULLING IN A WHOLE CROSS-ARM OF WIRES
Local motive power was used in stringing these wires in preparation for Army maneuvers

independent telephone companies involved (there are 28 in the Arkansas maneuver area alone) met with the Southwestern Company to work out arrangements to keep all the work coördinated. This was highly necessary, as one order from the Army might involve several telephone companies. The coöperation of all the companies was excellent throughout the maneuvers, a fact that contributed greatly to the successful handling of the project.

BECAUSE the public was also affected, the company conducted an informative advertising campaign to tell people that there might be delays in telephone service during the maneuvers, and why. An explanation was made of the work being done to hold these delays to a minimum, but it was frankly admitted that service was bound to suffer somewhat. The advertising took the form of newspaper advertisements, inserts in customers' bills, and special posters placed at our own and connecting-company public telephones. It is difficult to tell the exact effect this advertising had, but one fact stands out: not one serious complaint was received throughout the entire maneuvers period.

Thanks to these preparations, and the excellent coöperation from everyone concerned, the job of providing service for the maneuvers was accomplished, in general, with gratifying smoothness. And the Army said it was satisfied—which was the important thing. Coöperation throughout the defense job is so excellent and so consistent, however, that only its lack would be cause for comment. Practically everything the Southwestern Bell has done and is doing involves other organizations: the American Telephone and Telegraph Company, its Long Lines Department, the Western Electric Company, independent telephone companies.

The help of the A. T. and T. Company is of great value, not alone in the form of staff assistance and advice but in the handling of matters with the Army and Navy which could not well be settled in the field. There is constant interchange of work with the Long Lines Department, and many a Long Lines circuit has been borrowed to fill an emergency gap. Western Electric has brilliantly upheld its reputation for delivering the goods—usually wanted in quantity, and right now! The independent telephone companies have collaborated closely and whole-heartedly. And too much emphasis cannot be placed on the coöperation of the country's armed forces. Faced with staggering problems of their own, they have been both considerate and helpful in their dealings with the telephone company.

THIS has been the story of what the Southwestern Company has had the opportunity to contribute to the accomplishment of the nation's defense program. Basically, it might have been written about any one of the operating telephone companies in the Bell System.

PROVIDING SUBSTITUTES FOR "CRITICAL" TELEPHONE MATERIALS

As Shortages of Necessary Materials Develop, the Availability of Satisfactory Substitutes Becomes Increasingly Important to Continued Production of Telephone Equipment

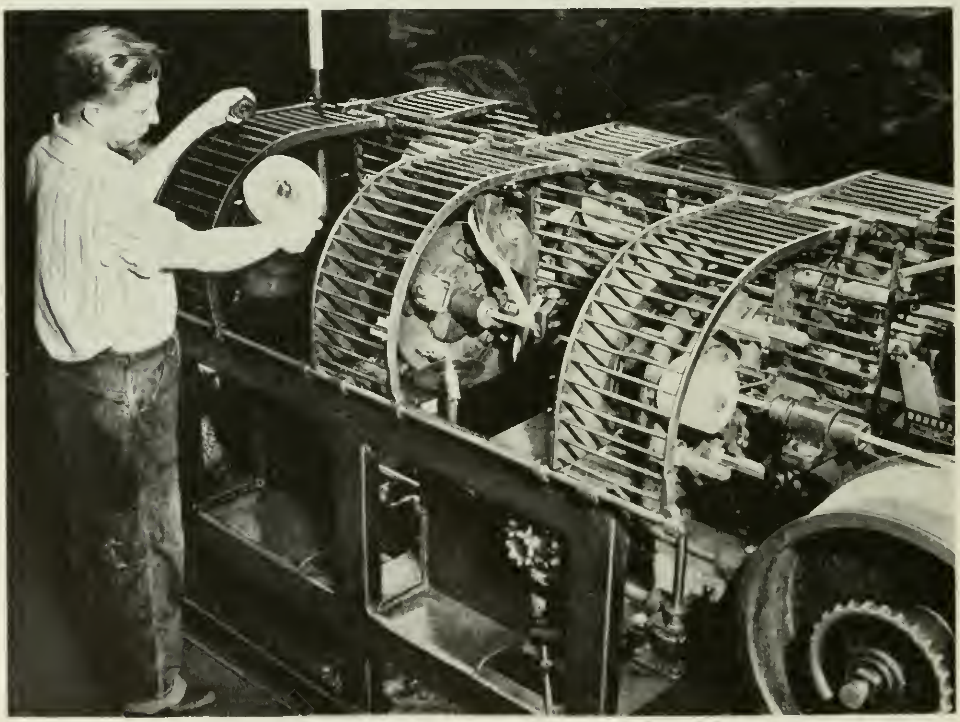
THE present national emergency has given rise to a demand for ever-increasing production. Such production consumes tremendous amounts of many raw materials. As they have become scarcer, the search for satisfactory substitutes has been greatly stepped up. So, too, the Bell System has stepped up its efforts toward thrifty use of the basic materials available.

For some time this vital activity to reduce Bell System usage of materials needed for defense purposes has been coördinated in the System by an Intercompany Committee consisting of the Plant Engineer of the American Telephone and Telegraph Company, the Director of Apparatus Development of the Bell Telephone Laboratories, and the Manager of Manufacture and the General Purchasing Agent of the

Western Electric Company. Back of them, however, the prompt coöperative effort of many other groups is putting the material changes into effect.

Development of suitable substitutes begins in the Bell Telephone Laboratories. The problem is many-faced, and requires a great variety of skills. First comes the materials engineer, who suggests available materials of suitable properties. Sometimes metallurgists or chemists may be consulted. Apparatus designers then take hold of the problem, to see if the changes in strength, conductivity, or insulation require changes in the form of the part or device. Their knowledge of Western Electric's manufacturing methods is helpful in recommending designs which can be made with existing or slightly modified facilities. In some cases, circuit experts may be called on to decide whether any changes will be needed in existing systems. Finally, manufacturing engineers of the Western Electric Company are responsible for the tool set-ups, and the actual processes of making and assembling the changed parts. The work of these men constitutes a useful function in the defense program even outside the Bell System, for they coöperate with the Government and various engineering societies in developing simplified practices and otherwise alleviating material shortages.

Bell Laboratories' engineers con-



Replacing a "Critical" Metal

Pliolite-coated paper tape is used instead of aluminum tape in this operation of switchboard construction at Western Electric's plant at Kearney, N. J.

SAVING RUBBER

Wood fibre board substitutes for the scarcer material in assembling terminal strips for central office equipment at Western's Hawthorne plant

sider the technical questions involved and pass on the suitability of available materials to replace those on the "critical list." Manufacturing department engineers at all Western Electric plants review the piece parts affected by the shortage of a given material, consider available supplies, discuss the manufacturing features with Bell Laboratories' engineers, and revise manufacturing information after agreement has been reached on the substitute to be used. Representatives of Western's purchasing department immediately place new orders, revise outstanding contracts, and attempt to keep a smooth flow of new material coming in with a reduced volume of the old. Likewise, the Western Electric works departments carry a large part of the responsibility, in promptly arranging for the new material to be put into stock and adapting their operations to the new material and methods of manufacture.

The Bell System's substitution program has a direct and obvious bearing on the outcome of the defense program. At the present going rate, it will divert for use in the defense effort nearly 1,900,000 pounds of aluminum annually; more than half a million pounds of nickel; well over 3,000,000 pounds of zinc and 8,300 of magnesium. Additional reductions are foreseen for 1942. It is estimated that about 300 fighter planes might be built with the aluminum the System will save from its present annual rate of consumption.

Three classifications have been developed in the substitution work. Class I includes those materials for which substitutes can be introduced as the result of investigation, research, and design work which has already been done. As an example, Western Electric and the Bell System are substantially reducing their use of zinc by coating much of their outside plant hardware with lead instead of putting these products through a galvanizing process.

In Class II are cases where substitutes may be found, but further work is necessary to determine whether their use is practicable.

The Laboratories are studying the possibilities of using lead foil for condensers instead of aluminum, of which the System would use 250,000 pounds for this purpose this year. The difficulty is to get the lead foil into the same dimensions as the aluminum and thus to avoid a redesign of the entire condenser, which might then be too big to fit into the limited amount of space available in certain assemblies of apparatus.

Class III includes those cases in which engineers have not as yet been able to find working substitutes for the scarce materials, and for which substitution may well prove to be impossible. For instance, there is no known substitute for the zinc electrode in a dry cell, nor, with minor exceptions, is there a substitute for copper.

Generally speaking, the materials used in Western Electric manufacture which have become most critical are copper, aluminum, zinc, nickel, steel, rubber, magnesium, nickel-steel. Some of the other materials which are rapidly approaching the critical state are phenol plastic, phenol fibre, brass and silk.

Western Electric now saves 130,000 pounds of aluminum annually by replacing the aluminum in the dial finger wheel with steel, which serves the purpose adequately. Copper has replaced aluminum in bus bars, and an annual saving of an additional 100,000 pounds of aluminum has thus been effected.

A thermo-plastic is to some extent replacing Zamak, a zinc aluminum alloy, in the manufacture of the housing for combined telephone sets. Since the combination of Zamak is approximately 4 per cent aluminum, .03 per cent magnesium, and about 95 per cent zinc, this is a substitution which releases for other purposes a sizeable quantity of vital metals. Of all the combined sets now in manufacture, 34 per cent of the housings are of plastic composition. At this rate, the annual saving of zinc alone will amount to 1,600,000 pounds.

The defense emergency has, of course, tremendously stimulated the work of the Bell System engineering groups. An immediate survey was made in 1939, based on a study of materials particularly used in the Bell System, and a list of critical materials developed. The list initially consisted mainly of critical materials which were purchased outside of the United States, or the sources of which were beyond control.

Looking to the future, Western Electric's engineers are considering the use of sisal and ixtle, fibrous materials readily obtainable in this hemisphere, in place of jute and burlap for cable construction.

In compliance with an order of the Director of Priorities and in view of the necessity of conserving the supply of rubber, Western Electric plans a gradual reduction of its use of crude rubber which will reach a level of

EVEN SWEEPINGS ARE COLLECTED

Gathered in railroad cars, trucks, operation departments, and from other System sources, this scrap will charge a blast furnace at Nassau Smelting and Refining Company, and will yield copper to be rolled and drawn into telephone wire

more than 20 per cent by the end of the year. This saving will be accomplished chiefly by the use of more reclaimed rubber in rubber compound and reduction in the use of hard rubber by the judicious use of materials having similar properties.

For the purposes of the emergency, temporary manufacturing information permits the manufacturing department to proceed with rapid introduction of substitutes. Because of the many factors involved—processing, engineering, materials and new procedures—manufacturing costs inevitably will rise as a direct result of the use of substitute materials. Nor are manufacturing conditions relieved by the fact that the defense program has greatly stimulated current telephone business, as well as plant expansion.

IN the Bell System, all materials removed from the plant are re-used in the plant, in whole or in part, if it is possible to do so. Materials which cannot be re-used are reclaimed. Reclaiming is the specific function of the Nassau Smelting and Refining Company, a general smelter and refiner of copper, lead, zinc, tin, antimony, and their alloys from secondary sources into commercial forms such as brass, bronze, copper, babbitt, solder and related products. Nassau, which employs 450 persons and maintains a metallurgical engineering and sales staff, also has the responsibility for the disposition of scrap iron, paper, rubber, and similar by-products from the operations of the Bell System. It is a wholly-owned subsidiary of Western Electric.

Nassau products include bronze billets for drop wire (for consumption at Western Electric's Point Breeze Works), solder for Western's manufacturing and installation departments and for the telephone companies, lead sleeving for the Eastern area telephone companies, rosin core solder, copper wire bar (delivered to rod mills and there rolled into rod for drawing into wire at Western's Kearny and Point Breeze Works), brass billets (shipped to a fabricator and, following the fabrication process, then to the Kearny, Point Breeze and Hawthorne Works), zinc (for Western Electric's use in galvanizing operations, and in the manufacture of brass billets), fine lead wires for protective apparatus.

The defense production job continues uninterrupted. Meanwhile, behind the lines, so to speak, thrift and ingenuity are at work to provide a constant supply of raw materials for that production and, equally important, to insure that Western Electric's manufacture creates no unnecessary drain on the nation's fund of raw materials.

THE PRESENT SITUATION AND THE PRESENT OUTLOOK

The Defense Program, Creating an Unprecedented Demand for the Bell System's Services, Has Posed Tremendous Problems—Some of Which Have Been Solved, While Others Lie Ahead

In ordinary times the telephone company keeps a reasonable margin of spare facilities for growth and for emergencies. Ever since the worst of the depression, the business has been growing steadily, and to keep its plant well ahead of the demand for service, the Bell System has made expenditures for new plant construction which total about $1,400,000,000, and net additions which total nearly $600,000,000, for the years 1934 to 1940, inclusive. This year the expenditure for new plant construction will be more than $400,000,000 and net additions will approximate $300,000,000.

These large expenditures are necessary because in the telephone business we can't handle more calls for more people without first building new plant—a lot of it. To take in $1.00 in annual revenue we first have to spend roughly $5.00 for telephones and wires and central office equipment and all the other things needed to render service.

That is an unusually high proportion of plant to revenue—much higher than is needed in most businesses. Moreover, all new telephone plant must be carefully planned to fit in with all the plant already in existence, since the interconnection of all facilities is needed in order that people may talk with each other by telephone, wherever they are.

This means that relatively long-term advance preparations must be made in order to be ready to handle big increases in business. Here is one of the reasons why ample margins of spare facilities are essential. Here is another reason why the enormous recent increase in the use of the telephone, brought about by the continuous acceleration of the defense program, is causing serious problems for the telephone company.

LET us compare the country's overall use of the telephone today with the situation two years ago, before the outbreak of war in September, 1939.

At that time the Bell System had about 16,200,000 telephones in service and people were using them about 72,000,000 times a day. Now there are some 18,500,000 Bell telephones in service and they are being used about 81,000,000 times a day. In two years the number of telephones has increased more than 2,000,000 and the average number of conversations each business day has jumped 9,000,000.

These increases are enormous. There has never been anything like them before. The increase in the demand for toll service, considered separately, is even more spectacular. The

UP IT GOES!

This new Long Lines cable will provide additional circuits in the important Middle Atlantic industrial area number of toll and long distance calls for the first six months of 1941 was about 15 per cent greater than for the corresponding period last year, and the increase in the number of longer haul calls was about 27.5 per cent. Comparing the first six months of 1941 with the first six months of 1939, we find an increase of 22 per cent in all toll calls and an increase of 41 per cent in the longer haul calls.

When war broke out in Europe in September, 1939, there was a sudden unprecedented surge of long distance calls—a sort of "nine days wonder" during which all records for traffic over the longer distances were broken. Now, two years later, we are handling more of these calls every business day than in those September days of 1939. What was astonishing then has become commonplace today.

Why has all this happened? The fact that industry is expanding tremendously for defense is only part of the answer. Equally important is the necessity for speed in meeting the emergency. Our national purpose is not merely to arm for defense. It is to do this with all possible speed. The telephone offers one way to speed things up. Hence the great increase in its use. When we understand this, we understand also how grave a responsibility rests on the telephone company.

What has enabled the Bell System so far to meet this responsibility? Two things, mostly:

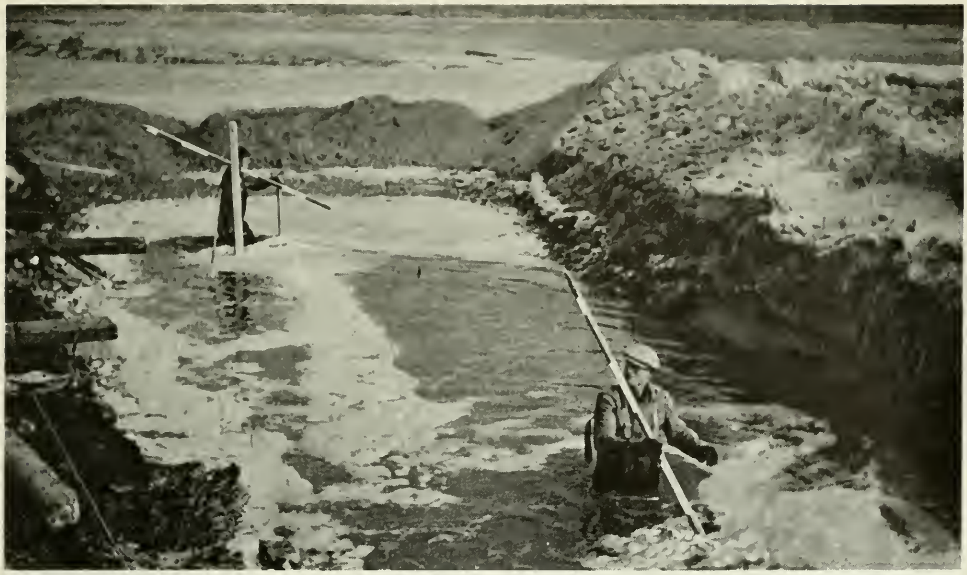
First, as indicated above, it was well prepared and had sizable margins of spare facilities.

Second, new construction activity has been speeded up about as fast as it could go. By the end of this year, net additions to plant for three years only—1939, 1940 and 1941—will have aggregated something like $550,000,000.

Nevertheless, certain problems have sharpened in the last few months and may become considerably more serious in the near future. One characteristic of the defense program is that ever since it started it has been growing by successive leaps and bounds. The program of a year ago, for example, was succeeded a little later by something much bigger, and today's agenda makes last year's prospectus look narrow in comparison. In a business like ours, where so much planning and so much construction are needed to give the service represented by each dollar of annual revenue, these successive upward jumps complicate the job. Given one set of conditions, we go to work to meet them. But soon the conditions are changed, and it appears that something more is going to be needed to meet the revised situation. This means not only that our original program will fall short, but that some of the time needed to plan a bigger program against some future date has been lost.

In short, if it had been known by anybody a year or more ago that this country was going to organize its defenses on the scale on which it now seems to be organizing them, the telephone company's present problems would be much simpler than they are.

As it is, the repeated acceleration of the defense program has handicapped the telephone builders in their race with telephone users. Recently, usage has been outrunning the growth of facilities. The builders' head start,



BED FOR A CABLE

The men are measuring the depth of an excavation in which a new telephone cable will be laid under the Platte River

in the form of spare plant margins, has been largely used up. Today, in many places, it's a neck and neck race.

This isn't true in all parts of the country, nor of all the types of service we render. It is most true of toll service over the longer routes, and between points where there are particularly heavy concentrations of defense effort. Also, while some of the routes experiencing "unlimited emergency" traffic are main trunk lines, others are spur lines that have never been called upon before to bear any very heavy load. Military cantonments and bases have mushroomed in former corn fields. So have dozens of great industrial plants. The two types of establishments together have given America something like 100 brand-new medium-sized cities, for many of which communications facilities must be built practically from the ground up. And there are more coming. To give service to and from these places, as well as in them, and at the same time to augment facilities between already established industrial centers, is a huge task in itself.

So far, the pressure of demand on long distance facilities has been evidenced mostly in ways like these:

—on certain routes, circuits sometimes cannot be obtained immediately.

—the average speed of service is a few seconds slower than a year ago.

—about 12 people out of every 10,000 who use long distance are displeased with the service to the point of saying so, either orally or by letter, compared with 11 out of every 10,000 last summer.

But today the question is:

"If demand keeps on going up, now that spare plant margins have been absorbed, what can the telephone company do about it?"

Right here another problem presents itself. This is the shortage of materials needed to build the plant needed to render more service. The race between builder and user is becoming, in fact, a sort of obstacle race.

For a long time the Bell System has been studying how to make the most effective use of materials, particularly of new materials as they become available. Such studies were begun as long ago as 1925. Thanks to this advance preparation, the Bell System is now able to make numerous substitutions in ways that interfere as little as possible with the rendering of grade-A service.

However, whenever the opportunity to use the best possible material is restricted, some penalty is unavoidable. Also certain materials have no substitutes for certain uses.

Without going into all the myriad details of the materials problem, we can see the broad consequences clearly. One is that some parts of our new plant, while they will be well made and capable of giving good service, will not be just as we would like to have them under normal conditions. Another is that substitutions cannot by themselves solve the whole problem. To give only one example, copper may be used in some places instead of aluminum, but there is no generally applicable substitute for copper.

The materials substitution program voluntarily undertaken by the System has resulted in large savings of scarce materials. Recently, however, it has been necessary for the telephone companies to adopt further restrictions and curtailments because of inability to secure sufficient quantities of these materials and in anticipation of further difficulties in obtaining them. These reductions have been made by adopting engineering and economic practices which involve severe penalties.

In doing this, the guiding principle must be to put first things first.

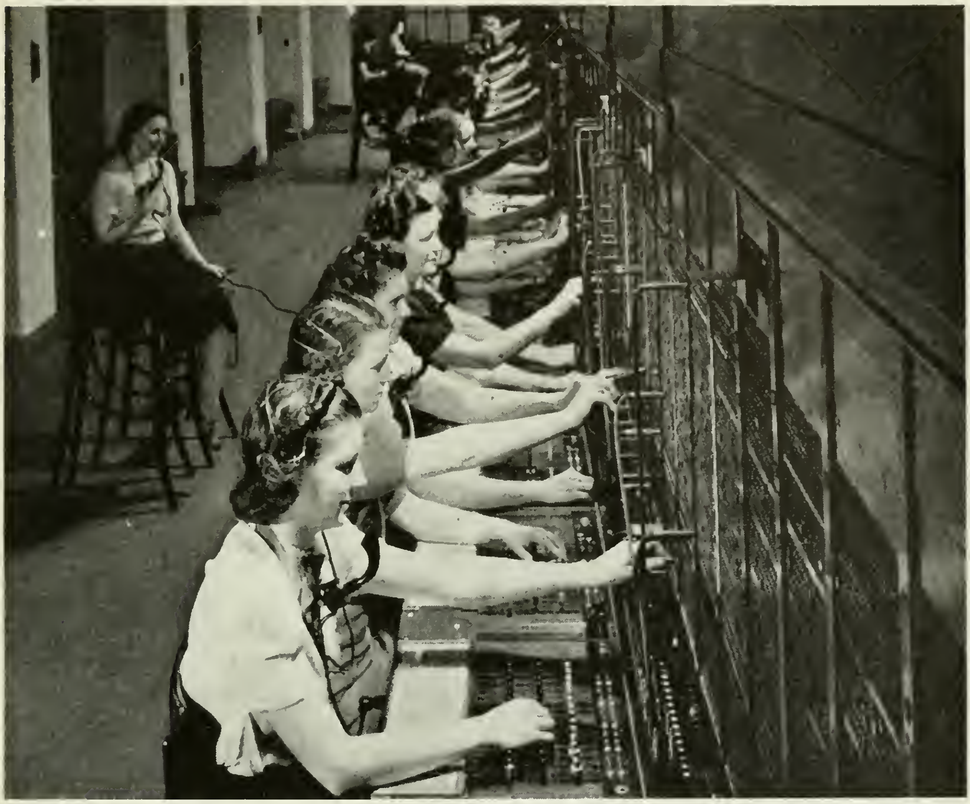
For example, old equipment which might normally be replaced can be kept in service, so that the new equipment which might have replaced it can be used somewhere else where the need is greatest.

Dial installations in some communities can be deferred, used switchboards can be reused, cables can be resheathed and reused, and other similar expedients can be adopted.

If there isn't enough copper to make enough wire to give an individual line to everyone who wants one, people can be asked to accept party line service "for the duration."

Orders for telephone installations that are necessary or important for defense can be completed ahead of other less urgent orders. So far, defense orders have been filled on schedule without the need to ask others to wait.

All these things can and will be done, if they are necessary to keep first things first. That all of them will be necessary we cannot say with certainty. However, it is clear that some of them are already necessary, and it is likely that others will be. Adoption of such measures will not mean that the Bell System is sparing any outlay of effort or money to provide and maintain the best possible facilities and service. On the contrary, the System has never made a more strenuous effort to keep the service

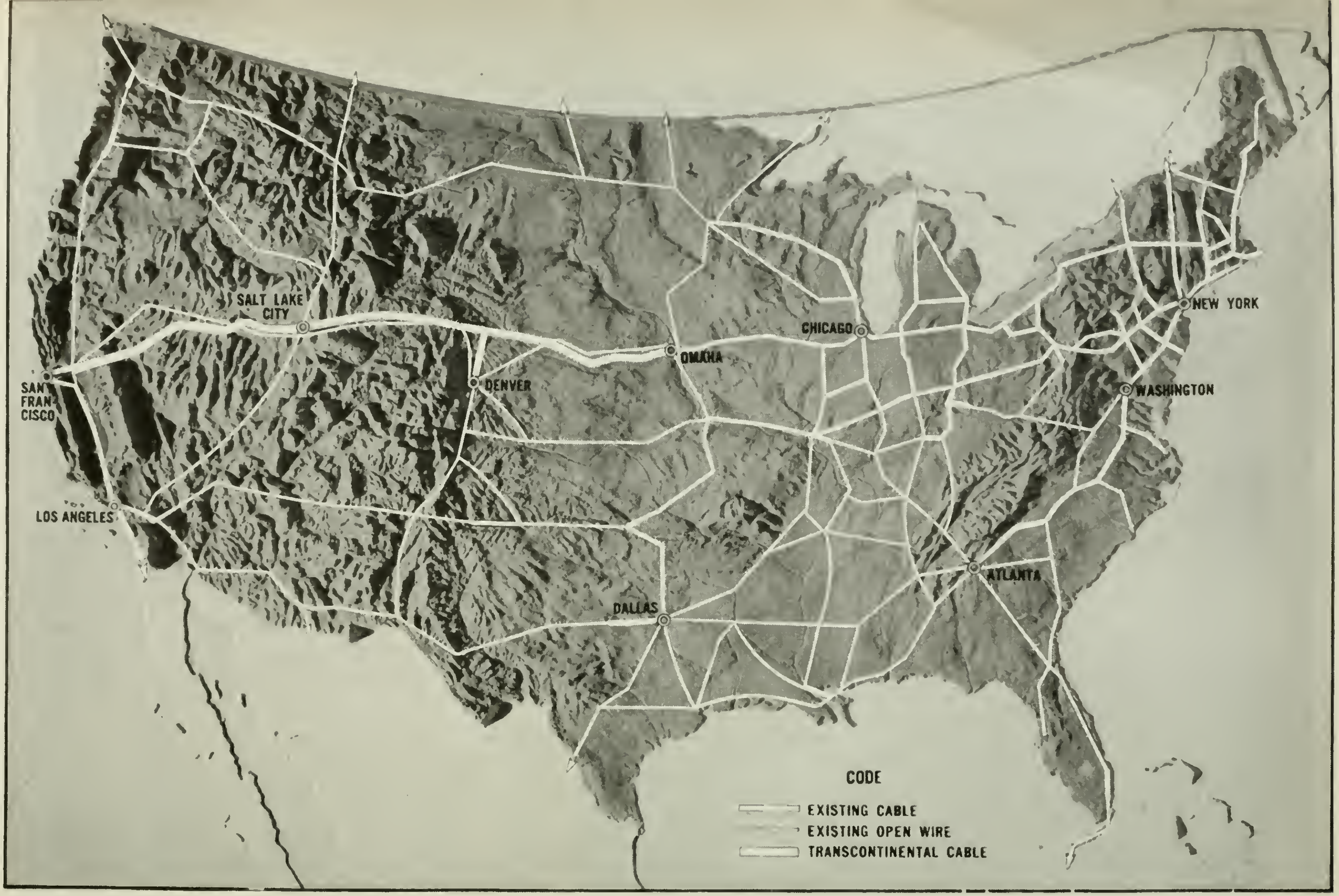


EVERY POSITION FILLED

Long Distance switchboards throughout the country are handling more calls than ever before

good, and some of the figures mentioned above are fair evidence of the current outlay of money. It is obvious, however, that if the unprecedented demand for service which is now being experienced should continue, in the face of possible serious shortages of essential materials, some ground must be given somewhere.

IT may be worth noticing, in conclusion, that were it not for the great technical progress made by the Bell System in recent years, some of the most serious current telephone problems would be infinitely more serious than they are. Thanks to cable carrier systems and cable-laying plow trains, it has been possible to increase long distance telephone facilities at a speed utterly impossible a few years ago, under any circumstances whatever. Thanks to the organization, resources and equipment of the System, the greatest demand in history has so far been met, and met well, and inconveniences to the public have been kept to a minimum. These facts are the best assurance we have that whatever the problems of the future may be, the nation can rely on the Bell System to meet them progressively, and in a manner that will well serve the public interest.



THE TRANSCONTINENTAL TELEPHONE CABLE ROUTE
AND PRINCIPAL EXISTING CABLE AND OPEN WIRE ROUTES IN THE UNITED STATES

ENGINEERING THE TRANSCONTINENTAL TELEPHONE CABLE

This Major Project, Largest Single Undertaking Since the Building of the First Transcontinental Line, Will Join the Eastern and Western Toll Cable Networks by Underground Circuits

By HORACE H. NANCE

WESTWARD across the plains of Nebraska and the mountains of Wyoming, where a hundred years ago endless herds of buffalo looked up in surprise at the creaking covered wagons of the pioneers, a strange sprawling caravan is grumbling and growling on its way from Omaha to the Pacific coast. The buffaloes and the wagons have long since disappeared, but this caravan again typifies the spirit of the pioneer. The trail it is following is to become a safer super-highway of transcontinental speech.

This caravan is a ponderous steel train of Diesel-powered caterpillar tractors, rooter, plow, and trailers; nine pieces of massive machinery, 275 feet long, weighing more than 100 tons. In one continuous operation it is cutting a narrow slit some thirty inches deep in the ground, laying a pair of long distance telephone cables on the bottom, and covering them up securely behind the train. Two oxen could pull a covered wagon; it would take several hundred to pull this train.

Slowly but steadily, day after day, the cables unwind from massive reels and thread their way smoothly down through the plowshare into the ground. At intervals the train stops to reload the trailers with new reels of cable, then proceeds on its way. Farther west, other trains will hurry the cable on through Laramie, Salt Lake City, and Reno to Sacramento, where it will meet the Pacific coast cable network. Behind the trains come the splicing and testing crews to join the sections of cable and to make tests necessary to insure proper electrical performance. At 17-mile intervals along the route, compact, efficient repeater stations are springing up, many of them designed to carry on for long periods without human attention at the site. From the factories of the Western Electric Company a steady flow of equipment is going to these stations, where installers are rapidly putting it into operating condition and connecting it to the cable conductors.

This work, started about a year ago and expected to be finished by late 1942, will provide a cable link from Omaha to Sacramento, 1630 miles long, connecting the Bell System's eastern and western toll cable networks. Although it is being rushed to completion to provide for the unusual traffic requirements due to national defense activities, it is designed to take care of normal growth requirements for some years in the future and to afford increased reliability and continuity of transcontinental service. When completed, it will be possible to talk over practically storm-proof cable from Bangor, Maine, to San Diego, California, a total distance of nearly 4000 miles.

Because of the nature of the territory traversed and the great length of the cable circuits which will be routed through the completed system, many unusual and interesting problems are involved. Some of these will be touched on here, but they can only be illustrative of the vast amount of research and of detailed planning which underlie a project of this kind and magnitude.

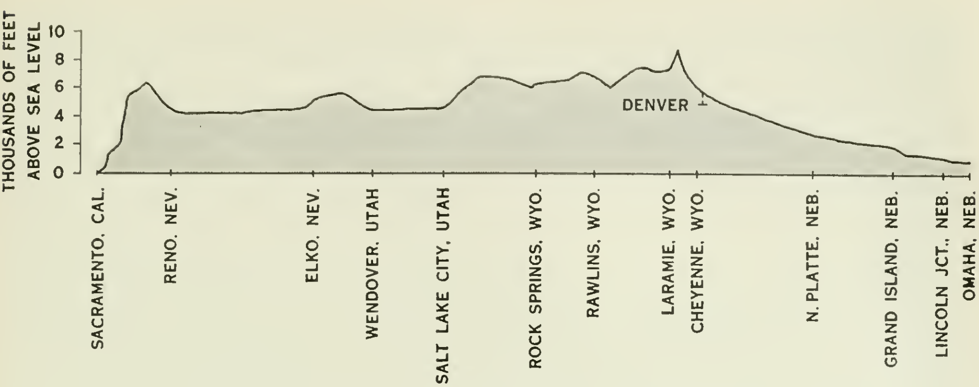
This project is a joint undertaking of the four Bell System companies whose services are handled along the route: the Long Lines Department of the American Telephone and Telegraph Company, the Northwestern Bell Telephone Company, the Mountain States Telephone and Telegraph Company, and the Pacific Telephone and Telegraph Company. The Lincoln Telephone and Telegraph Company will also acquire an interest in the cable through the territory in which it operates.

The new cable link consists actually of two cables, each carrying 54 or more pairs of wires. Most of the wires will be left non-loaded for the application of 12-channel type-K carrier systems, one cable being used for carrier transmission in one direction and the other cable for carrier transmission in the opposite direction. Some wires will be equipped with loading coils and used to provide voice-frequency circuits for the shorter haul traffic and maintenance requirements.

The section from Omaha to Laramie, with a branch from Cheyenne to Denver, some 645 miles in all, is now nearing completion, and will be placed in service this year. Forty-eight circuits will be provided initially through this entire section by means of type-K systems, and thirty-six of these will be extended west of Laramie to Salt Lake City and Pacific coast points on additional carrier systems now being installed on open wire. Additional circuits will also be provided this year to serve intermediate points along the route.

When the cable is completed to the coast, next year, sufficient type-K systems are expected to be put into operation to provide about 100 additional circuits, and ultimately, when the cable is completely equipped with carrier, it will provide a total of 500 to 600 circuits. The cost of this cable, with its initial equipment, is expected to be about $21,000,000.

Active engineering work on the transcontinental cable has been proceeding for several years. To view this important project in its proper perspective, it must be remembered that universal service was a definite objective of the Bell System from its inception, and that the extensive technical advancement and engineering effort of the System has continuously been brought to bear on current problems of extending service or of im-



PROFILE OF THE TRANSCONTINENTAL CABLE ROUTE

proving it by the use of new instrumentalities. The establishment of transcontinental service on January 25, 1915, was the result of the coordination and application of the technical advances made by the Bell System up to that time in outside plant construction, the design and construction of loading coils, and of telephone repeaters with their associated hybrid coils and balancing networks.

Transcontinental Development

AFTER the initial years, during which additional transcontinental facilities needed were provided by the stringing of additional open wires, carrier current development reached the commercial state, and carrier systems were put into transcontinental service between Chicago and Sacramento in 1926. This was the type-C, three-channel system, and more systems of this type were added from time to time as transcontinental traffic increased.

By 1937, four main transcontinental open-wire routes had been constructed, and type-C systems were operating on them. These routes were the Northern, which went west from Minneapolis; the Central, via Denver and Salt Lake City; the newest one, known as the Fourth, west from Oklahoma City through Albuquerque; and the Southern, from Dallas via El Paso. As additional circuits were provided from time to time, attention was given to maintaining a good distribution of traffic over the various routes, in order to minimize the disturbance to service which could occur if one of the routes should be put out of commission by storms or other destructive forces.

Carrier-current development work continued, and in 1938 the first of the 12-channel, type-J carrier systems for open-wire lines was applied to the Fourth Transcontinental Route between Oklahoma City and Whitewater, Calif., an existing point on the Pacific Coast toll cable network. The type-J system utilizes frequencies extending up to 140,000 cycles, operates on the same pair of wires with an existing type-C system, and affords a somewhat better quality of message circuit transmission than had previously been obtained on open wire.

By the time the first type-J system had been placed in service, the toll cable network from the east had reached Omaha, Kansas City, Oklahoma City, and Dallas. On the Pacific Coast, toll cable was already available from San Francisco to Sacramento and to Los Angeles, and extended east from Los Angeles as far as Whitewater.

Transcontinental Cable Needed

For a considerable number of years it has been evident that the fast growth in the transcontinental telephone traffic would soon tax the capacities of the open-wire lines, and that a tronscontinental cable would ultimately be required. The growth, even in the late 20's, had indicated this, and some studies and tentative plans for cable were made at that time. Since this was prior to the development of carrier systems for cables, the tentative plans contemplated a full-size cable similar to those already installed east of Omaha.

The business depression, and later the development and application of 12-channel carrier systems on open wires, deferred the cable plans. The rapid growth in the last few years, however, and now our urgent national defense requirements, combined with the need for increased protection to the important transcontinental services, have made it obvious that cable should be extended, as fast as possible, to the Pacific Coast. Today there is a total of about 250 Long Lines circuits on the four transcontinental open wire routes passing through a meridian just east of Denver and about 200 circuits on these routes west of Denver. There were only three circuits in 1915 and less than a hundred up to six years ago, west of Denver.

As an illustration of the growth in the longer haul traffic, data for the four longest message circuit groups are given in the table at the bottom of the page.

The rapid growth in transcontinental business is due to a complex combination of factors. Important among these are the growth in population of the western states during this period, and the development of industries on the Pacific Coast, such as the motion picture industry. Added to these is the growing community of interest between east and west, and, of course, the effect of better and faster long-haul service at lower rates.

Circuit Group	Average Daily Messages for Months of Mar., Aug., and Oct.			
	1920	1926	1930	1940
New York–San Francisco	13*	26*	107	215
New York–Los Angeles	7*	43*	222	413
Chicago–San Francisco	20	39	136	267
Chicago–Los Angeles	7*	46	164	244

* Direct circuits between terminals not available in these years. Traffic (partly estimated) switched over other groups.

WESTWARD VIEW
A Long Lines engineer studies the lay of the land

Deciding on the Route

IN planning the general route to be taken by the cable, it was necessary to consider a number of factors, such as:

(*a*) The volume of traffic and length of circuit routings, via the cable, between centers in the eastern half of the country and centers on the Pacific coast. Likewise the volume of traffic that would be routed through the cable to intermediate points on the route.
(*b*) Suitability of route for installing and maintaining buried cable and repeater stations and otherwise obtaining maximum protection to the over-all transcontinental service.
(*c*) Initial and future costs.
(*d*) Extent to which the cable may permit later removal of open wire plant, and protect the remaining open wire lines.

Long distance traffic from the east to the Pacific coast now divides about 60 per cent toward Los Angeles, 25 per cent toward San Francisco, and 15 per cent toward the Pacific northwest. With the greatest amount of traffic flowing toward Los Angeles, it seemed that cost factors might favor a route heading directly for that point. However, Los Angeles and San Francisco are already connected by cable, and the Pacific Company is proceeding with the installation of supplementary cable and 12-channel carrier systems over that route. Studies indicated that there would be no controlling cost advantage in routing the transcontinental cable directly toward Los Angeles, as compared with routing it toward San Francisco.

An important consideration was the need for providing additional circuits into Denver, the largest center between the western outpost of the ex-

With Transit and Rod
The route to the west becomes definite

isting toll cable network and the Pacific Coast, and the studies showed that it would be desirable and economical to connect Denver to the cable network within a very few years, regardless of the route to be taken by the transcontinental cable. It appeared highly desirable that Salt Lake City, the second largest city in the Mountain States region and a natural communication outlet for the Pacific northwest territory, should also be served by the cable.

From the standpoint of reliability of service and future maintenance costs, buried type of cable construction has been favored for this project. As a part of these studies, therefore, an investigation to determine the extent to which it would be practicable to bury cable was undertaken on three general routes.

One of these routes was from Omaha to Sacramento via Cheyenne and Salt Lake City. Another route was generally common to this as far west as Salt Lake City but then diverged southwestward directly toward Los Angeles. A third route, starting from Kansas City, passed through southeastern Colorado to Albuquerque, N. M., and thence followed the general route of the Fourth Transcontinental open wire line to Los Angeles.

Studies of available soil data, supplemented by a large number of test borings to determine whether rock would be encountered near the surface, showed that, with the exception of comparatively short sections, cable could readily be buried over the Omaha-Sacramento route. On the route from Kansas City to Los Angeles, however, and also on the route from Salt Lake City to Los Angeles, conditions were not favorable for burying cable for some 280 miles on the former and 130 miles on the latter. A general route via Cheyenne and Salt Lake City toward San Francisco, therefore, appeared preferable to the other routes from the standpoint of this objective.

The installation of cable on the route from Omaha to Sacramento will permit the ultimate displacement of a greater amount of open wire plant than could be released if the cable were installed on any other route; furthermore, the plant which can be released is in areas subject to snow and ice storms and is, therefore, relatively more expensive to maintain than that over more southern routes.

Transmission Considerations

IN planning present day transcontinental facilities, consideration has to be given to providing adequately not only for a high standard of message circuit transmission but, in addition, for program transmission, telephotograph and telegraph transmission, and for the possibility of demands for further improvement in performance for these services in the future. From these standpoints, type-K carrier facilities are well suited for use on this project. This type of facility, with a velocity of transmission of about 100,000 miles per second, stabilized feedback amplifiers, and other desirable transmission design features, provides clear and faithful transmission over long distances. Furthermore, its application is particularly economical in this case, where a large number of long circuits, many of them over 1,000 miles in length, are involved.

The first 12-channel type-K carrier systems were placed in commercial service between South Bend, Indiana, and Toledo, Ohio, in 1938, using nonloaded conductors in two existing cables. In the succeeding years, type-K systems have been applied in many other sections of the plant; and, since they have proved to be excellent from the standpoint of both transmission and operation, they are expected to be highly satisfactory for the transcontinental cable.

Transmission features similar to those of the type-K system are also afforded by the type-L, or coaxial, system, but this latter system is not yet available for use over the great distances involved in the present project.

Through the Old West

FROM Omaha, the cable route selected is across the Nebraska prairie, past Lincoln, the state capital, thence along the Platte River near the old Oregon Trail through Grand Island, Kearney, North Platte, and Ogallala,

NO ROCK HERE
The earth auger tests the soil to the depth which the plow will penetrate

where it leaves the river, and then through Sidney over the grassy plains to Cheyenne, a distance of 500 miles. Cheyenne's elevation is 6,000 feet above sea level and 5,000 feet above Omaha.

From Cheyenne to Denver, about 100 miles south, the cable route is through prairie country, decreasing in elevation from 6,000 feet at Cheyenne to 5,000 feet at Denver.

The region between Cheyenne and Laramie, a distance of 45 miles, varies in elevation from 6,000 to 9,000 feet, and is subject to sudden blizzards and heavy snowfalls accompanied by high winds. The cable route between these points parallels the Lincoln Highway (U. S. 30), which is kept open during the winter. West of Cheyenne the soil becomes increasingly rocky, and some blasting through rock for short distances is required in the section over the Sherman Hill Divide. This is the highest point on the cable, nearly 9,000 feet above sea level.

From Laramie the route bears northwest, following in general the old Overland Trail to swing around Elk Mountain and then parallel the highway westward through Rawlins, over the Continental Divide at Creston, elevation about 7,000 feet, through Rock Springs, Green River, and Fort Bridger. Here it again meets the Oregon Trail, then goes through Evanston and Castle Rock. In general, the land is rolling, covered with sage and greasewood. At this point the route turns to the southwest through mountainous country to Coalville, and thence to Salt Lake City, a total distance from Laramie of 378 miles.

The mountainous country between Evanston and Salt Lake City was the last obstacle which the Mormons had to surmount before arriving at the Salt Lake City area which had been chosen by Brigham Young as a site for the future Mormon state of Deseret. It is also an obstacle for the cables, and intensive field work, guided by detailed aerial surveys, has been required to obtain a satisfactory route. The cables will enter Salt Lake City a short distance from Emigrant Canyon, down which Brigham Young led the Mormon Pioneers in 1847, and at the mouth of which took place the dramatic scene where he pointed out their future home and said "This is the place."

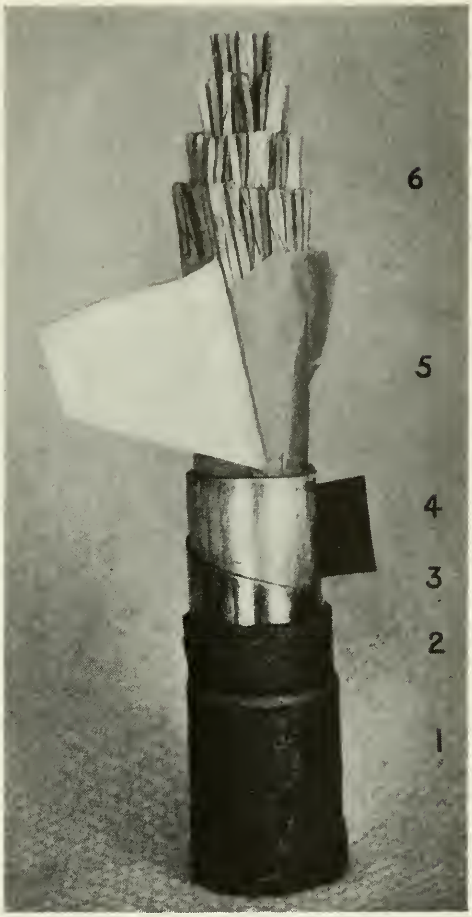
The route from Salt Lake City to Wendover, Utah, skirts the southern edge of Great Salt Lake, turns slightly to the northward to avoid a range of mountains, and traverses the mud and salt flats of the Great Salt Lake Desert before reaching Wendover, a distance of 124 miles.

Great Salt Lake is the only remnant of an ancient inland sea. The slope of its shores is very gradual, so that a small increase in the water level will greatly increase the size of the lake. Water level data on the lake have been kept for only about 35 years, but it appears that the level has been steadily decreasing in the last ten years, because of greater consumption of water for irrigation purposes from the rivers which flow into Great Salt Lake. The cable will be placed above the highest water level which the lake has reached during the period studied. The mud and salt flats stretch east of Wendover for about 40 miles and are practically level. They are flooded during certain periods with several inches of water. However, at times the surface is dry, and it is planned to plow in the cables during such periods.

From Wendover the cable route will cross the plains and plateaus of Nevada, including a few minor mountain ranges, on a fairly direct line through Elko and Reno. West of Reno the route crosses the Sierra Nevada near Donner Pass, and continues down the western slope to Sacramento, a total distance from Wendover of 483 miles. The Pacific Company has made extensive use of aerial surveys to guide the field work in the selection of a suitable route through this territory, particularly the difficult mountain terrain. The heavy snowfall in this region is expected to be an obstacle to maintenance work, and for this reason the cable will follow existing highways in the higher and more rugged sections.

Cable Details

THE detailed arrangements of the transcontinental cables for the operation of type-K carrier systems are essentially the same throughout the length of the route. One cable contains, in various sections, 54 to 88 pairs of paper-insulated 19-gauge conductors surrounded by lead sheath over which is placed a steel tape and jute and other protection. This cable is used primarily for one direction of carrier transmission. Certain of the pairs are loaded for use as voice-frequency plant maintenance circuits or, in some sections, for message circuits between intermediate points. The second cable, of similar construction, contains an equal number of conductors for the opposite direction of carrier transmission and varying numbers of loaded conductors. In some sections, where a sizable number of voice-frequency circuits are required, this cable may be quadded.



CONSTRUCTION OF THE CABLE

This specimen of a typical section of one of the twin cables consists (reading up from the bottom) of: 1, jute protection; 2, thermoplastic protection; 3, steel "gopher tape"; 4, lead sheath; 5, double paper wrapping of core; 6, the conductors

Some 1,500-foot lengths of cable were used in the first sections plowed in. In general, long pieces of cable can be buried more economically than short lengths. Accordingly, trials of 3,000-foot lengths were made, and since it was found that these could be satisfactorily handled, 3,000-foot lengths are now generally being supplied and placed.

While the cable is being manufactured, great care is taken to avoid deviations from uniformity in the electrical characteristics of the conductors. When it is plowed into the ground, it is lubricated and its tension regulated to minimize physical deformation of the cable, so that the electrical characteristics of the cable in place will be as close as possible to those desired. In spite of these precautions, however, experience has shown that there will be residual small deviations in the characteristics of the cable conductors which, if permitted to remain unreduced, would have a serious effect on the operation of type-K carrier systems. This effect would show up principally as crosstalk between the channels of paralleling systems.

These deviations are reduced when the cable lengths are spliced together. The number of times one pair lies adjacent to another in the completed cable is also controlled. The splicing, a most important factor because of the high frequencies involved, is carefully carried out in pre-arranged patterns, and electrical tests are made to check the results as well as to contribute to the advance of the technique.

In order to obtain warning of cable damage, and to minimize the effects of this damage, it is planned to place the cables under permanent gas pressure, a method which has come into general use in the toll cable plant over the last decade and has been found extremely effective.

The gas will be dry nitrogen, and will be maintained at a pressure of about nine pounds per square inch. Electrical contactors which close and give warning if gas pressure falls at any point, due to damage to the sheath, will be placed along the cables at intervals of about 10,000 feet, and valves for testing the pressure will be located every 3,000 feet.

The valves will be above ground, and connected to the cable by means of lead pipe, which will be fastened to creosoted stubs set in the ground deep enough to be anchored firmly and projecting above ground far enough to be readily seen above snow and growing crops. Other stubs will be placed at various intermediate points, and all of the stubs will serve as markers of the cable route.

Once a cable is plowed in, about thirty inches below the surface of the ground, it would appear that it would be safe from any interference for a long time. Facts about buried cable indicate that, even after the cable is installed, there are a number of sources of potential interference which must be reckoned with.

Prevention of Corrosion

Corrosion of cable sheath, often referred to as electrolysis, is caused by a transfer of current between the cable sheath and earth, or by direct chemical attack. For example, if a cable traverses two areas having a difference in potential, the fact that the cable sheath is a conductor will allow current to flow from the high to the low potential area along the cable

MEASURING EARTH RESISTIVITY
The kind and extent of protection against lightning provided for the cable along different sections of the route largely depends on the results of field tests such as that shown here

sheath. The point or points at which this current leaves the cable sheath will show pitting or corrosion, which is the visible mark of electrolytic action. If not checked, this will eventually eat through the sheath.

Information has been obtained, therefore, concerning telephone experience in localities along the route, and the operators of gas, oil, and water pipe lines that parallel and cross the route have been interviewed regarding their experience. If an area requires that special measures be taken to prevent corrosion, these measures are worked out on the basis of all data available, and coördinated with pipe lines and other structures which either suffer from or are potential causes of corrosion.

For example, it was found that the area between Overton and Ogallala, Neb., a section of about 120 miles, is particularly subject to corrosion. The pipe line companies in this section have had experience in combating this situation, and their problems and methods were examined in detail. In the case of one bare iron pipe line, a system of corrosion protection called "forced drainage" is being used. A number of windmill- and gasoline-driven generators are used at rather short intervals, each of which draws a current of a number of amperes from the pipe line and returns it to a ground made up of buried pipe some distance away. This keeps the pipe line at a negative potential with respect to ground. The distribution of current around these grounds was measured, and as a result it was found that it would be desirable to maintain a separation of about a mile between the pipe line and paralleling cable equipped with ordinary jute covering.

It was not possible to maintain this distance from all pipe lines through the Overton-Ogallala section, however, and another method of protection was adopted. This consists of an insulating thermoplastic and thin impregnated jute covering for the cables, in place of the usual heavy jute covering. The thermoplastic layer is about 1/16 inch thick and is composed of rubber, asphalt, and inert filler. Tests have not been completed over the entire route, but it is likely that the thermoplastic covering will be used to a large extent across Wyoming, Utah, and Nevada.

Possible corrosive effect on cable sheath of the soil and water in the flats of the Great Salt Lake Desert was first considered in 1930 when for test purposes a number of sections of various types of cables which were employed in underground construction were buried at different points in the salt marshes and flats east of Wendover. These cables were recently dug up, and found to have been little affected by corrosive action of the soil.

Protection against Lightning

Lightning can damage buried as well as aerial cable. When lightning strikes the earth at any point, a momentary but tremendous current flows away from that point in all directions through the earth and all other possible paths. If the stroke occurs to or near a buried cable, the cable will, therefore, carry away a large proportion of this current in both directions. The higher the earth resistivity, the greater is the distance along which this current will be carried by the cable sheath. If the current flowing along the sheath is large enough, the drop of potential due to the resistance of the sheath may result in building up sufficient voltage between it and the wires inside to break down the insulation and in some cases cause holes in the sheath so that the cable has to be dug up and repaired. The insulation may be punctured in various places over an interval of several miles, or the damage may be confined to one location. Probability of damage to a buried cable can be reduced by decreasing the resistance along the sheath.

The relationship between earth resistivity and the geological structure of the United States has been the subject of considerable study by the Bell System. From this study a very good general knowledge of the earth resistivity which may be expected in any area has been obtained. By means of these data on earth resistivity, and information obtainable from iso-ceraunic charts, which show the frequency of thunder storms in all sections of the country, it is possible to predict in a general way the relative amount of trouble from lightning which might be experienced with buried cable in any particular region.

The engineering work on the transcontinental cable, accordingly, included a careful investigation of the route from this standpoint, with the help of these charts and of accurate field measurements of the earth resistivity at intervals along the route. Based on the data thus obtained, pro-

AN "UNATTENDED" REPEATER STATION

This structure at Durham, Wyo., is typical of those built at intervals on the cable route. They house the delicately attuned equipment required to amplify the currents as they become attenuated along the line. The apparatus is designed to operate for considerable periods without direct attention, control circuits to the nearest attended station indicating any need for testing or trouble clearance

tective arrangements against lightning damage were designed for the cable.

These arrangements vary in the different sections, but include such plans as increasing the insulation between the core and the sheath by doubling the thickness of the paper wrapping of the core, placing copper shield wires in the same trench with the cables, or adding copper wires between the sheath and the core, and combinations of these measures. For example, in a section east of Cheyenne, and from Cheyenne to Denver, shield wires are buried in the trench with the cables. Going west from Cheyenne the earth resistivity increases rapidly, reaching the highest value on the entire route over the outcropping granite formations of Sherman Hill Divide. Between Cheyenne and Laramie, therefore, various combinations of the preventive measures are being used, all three being employed over Sherman Hill Divide.

Gophers Attack Buried Cable

WHILE it might not seem that an asphalt-coated, jute-wrapped, lead-covered cable would make a palatable meal, the gophers and prairie dogs in many mid-western states feel otherwise about it. It has been found that if the opportunity is presented, they will attack the covering vigorously, finally chewing through it to the conductors and thus causing service interruptions. In cables maintained under gas pressure, puncturing the sheath would of course release the gas. Studies of the habits of the pocket gopher, for instance, have shown that he operates in a zone from 12 inches to 48 inches below the surface of the ground, and prefers soil which has been loosened, as by plowing. To prevent trouble from this source, a steel tape about an inch wide and $\frac{1}{100}$ inch thick, referred to as "gopher tape," is being placed around each of the transcontinental cables, directly over a paper asphalt pad wrapped around the lead sheath, during manufacture. The protective jute or thermoplastic covering is placed over the gopher tape.

Repeater Stations and Equipment

The use of K carrier telephone systems utilizing frequencies up to 60,000 cycles per second requires repeaters spaced at intervals of about 17 miles to compensate for the transmission loss experienced at these frequencies. Between Omaha and Sacramento, there will be a total of 100 repeater stations, 18 of which are classified as main stations and 82 as auxiliary stations. The main stations, many of which are already repeater stations on open wire lines, will serve as points from which testing and trouble clearing will be directed.

In general, the main stations will be attended, the auxiliary stations unattended. These auxiliary stations have been designed to house the necessary equipment, including repeater, testing, power, heating, and ventilating apparatus. Where the climate is relatively mild and electric power is available, electric heaters will be used to maintain a temperature of at least 40 degrees in winter. Electrical ventilating equipment will operate automatically in hot weather to aid the efficient operation of the equipment. The auxiliary stations to house this equipment are 24 × 24 feet in size.

For use where commercial power is not available, or a higher heating capacity is required, a new oil-burning plant has been engineered. This will require a building 20 × 40 feet in size. The six auxiliary stations between Omaha and Grand Island will be 24 × 24 feet in size, but the stations from Grand Island to Salt Lake City will be of the larger size to accommodate the oil heating plant. Beyond Salt Lake City, the plans for the auxiliary stations have not yet been completed.

The locations of the stations are chosen carefully to be accessible from good roads and as close to existing sources of electric power as practicable and, at the same time, to be consistent with the desired repeater spacing. The power plant, being vital to the operation of the station, is engineered to be as free as possible from danger of interruption. In all stations, large size rubber jar batteries are used which will provide a considerable initial reserve. Where commercial power is not readily available, economic studies are made to see whether it would be better to pay for the extension of power lines, or to provide engine-driven power plants.

Where commercial power cannot be obtained economically, twin engine-driven d-c generators, arranged to operate automatically and alternately, are provided. The accessibility of the station and other factors determine whether or not emergency engine-driven charging equipment will be provided. Where a number of stations are easily accessible, it is often preferable to provide a few portable emergency engine-driven alternators which can be readily moved to any station.

The Pacific Telephone and Telegraph Company has a unique problem of snow sometimes as much as 25 or 30 feet deep on the cable route over the Sierra Nevada near Donner Pass. It is considering constructing two-story stations, with first and second floor and roof entrances, so that maintenance men can get into them, whatever the depth of the snow. Oil heat is also being considered for these stations.

THE emigrants, intensely individual and with a restless urge to move westward, nevertheless retained a strong desire to maintain communication with people behind them. This desire was first met by the overland mail and the Pony Express. Later, the telegraph, the railroad, and finally the telephone came into being. Utilizing these instruments for communication, these individuals and their descendants became welded into a strong and unified nation.

Today we are engaged in a supreme effort to arm and defend that nation. More transcontinental communication facilities are urgently needed to help direct this effort.

That plow train, moving steadily westward, with all the research, experience, and modern engineering of the Bell System behind it, is forging a vital, powerful link in the machinery for the defense of America.

APPROACHING MOUNTAINOUS COUNTRY

This is typical of much of the terrain which the cable crosses. The view here is westward in the direction of Evanston, Wyo.

THE 1941 CONVERTIBLE BOND ISSUE

Funds to Provide for Bell System's Construction Program Obtained by Offering of $233,584,900 of Fifteen Year Three Per Cent Convertibles to 631,030 Holders of A. T. & T. Stock

By JAMES F. BEHAN

By means of a prospectus dated July 16, 1941, the American Telephone and Telegraph Company offered to stockholders for subscription at par, without underwriting by bankers, $233,584,900 Fifteen Year 3% Convertible Debenture Bonds Due September 1, 1956, convertible into stock after January 1, 1942, at $140 per share. The bonds will be convertible through 1954 unless previously called for redemption, but the conversion price and the number of shares issuable on conversion are subject to adjustment in certain events. Under the terms of this offer, which was in the ratio of $100 principal amount of bonds for each eight shares of stock held, 631,030 stockholders of record became entitled to receive 18,686,794 subscription rights, one for each share held.

"One of the biggest jobs that Wall Street's trading machinery has tackled in a decade or longer got started Wednesday." Such was the comment of the *Wall Street Journal* on the start of market trading in the rights on July 16. For the Company, however, the issue of the offering prospectus, which permitted trading in rights to begin, represented the culmination of weeks of work.

Tentative preparations for a convertible bond offer had been started in the Comptroller's, Legal, and Treasury Departments and in the Secretary's office during the early spring. The first concrete step, however, was the submission of a proposed Proxy Statement to the Securities and Exchange Commission early in May, 1941, to provide for a possible meeting of stockholders for the purpose of authorizing such an offer. Thereafter, it was a question of working early and late on the mass of detail involved in bringing the project to a successful conclusion. The rigid time-table of printings, SEC filings, executive actions, and stockholder mailings was no respecter of persons. On many occasions lights were kept burning long into the night at 195 Broadway, such as when the Comptroller and those associated with him in preparing the Registration Statement and Prospectus were faced with an important date in the SEC filing schedule.

At the annual meeting of stockhold-

Special Training

The Treasury Department's supervisor of methods explains things to one of the groups receiving two weeks of preparatory instruction

ers in April, President Gifford had announced that, due to the growing demand for telephone facilities resulting from the national defense program, construction requirements in the Bell System for 1941 would approximate $400,000,000 and that some financing would be necessary to meet these requirements. On May 21 the Board of Directors took action, recommending that the financing be undertaken through a convertible bond offer and calling a special meeting of stockholders for June 25 to act on the recommendation. Nearly two-thirds of the stockholders were represented at this meeting, either in person or by proxy, and over two-thirds of the outstanding stock was voted in favor of the offer.

Securing the return of sufficient proxies to be sure of the necessary two-thirds favorable vote of the stock required to authorize the proposed issue presented somewhat of a problem, not because any appreciable number of stockholders objected to the Company's financial program but because people in general—and A. T. & T. stockholders constitute a good cross-section of people in general—are apt to postpone or overlook action on propositions put up to them in proxy statements, if they appear at all complicated. However, stockholders responded promptly to telephone calls about having their stock represented at the meeting and also to a short follow-up letter, which President Gifford sent out about two weeks after the proxy statements were mailed. This special mailing, which involved the printing, numbering, and addressing of a duplicate set of 630,000 proxy forms for the entire stock list, established a time record for that type of work. The mailing was in the post office five days after executive decision to make it. Shares voted against the issue added up to less than one per cent of the stock outstanding.

An unexpected misconception of the

EARLY ACTIVITY

This was one of three groups which enclosed the Prospectus and President Gifford's letter for mailing to stockholders last July

Company's proposal developed in the minds of quite a number of stockholders at the time proxies were solicited, and was encountered again during the subscription period. The fact that the management was recommending an issue of *convertible* debenture bonds led some people to think that they would have to convert their present shareholdings of stock into the new bonds. Naturally, they were not in favor of doing this; but later one or two stockholders did go so far as to send stock in for exchange, in the belief that the Company desired it.

In response to an inquiry at the special meeting of stockholders as to why the management had not decided on an offer of stock instead of convertible bonds, President Gifford stated:

"We anticipate that we shall need a great deal of money this year and next year and probably the year after that. We don't try to go too far into the future. This issue, if successful—and of course it will be—will give us $234,000,000, roughly, in the fall.

"Now, if we want some more money next year, and we will want more at the rate we are going, if the convertible bond issue is used, we shall get, if the conversion rate were $150—it hasn't been fixed yet—another $100,000,000 next year or the year after, or whenever the conversion privilege was exercised.

"In other words, we would have raised not only $234,000,000 but something over $300,000,000 by this method. If we raised it all by a stock issue at one time, we would have this larger amount of cash to carry with no return on it and we would receive it sooner than we need it."

Because of its size and the number of stockholders involved, the issue attracted wide attention throughout the financial community and the three per cent interest rate, coupled with the fifteen year maturity, was generally commended. The following comment in the *New York Journal of Commerce* of June 26, 1941, was typical of early predictions of success for the issue: "While investment bankers hold firmly to the more or less occupational thesis that every issue should be underwritten, it is readily conceded that in the case of Telephone it matters little to the company."

Nevertheless, in the light of the uncertain times which the nation faced in July, and still faces, no one could feel completely sure about an offer of bonds to stockholders which necessarily had to remain open for subscription for a month and a half after the terms were set. Fortunately, the market quotations for stocks as well as for bonds held moderately firm during this period. The price of A. T. & T. stock slid off a bit under pressure of the new financing, but rights to subscribe for the Convertibles never sold on the New York Stock Exchange below $1\frac{7}{32}$ ($1.21875) and the closing price on the expiration date, August 29, 1941, was $1\frac{18}{32}$ ($1.5625), the high for the period. Since eight rights were required to subscribe for each $100 of bonds, these prices for rights represented an equivalent low for the bonds of $109\frac{3}{4}$ and an equivalent high of $112\frac{1}{2}$. At $109\frac{3}{4}$ the investment

Subscribing in Person

The Treasury Department established a temporary counter in the lobby of the A. T. & T. building for the convenience of people wishing to make subscription personally yield on the bonds to the earliest call date at par in 1953 was 2.08 per cent.

Under these price conditions, a full subscription for the offer was assured if stockholders took care to exercise their rights or to sell them in the market for others to exercise within the allotted time. As the expiration date approached, this remained the only uncertainty. Not until the final closing, however, could the Company determine to what extent stockholders might be overlooking the value of their rights.

95.4 Per Cent Subscribed

Up to Wednesday night, August 27, subscriptions for only $65,000,000 of bonds, or 28 per cent of the amount offered, had been received. By the close on Thursday but 4 per cent more had come in. This meant that some $135,000,000 additional had to be subscribed by Friday, the final day, if the offer was to be as much as 90 per cent taken.

It had been publicly announced the day before that subscriptions placed in the mails in continental United States up to midnight on August 29 would be accepted if they conformed to the terms of the offer as stated in the Prospectus. How many subscriptions would be in transit, unreceived, when the offices closed at midnight Friday, it was not possible to say; but smiles were plentiful around the Treasury Department that evening, when the day's bank deposits were totalled up and found to approximate $139,000,000.

After everything had been received and accounted for and all pending cases disposed of, the books showed

Principal amount of bonds offered		$233,584,900
Amount of bonds subscribed		$222,745,200
Per cent subscribed		95.4%
Amount of bonds unsubscribed		$10,839,700
Shares of stock outstanding on record date		18,686,794
Rights required to subscribe for $100 of bonds		8
Price range during subscription period:		
Stock—Ex Rights—	High	155 7/8
	Low	152
Rights—	High	1.5625
	Low	1.21875
Bonds—	High	112 5/8
	Low	110
Stockholders on record date		631,030
Approximate number of subscriptions *		116,000
Average principal amount offered per stockholder		$370
Average principal amount per subscription *		$1,921
Subscription warrants issued, including transfers		1,030,000
Incoming Bond Issue letters		170,000
Bond Issue telephone calls		17,000

* In these figures a group subscription by a bank or broker for its customers is counted as one subscription since it was recorded in the bank or broker's name.

$222,745,200 of bonds subscribed for, representing 95.4 per cent of the amount offered. This result stamped the financial operation as a complete success.

Some interesting statistics are shown on the opposite page.

It would be natural to ask why only 95.4 per cent of the convertible bond offer was subscribed; why stockholders allowed 867,000 rights, with a market value of roughly $1,350,000, to go unused, notwithstanding the demand in the market and the high closing price. Current unfamiliarity with subscription rights is believed to have been the chief reason for the amount left unsubscribed—although correspondence after the close of the issue indicated that "absence from home" because of vacations, illness, etc., was also a factor. Eleven years had elapsed since the last subscription offer by the Company, with the result that some 380,000 stockholders, representing 60 per cent of the total, had never before had A. T. & T. rights to deal with.

Pursuant to a supplement to the Prospectus, the Company has sold the unsubscribed portion of the issue, amounting to $10,839,700, on the various stock exchanges through member firms of such exchanges, who received for their services only the regular brokerage commission.

Bankers Trust Co. Aids Stockholders

In previous issues of stocks or convertible bonds, stockholders could buy and sell rights through the Bell Telephone Securities Company. Similar arrangements made for this issue with Bankers Trust Company adequately replaced these facilities. In fact, transactions handled for stockholders by Bankers Trust Company exceeded those handled by the Bell Telephone Securities Company in past issues, as indicated in the table below.

These figures demonstrate the unquestioned need for the provision of some such facilities for stockholders. An offering on a one-to-eight basis meant that 250,000 stockholders, scattered throughout the country, would receive fractional warrants only (that is, warrants for less than the number of rights required to subscribe for a $100 bond), and that 325,000 additional stockholders receiving full warrants would also receive fractional warrants which they would have to sell or match up with additional fractions if they were not going to allow them to lapse.

The Bankers Trust arrangement, and the modest agency charge of five cents per right for buying and selling made by the bank, proved entirely satisfactory to stockholders. The bank's personnel could not have been more

	Rights Bought	*Rights Sold*	*Total Transactions*
Bell Telephone Securities Company:			
1928	234,000	341,400	121,700
1929	275,600	927,400	154,500
1930	181,000	513,800	156,100
Bankers Trust Company:			
1941	303,000	2,352,500	216,700

enthusiastically coöperative than they were with the Company's bond issue organization. More than 200 of the bank's employees received advance instruction so that they could take part in the work whenever the daily volume of transactions required it, and the entire ninth floor of the bank's head office building at 16 Wall Street, along with special counter space on the ground floor, was given over to the rights job. According to an article which appeared in the Bankers Trust magazine, *Pyramid,* they developed unique names for some of their specialists. File girls wearing aprons became "Flower Girls." Girls cutting checks apart with knives became "Check Butchers." Men rubber-stamping warrants became "Pounders." Girls photographing warrants became "Shutter-Bugs," and the man in charge of supplies became "The Green Grocer." President S. Sloan Colt's message in the *Pyramid,* reprinted below, indicates that almost everyone in the bank was in one way or another affected by the operation.

"We are within four days of the completion of the rather unusual piece of work which Bankers Trust Co. has had the opportunity of doing for the Stockholders of the American Telephone and Telegraph Company in acting as Agent for buying and selling rights issued in connection with the recent bond issue. As the Pyramid goes to press tonight, I want to congratulate those who planned and carried out this unique service with such efficiency and enthusiasm. I have heard nothing but the most favorable comments from the public whom we have served.

"Nearly everybody in the bank was directly or indirectly affected by this operation and I want to

Telephone Traders at Bankers Trust Co.

These men kept in touch with the market in rights in New York and other cities

Permanent Records

Micro-film cameras were used to photograph documents covering transactions handled at Bankers Trust Co. Similar equipment was used in Treasury Department operations at 63 Wall Street and 195 Broadway

thank the entire staff for the splendid coöperation which made possible the success of the undertaking."

As well as being of convenience to stockholders without banking or brokerage facilities, the arrangement with Bankers Trust Co. helped solve the problem of how to dispose of the rights of nationals of "blocked" countries. At the time of the offer, 2,100 of the Company's stockholders resided in blocked countries into which it was illegal to send the rights, and another 1,300 resided in other places outside of continental United States where it would have been impracticable to mail warrants because of the time factor. To protect their interests, all these stockholders were sent special notices stating that their rights would be sold for their accounts through Bankers Trust Co. on the expiration date, if they had not previously arranged with the Company for the exercise or disposal of the withheld warrants.

Approximately 116,500 rights were delivered to Bankers Trust for sale for stockholders' accounts under this arrangement. A similar disposal was made of warrants for 4,100 rights which for one reason or another were not deliverable to domestic stockholders. In the case of nationals of blocked countries the proceeds had to be credited to blocked accounts in domestic banks for such final disposition as the laws and regulations of the United States might permit.

One of the early concerns of the Treasury Department was settled by the discovery in May that 36,000 square feet of excellent office space for the bond issue work could be rented in an office building at 63 Wall Street. This space, located on three adjoining floors, was already equipped with Holmes-protected vaults and it was otherwise ideally suited to house the large organization which would be needed. Additional space was also required at 195 Broadway, and a special subscription counter was set up in the lobby of the building, where, of course, the larger subscriptions were filed by bankers and brokers. As in past offers, subscriptions were also received at the Treasurer's office in Boston.

Equipment and Organization

To equip the temporary quarters, some 2,000 pieces of furniture and miscellaneous office equipment were needed, much of which was rented, or borrowed from other companies.

The growing scarcity of materials and equipment presented a problem which had not been encountered by the Department in organizing for previous offers to stockholders. This meant anticipating requirements further in advance, and more careful planning all around.

For example, the paper required for the Prospectus amounted to more than 150,000 pounds—enough to fill five freight cars. The mills which specialize in the type of paper to be used were unable to supply this large quantity within the time limits available, and it was necessary to have the paper manufactured to a special formula by a regular book-paper mill. More than 650,000 copies of the Prospectus were printed on the first run. To meet the schedule of six days for the printing and delivery of such a large quantity, the job had to be done by two printers and involved the use of 17 presses. It was the same story for the Prospectus envelopes. Since no one manufacturer could deliver the required 630,000 envelopes when needed, the order was placed with three envelope manufacturers, and three different grades of paper had to be used.

Manufacture of the subscription warrants to be mailed to stockholders presented another interesting problem. More than a million warrants were needed in the initial order, and 14,500 pounds of special paper had to be milled in advance for this purpose. For numbering and final printing of terms on the warrants, it was necessary to install at 195 Broadway eight printing presses and one power cutter. These presses were operated from 16 to 20 hours a day for a period of eight days.

VISITORS to the temporary quarters at 63 Wall Street were particularly interested in the number of stages through which bond subscriptions passed. By reason of the volume and nature of the work, a step-by-step process was used which involved a dozen or more separate operations. During one of these steps a "micro-picture" of each subscription and accompanying remittance was made by Recordak for record purposes. This machine took small pictures on a continuous film, and had self-contained equipment for projecting full-size enlargements of the material photographed.

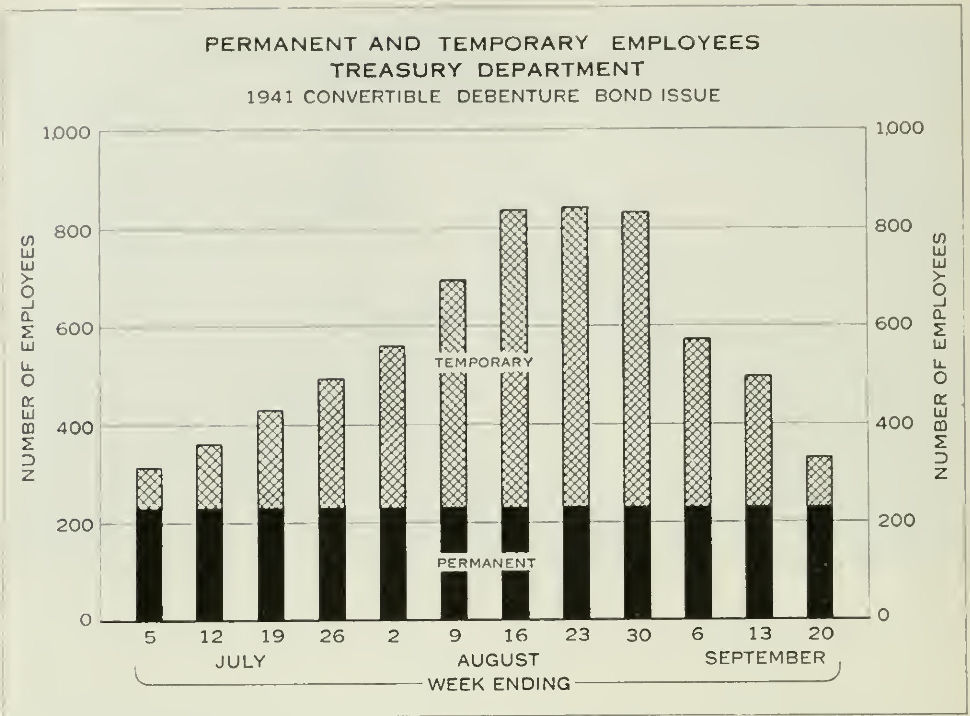
A favorite picture to show visitors

TEMPORARY PRINT SHOP
These presses were installed in the A. T. & T. building in connection with final printing of the warrants

in demonstrating this equipment was one of a cashier's check which had been received from a small country bank to cover a $700 subscription but which, by a slip of the check-writer, had been written for $1,000,700. Needless to say, the check was returned for correction. A large number of checks received, many from banks, had to be returned because of being incorrectly written or unsigned. If one of the amounts on a check was correct, however, and the other was not more than $200 or $300 off, the check was put through for clearance with a certification by the Company as to the correct amount.

Because the long-distance wires are important to the speeding-up of the nation's defense program, the communications bureau at 63 Wall Street, which was receiving about a thousand letters per day to answer, did not make use of out-of-town telephone calls as frequently as it otherwise would have done. All told, telephone calls about the offer, both incoming and outgoing, exceeded 17,000. Some were quite amusing. In one instance, where a telephone call was put through to an out-of-town bank to inquire if it would honor an unsigned check which it had mailed in as a subscription payment, an urgent request came back to deposit the check by all means, because it was intended to cover a subscription for the president of the bank and it would be very embarrassing to the cashier to have the check returned for correction. The telephone, in many cases, offered the only way to get a subscription matter straightened out in the time available.

All together, some 430,000 temporary bonds were issued to cover subscriptions received. Of these, ap-



proximately 134,000 pieces, representing $131,000,000 in bonds, were delivered over the counter to banks, brokers, and other large subscribers direct from space temporarily assigned to the Department in the offices of the City Bank Farmers Trust Co., Trustee of the issue; and deliveries of another $19,000,000 of bonds were made over the counter at 195 Broadway. The remaining bonds, consisting largely of $100 and $500 denominations, covering some 110,000 subscriptions, were sent out by registered mail. A new process was developed for addressing the envelopes used for this delivery, which consisted of cutting and pasting a carbon copy of the subscription register on the mailing envelope to indicate the subscriber's name and address and covering this with a transparent piece of tape. More than nine miles of this protective covering were used before the last bond was on its way.

It is said around the Treasury Department that almost anything can happen during a subscription offer. The idiosyncracies of stockholders which come to a focus on the Company at such times provide many surprises. For example, one subscriber to this issue sent in only the lower half of her warrant, which provided for the subscriber's signature, having torn off the upper half, which showed such essential information as the number of rights it represented and the name of the holder. She later explained by telephone that she wanted to keep this upper half as a record of the transaction and as a receipt. Strange things happened in the bond issue organization itself, such as a temporary employee's getting lost and going to work in the wrong section for one supervisor while another supervisor was anxiously awaiting her arrival. But incidents of this sort were of no importance compared with the balancing out to the penny of the bank account through which $223,000,000 in subscription remittances had been cleared, or with the full accounting for more than 430,000 bearer bonds upon completion of bond deliveries.

The out-of-pocket cost of the bond issue to date, excluding the exchange of temporary for definitive bonds, to take place next year, has been approximately $1,000,000. Much of this expense, such as the Federal stamp tax of $257,000 and the fees for registration, listing, and authentication of the bonds, would have been the same for a public offering of the bonds through underwriters.

OUT of a total of 625 employees in the bond issue organization at the peak of the work, 496 were temporary employees, the balance comprising regular employees of the department or employees borrowed from other Bell System organizations—of whom there were seventy-six. To secure the required number of temporary employees, over 1,500 applicants were interviewed. Of the number engaged, 283 were either college or post-graduate students representing 105 colleges and universities. In addition, 50 high school and college instructors were engaged for the summer recess. These employees adjusted themselves to a new environment and to unfamiliar work in a most gratifying manner.

Most of the new people were given a short training course in order to familiarize them with the background of the Bell System, the bond issue organization, and the terms of the offer. In addition, certain groups were given specialized courses involving the handling of correspondence, the acceptance of counter subscriptions, the allotment and mailing of bonds and various machine operations. These training courses involved a total of 8,200 employee hours and without doubt helped the employees to adapt themselves quickly to the work.

In order to get a picture of the spirit and efficient operation of the bond issue organization it was only necessary to walk through the offices and see the interest which employees took in their assignments, although at times these had to be long and hard. Saturdays and Sundays were like any other days when there was work to do or a schedule to be met. It is not possible to speak too highly of the way in which both temporary and permanent employees applied themselves to the work or of the example set by their supervisors.

THE TELEPHONE AFLOAT

Through 24 Shore Stations on Our Coasts and Inland Waterways, More Than 3,000 Vessels Can Communicate Readily by Radio Telephone with the Bell System's Telephone Network Ashore

By GAIUS W. MERWIN

With more than 3,000 vessels equipped with radio telephones which have immediate access to the 23,000,000 Bell System and connecting telephones in the United States, the telephone afloat is indeed an important factor in the life of those who go down to the sea in ships. Ship telephone service has taken its place as a regular Bell service since its inauguration to ocean-going liners in 1929 and to smaller coastal and harbor vessels in 1934.

Today, due to the war, most of the liners which had been equipped with radio telephones are either serving as troop transports, are tied up idle at their docks, or have been sunk in the service of their country. Thus, telephone service to these large ships must wait until peace reigns again. On the other hand, telephone service to boats in harbors, along our coasts, and on the Great Lakes has continued its rapid growth, from the standpoint both of boats equipped and of number of messages handled.

Ship telephone service through the coastal harbor shore stations of the Bell and connecting radio telephone companies is available to ships in the coastal and inland waters of the United States.

Starting with the first Bell System coastal harbor radio telephone shore station, which was opened for commercial business at Marshfield, Mass., near Boston, on July 1, 1934, by the New England Telephone and Telegraph Company, a whole chain of radio telephone shore stations serving the nation has come into being in recent years. In addition to the Boston station, which serves New England waters, the Atlantic coast line is dotted with a series of stations which include New York (two stations), Wilmington, Norfolk, Charleston and Miami. Ships plying the waters of the Gulf of Mexico are served by shore stations at Tampa, New Orleans, and Galveston. Similar service is available on the Pacific coast, as ships can talk at any time to homes and offices through the shore stations located at San Pedro, San Francisco, Astoria, Portland and Seattle. Of these fifteen Bell stations, Wilmington, Charleston, Tampa, and Galveston started service in 1940, and an additional channel was

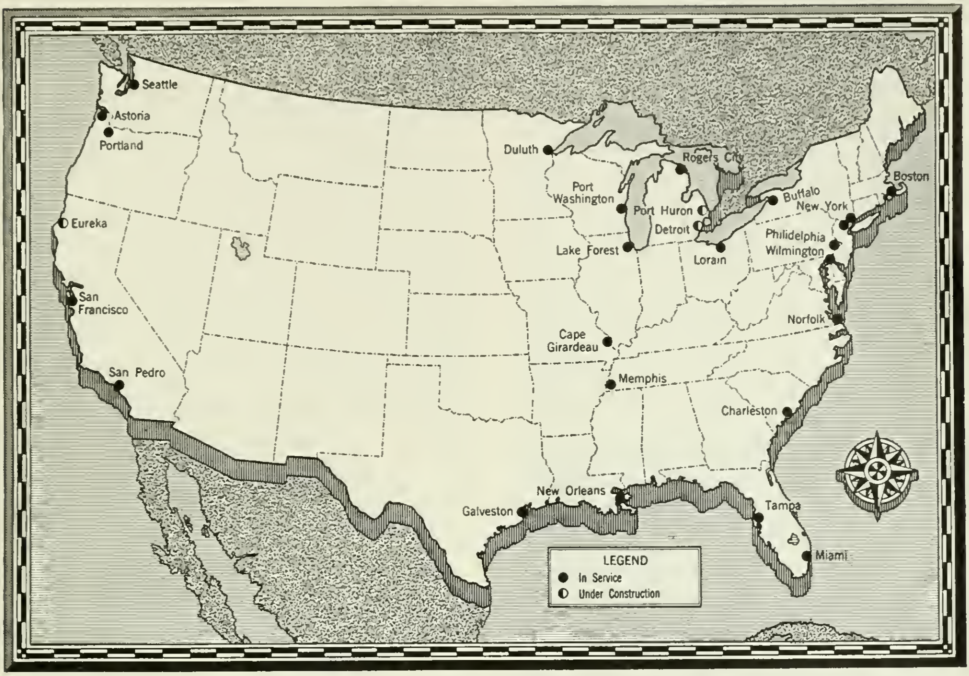


Figure 1
Shore stations of the coastal and harbor radio telephone service

also added to one of the New York stations last year. New stations at Astoria and Portland were opened in February, 1941, and others are under construction at Eureka, California, and at Detroit and Port Huron, Michigan.

Figure 1 shows the location of all these Bell radio telephone shore stations, and also shows those which have been provided by connecting radio telephone companies for serving boats on the Great Lakes and on certain rivers. These connecting-company shore stations are located at Buffalo, N. Y.; Lorain, O.; Rogers City, Mich.; Lake Forest, Ill.; Port Washington, Wis.; Duluth, Minn.; Philadelphia, Pa.; Memphis, Tenn.; and Cape Girardeau, Mo.

All these shore stations serve as connecting links between the land telephone lines and the various vessels as they ply the waters of our coasts and inland seas. A call from a boat goes by radio to the radio telephone shore station desired, where it is picked up and placed on the wire lines of the Bell System and its connecting companies, and the making of such telephone calls becomes as much a matter of daily routine as the land telephone service used every day.

Operation of the Service to Ships

Figure 2 shows the Wilmington transmitting station, and Figure 3 shows the Tampa receiving station, which are good examples of the more recent shore station installations. These radio telephone transmitters and receivers are connected by wires

to the telephone company operating rooms.

Such radio equipment does not require constant attendance, but in many cases is remotely controlled from the telephone company's operating rooms, which may be miles away. To place a call from a land telephone, all that one has to do is to ask for the marine operator, or under certain conditions give the details of the call to the toll operator. The telephone company marine operators keep in touch

FIG. 2. *The radio telephone transmitting station at Wilmington, Del., for coastal and harbor service*

with the various boats, and, in case one is not sure as to the location of the particular vessel desired, will place the call through the shore station which appears to be nearest the ship at the time of the call. In order to bring down the cost of providing service to ships and to give the best possible service, the calls are generally handled by regular traffic operators, with technical radio men always on call if anything goes wrong with the automatic features of the system.

THE operating facilities at the marine positions of the telephone switchboards are relatively simple, consisting of an arrangement of jacks and lamps associated with the radio transmitters and receivers. No special key shelf arrangements are required, except the provision of a dial where this is not already provided for other purposes.

Vessels may be equipped with selective signaling apparatus, which rings a bell on the ship when the shore station operator wishes to call it. Ships not equipped for selective signaling are called by name following the operation of the cord circuit ringing key at the marine position which transmits a distinctive attention signal For both selective and non-selective signaling, a boat will receive notification of a call only when its set is adjusted to the particular frequency of the radio terminal office which is calling. With the set so adjusted, a bell will ring on a ship equipped for selective signaling, and the attention signal followed by an announcement that a given ship is being called will be heard in the loud speakers of all ships not equipped for selective signaling.

The radio telephone sets used on

boats for talking with the shore are in all cases provided by the owners of the boats. More than 20 different concerns are building various types of boat sets, most of which vary from 10 to 100 watts in power. Some of these sets cost as little as $200 to $300 installed; although where boats need fairly long haul communication, the sets may cost $1000 or more, depending upon the type and power of the set, the number of frequencies available, etc. As shown by Figure 4, the smaller radio telephone sets do not take up much more room than a medium sized home broadcast receiver.

Actually this Western Electric set shown weighs 33 pounds, and is only about 13 inches in length—which is its greatest dimension. It is arranged for four different frequencies, so that without changing the crystals one can talk to two different shore stations, on the boat-to-boat frequency, and to the Coast Guard, which may be reached when assistance is needed. The hand telephone provided with the set has a press-to-talk switch in the handle. In a larger set such as shown in Figure 5 and having a power of 100 watts, space is provided for ten different frequencies, and voice-operated relays are included which eliminate the need for a press-to-talk switch. Figure 6 shows the ship telephone used as a part of this set.

Two classes of coastal and harbor radio telephone service are offered through the Bell System shore stations: general service and dispatching service.

General service covers random calls between any land telephone and any suitably equipped vessel or between two vessels. The rate for the radio link includes a connection with any telephone within the designated local service area of the radio terminal office, and in some cases within a certain zone along the shore. Where points on land outside this area are involved, an additional charge for the land portion of the call is added to the radio-link charge.

Dispatching service is intended for communication between vessels of one customer and one or more designated

Fig. 3. *The radio telephone receiving station at Tampa, Fla., for coastal and harbor service*

FIG. 4. *This ship's radio telephone set, made by the Western Electric Company, provides conversation channels on four frequencies*

telephone stations of that customer on land, as for instance, between the dispatching office of the owner of a fleet of tow boats and such boats. The radio-link message charge for this service is lower than for general service, but the customer guarantees a certain amount of message revenue each month.

Growth of the Service

SHIP telephone service has shown a rapid rate of growth, as is shown in Figure 7. From 100 boats in 1936, the number of vessels equipped with radio telephones registered for Bell System service had grown to about 2,500 at the end of 1940, and there are now more than 3,000 boats equipped. Along with the marked increase in the number of boats equipped with telephones has come a very rapid increase in the number of radio telephone messages handled, as is also shown in Figure 7. In 1940, the number of these ship telephone messages handled through the Bell System shore stations was in excess of 50,000, or more than double the number handled in 1939.

When we speak of radio telephone service to ships, we can think of service to practically any kind of a boat that floats. The boats listed for telephone service include not only small fishing craft and pleasure craft, but also the largest commercial vessels. The illustrations on pages 240 and 241 show examples of some of the widely different types of boats which are equipped with radio telephones.

About 1700 yachts and pleasure craft are equipped with radio telephones. Being able to keep in touch with home and office by telephone has enabled many a yacht owner to enjoy extra days afloat. In case of a breakdown of any kind, aid can be summoned in short order and anxious hours avoided by those on shore. As a matter of fact, just the safety factor of being able to call for assistance has caused many a private boat owner to equip his yacht with a telephone.

The need for communication is present in all undertakings, and in the case of dredges, which are constantly at work on our harbors, canals, and rivers, the telephone is of constant aid in calling for an additional scow, or, when there is some breakage, in calling some nearby city so that the parts needed may be dispatched at once and little time lost in keeping the channel clear. The towing companies find that equipping their tug boats with radio telephones saves them much time in giving instructions as to picking up new tows. When a tow gets into difficulties, aid can be quickly summoned by telephone, and many a tow has been saved from loss by such a call for aid.

Another commercial use for the radio telephone has developed within the last year or so. In the constant search for petroleum, a new oil field has been located under the swamps and waters of southern Louisiana, and

FIG. 6.
This is the ship's telephone for use with the set shown below

a number of the large oil companies located in the area make frequent calls through the telephone company's shore station serving the Gulf coastal area.

Furnishing Weather Reports

IF a boat owner wants the latest weather report, he can get it from the telephone company, since twice a day the various shore stations send out weather reports on their regular shore-to-ship frequency. The weather reports are prepared especially by the United States Weather Bureau for the Coast Guard, with reports on wind and sea conditions. A typical report follows:

> "This is the New York Marine Operator. Notice to all vessels. The following marine information was obtained from the United States Coast Guard at New York.
>
> "United States Weather Bureau information—Forecast for southern New England and New Jersey coasts—Diminishing northwest winds this afternoon, clear this afternoon, increasing cloudiness Thursday.
>
> "Sandy Hook observation 10:00 A.M. Eastern Standard Time—Barometer 30.12 inches falling, temperature 68 degrees, wind west 9 miles steady, sea slight, visibility 3 miles, weather clear with light haze."

The Coast Guard include with such weather information reports as to derelicts or other obstructions to navigation, and the whole report is sent by the Coast Guard to the telephone company by teletypewriter over wires furnished for this purpose. As a further service to the boat owners along our coast, when storm warnings are received such warnings are given out by the shore stations upon receipt and

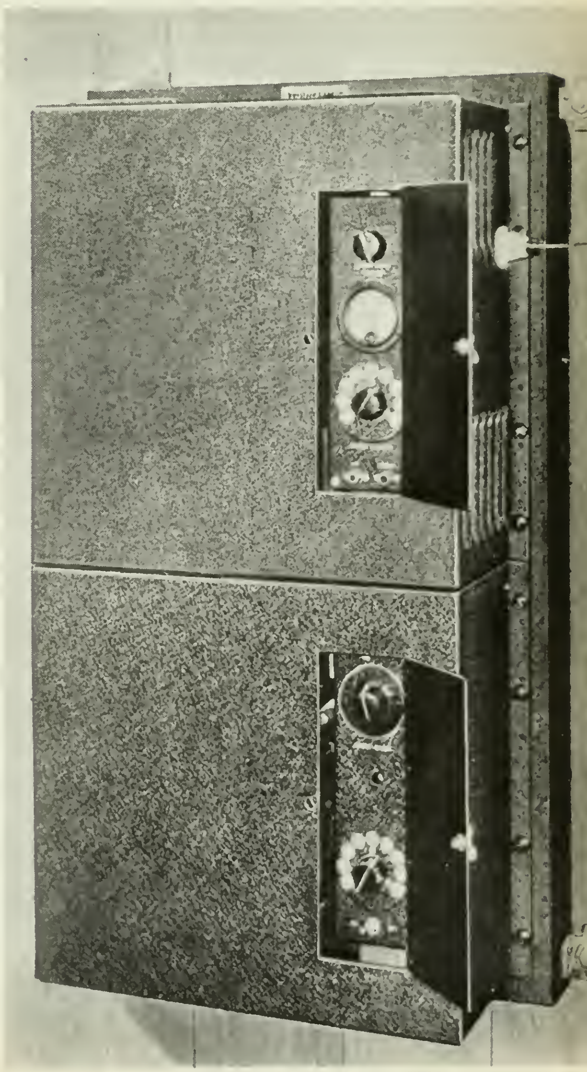


FIG. 5. *This larger Western Electric equipment has 100 watts' power, and provision for ten frequency channels*

Working Vessels

Ferry, tug, dredge—these are typical of the boats with jobs to do whose owners find radio telephone service an aid to efficient operation

Pleasure Craft

Lone Wolf, *above, and* Wakiva, *below, are among the 1700 now radio-telephone equipped*

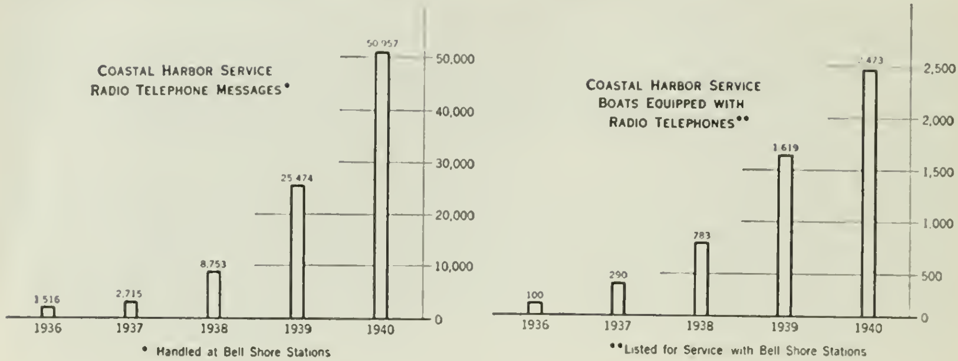


Figure 7

These charts illustrate the increase in use of the coastal and harbor radio telephone service

at two hour intervals up to the time of the next weather report. Furthermore, if a boat owner has failed to receive the regular weather report, he can call the nearest shore station and for a small charge the weather report will be given to him by the telephone company's operator.

Before a ship's radio telephone set can be operated, the owner of the vessel has to secure a ship radio station license from the Federal Communications Commission, and the owner or some one on the boat must have also a Restricted Radio Telephone Operator Permit—or higher grade radio telephone operator's license. To obtain a restricted permit requires only a knowledge of the principal laws and regulations relating to the operation of this type of radio equipment, and enough instruction to operate the radio equipment.

The fifteen Bell System shore stations on our two coasts and the Gulf of Mexico give a coverage of practically our entire coast. Like the wire telephone plant, the radio plant is being constantly extended to meet the service needs of the public. However, it can now really be said that vessels along our coasts can talk at practically any time to any shore telephone just about as easily as we can talk to any of the 23,000,000 telephones in the United States. Thus, from the original aim of the telephone business of connecting all land telephones of the nation, the horizon for telephone service has been pushed out further and further, not only to reach all continents but also to serve those who travel by water as well as by land. Service to ships is simply another step in carrying out the aim of making telephone service available "anywhere."

PATENTS AND FREE ENTERPRISE

Comments on Monograph 31, Prepared for the Temporary National Economic Committee, and on the Relationship between the Patent System and Business and Industry in the United States

By WILLIAM R. BALLARD

One of the important subjects covered in the investigations of the Temporary National Economic Committee (often referred to as the Monopoly Investigation) was the use of patents in American industry. In addition to testimony at open hearings where views pro and con found expression, the Committee printed and distributed a large number of "Monographs" in the nature of ex parte *statements by various individuals. One of these, Monograph No. 31, is entitled "Patents and Free Enterprise." The following article discusses the same subject, using that Monograph to some extent as a text.*

MONOGRAPH 31 is not a reasoned discussion of the real relation between patents and free enterprise. Notwithstanding lip-service paid to the theory of patents, it is, in fact, merely a general attack on the patent system and upon the motives and practices of business.

Evidently the author has had little experience with either patents or practical business enterprise, and on its own merits the monograph does not deserve to be dignified by serious notice. Nevertheless the document, bearing as it does the name of the Temporary National Economic Committee and the stamp of the U. S. Government Printing Office, will doubtless be quoted as an authority by many who know no better or who are promoters of pet panaceas ready always to seize upon any "authority" that fits their theories. Under the circumstances, it seems in order to indicate the real character of the monograph by citing a few instances of its unreliability and then, by way of general answer, to give a brief statement of the real relation between patents and free enterprise.

I

ONE of the author's more fundamental errors is in treating a patent as an instrument for taking something away from the public and giving it to an individual. He says of the patent that it is ". . . a privilege, in the public domain . . ." (p. 158), "A private stake in a public domain . . ." (p. 51), ". . . staked out within the public domain" (p. 44), ". . . a private privilege in the public domain

. . ." (p. 151), etc. From this basic assumption the author moves on to expand his theory that the patentee's "privilege" should be sharply circumscribed (if not abolished) and that, as patentee, he has special "obligations to society" (p. 52). And he ridicules the courts for not disposing of all patent litigation (regardless of the actual issues involved) on the basis of the inquiry: Has or has not the patentee used his patent to promote public welfare?

The author's premise being entirely false, what he builds upon it is naturally worthless. A patent is *not* a private privilege carved out of the public domain. So far from being a means of taking something from the public and giving it to an individual, a patent is a means for getting something from an individual and giving it to the public. If a man makes an invention of the kind which can be protected by a patent, it is something which the public does not then have, and to which it has no claim. That invention belongs to the man who made it. He may, if he choose, keep it secret and practice it to his own profit. He may, if he choose, let the art die with him, as certain ancient arts actually did die. If anyone surreptitiously filches his secret invention, he has his remedy at law for the injury. The patent system is designed to induce him not only to do the inventing but to disclose his invention and give it to the public gratis after the term of the patent, in return for the assurance that he will be protected in the exclusive use of his own for those seventeen years, notwithstanding the disclosure. In this transaction, it is clear that only the inventor gives up anything of substance. To purchase the residuary rights in his invention the public contributes neither money nor anything else it possesses. It gives only a promise of temporary protection for the inventor's own intellectual property so that he may, if he can, make a profit for himself during the period of protection.

What, then, shall be said of one who undertakes to instruct the nation on "patents and free enterprise" and proceeds on the theory that a patent is a transfer of something from the public domain to an individual? Correct statements of the matter, which the author might easily have consulted, are abundant in the writings of authorities on the subject. As long ago as 1852 Daniel Webster stated it as plainly as this:

". . . The Constitution does not attempt to *give* an inventor a right to his invention, or to an author a right to his literary productions. No such thing. But the Constitution *recognizes* an original, pre-existing, inherent right of property in the invention, and authorizes Congress to secure to inventors the enjoyment of that right. But the right existed before the Constitution and above the Constitution, and is, as a natural right, more clear than that which a man can assert in almost any other kind of property. What a man earns by thought, study and care, is as much his own, as what he obtains by his hands. It is said that, by the natural law, the son has no right to inherit the estate of his father—or to take it by devise. But the natural law gives a man a right to his own acquisitions, as in the case of securing a quadruped, a bird, or a fish by his skill, industry, or perseverance. Invention, as a right of property, stands higher than inheritance or devise, because *it is personal earn-*

ing. It is more like acquisitions by the original right of nature. In all these there is an effort of mind as well as muscular strength.

"Upon acknowledged principles, rights acquired by invention stand on plainer principles of natural law than most other rights of property. Blackstone, and every other able writer on public law, thus regards this natural right and asserts man's title to his own invention or earnings.

"The right of an inventor to his invention is no monopoly. It is no monopoly in any other sense than as a man's own house is a monopoly. A monopoly, as it was understood in the ancient law, was a grant of the right to buy, sell, or carry on some particular trade, conferred on one of the king's subjects to the exclusion of all the rest. Such a monopoly is unjust. But a man's right to his own invention is a very different matter. It is no more a monopoly for him to possess that, than to possess his own homestead.

"But there is one remarkable difference in the two cases, which is this, that property in a man's own invention presents the only case where he is made to pay for the exclusive enjoyment of his own. For by law the permission so to enjoy the invention for a certain number of years is granted, on the condition that, at the expiration of the patent, the invention shall belong to the public. Not so with houses; not so with lands; nothing is paid for them, except the usual amount of taxation; but for the right to use his own, which the natural law gives him, the inventor as we have just seen, pays an enormous price. Yet there is a clamor out of doors, calculated to debauch the public mind." (Emphasis by Mr. Webster.*)

* "The Writings and Speeches of Daniel Webster," National Edition 1903, Vol. 15, pp. 438–439.

Even the following brief statement by Chief Justice Marshall (in a case cited by the author on another point) should have kept him from this basic blunder. Chief Justice Marshall said of the patent:

> "It is the reward stipulated for the advantages derived by the public for the exertions of the individual, and is intended as a stimulus to those exertions . . . The public yields nothing which it has not agreed to yield; it receives all which it has contracted to receive. The full benefit of the discovery, after its enjoyment by the discoverer for fourteen [now seventeen] years, is preserved; and for his exclusive enjoyment of it during that time the public faith is pledged." (6 Peters 217, 241–2.)

This underlying error alone indicates very clearly how little dependence can be placed upon statements in the monograph, but the whole article is honeycombed with lesser errors which show the same thing. A few will be noted.

II

IN chapter VIII (p. 123 et seq.) the author discusses the procedure under which patents are granted, and asserts that it is such as to bias the Patent Office examiners in favor of the applicant and against the public in the granting and refusal of claims—that each officer passing upon the claims is prone to allow rather than to reject, lest he be reversed on appeal. Evidently the author has never been an examiner in the Patent Office, or had much to do with them. If he had, he would know that they take themselves quite seriously as custodians of the public interest, and are eager to discover anticipating evidence. So zealous are they, indeed, that it is common for inventors and their attorneys to complain that the examiners constantly reject claims for meritorious inventions without adequate evidence of anticipation. Fear of reversal on appeal is not a factor. An examiner reversed on appeal may feel pity for the blundering tribunal that reversed him, but never fear or remorse. He is a specialist in a particular art, and regards himself as the one expert best qualified to make the correct decision.

III

ANOTHER error of fact is found on page 43, where the author, speaking of the use made of patent rights in the earlier history of the country, says:

> ". . . It was, however, even as late as 1890[13], unburdened by covenants which ran with the chattel or radiated along the channels of trade . . .
>
> "[13] The Sherman Act was passed July 2, 1890."

It is important to the author's thesis to show that only in later years has the patent right been misused to the public detriment, one of the "misuses" particularly attacked being the granting of licenses for limited uses of the invention.

But this simply is not true. Patentees have granted licenses for limited uses, for limited amounts of manufacture, and for limited territories, etc., from the very beginning. The case of *Mitchell* v. *Hawley* (cited by the author himself in another connection) dealt with licenses granted about 1868 which were limited to making and using the invention

> ". . . in the said States of Massachusetts and New Hampshire, and in no other place or places . . ."

and forbade the licensee to

> ". . . in any way or form dispose of, sell or grant any license to use the said machines beyond the 3rd day of May, A.D. 1867"

and also with a sublicense

> ". . . to run and use two sets (four machines) . . . in said town of Haverhill . . ."

But strictly limited licenses were old even before that. Along in the 1840's, Goodyear held patents covering materials impregnated or coated with vulcanized rubber and he granted licenses limited in various ways, as for example *:

> ". . . for the manufacture of wearing apparel of every name and description for men and boys, excepting boots and shoes, bathing caps, gloves and mittens."

and again for:

> ". . . the manufacture of army and navy equipments . . ."

In a suit involving a limited license of this type the judge said:

> "For these reasons, I am of the opinion that the respondents, acting under that license, are restricted to the manufacture of cloths to be japanned, marbled, and variegated, as therein described, and that it confers no authority to manufacture any of the articles specified in the bill of complaint." †

* *Goodyear* v. *Providence, etc.*, 10 Fed. Cases 712.

† Idem, p. 723.

This decision was affirmed by the Supreme Court of the United States (9 Wallace 788), and in its decision that court noted that the license relied upon by defendants was one to an individual to be exercised "at his own establishment" only, and the court said this did not authorize manufacture in a place occupied jointly by that licensee and others.

IV

In chapter VI (p. 87 et seq.), the author, speaking of the telephone industry, gives as facts (taken from the reports of the Federal Communications Commision investigation and "carefully checked") various delays by the Bell System (ranging from nine to thirty years) in the introduction of various named innovations assumed to have been needed and said to have been ready at hand all the time. And he reduces the allegation to tabular form at the top of page 93 to give it an air of exactness and finality. There is no truth in all of this, as those acquainted with the facts well know. Statements substantially the same as those made by this author are to be found in the reports of the F. C. C. investigators, but the comments on F. C. C. Exhibit No. 1989, filed by the American Telephone and Telegraph Company (pp. 64, 71, 94 to 122), and its brief on the proposed Walker reports (pp. 68 to 75), show that these statements were utterly unfounded. It would be interesting to know what means the author used for "carefully checking" these untruths.

V

Again, the author misstates the fact in his discussion of the electric lamp patents and the Supreme Court's decision in *United States* v. *General Electric Company,* 272 U. S. 476. Despite the actual patent situation there involved, which the author seems to have known, he treats the licensing system in that case as a scheme to control the price of "the unpatented incandescent lamp" (footnote (*c*), p. 100). The fact, of course, is that the lamp in question was covered by three patents of basic character on important physical parts of the lamp itself. This makes all the difference in the world, because if the patents had been merely on a process of manufacture or a machine for manufacturing, the effort to control the price or the use of the unpatented product—the lamp—would plainly have been open to attack and subject to much of the criticism offered. The facts, if properly presented, would have undercut the author's high-sounding story.

Also, notwithstanding his own statement of the facts as to the agency contracts, he treats the arrangements there criticized as controlling the "resale" price of the lamp (footnote 31, p. 102 and footnote 25, p. 100). That is contrary to the fact. It was precisely because the control by the patentee was control only of the *original* sale price, and not of the resale price, that it was lawful rather than unlawful, and was upheld by the Supreme Court.

VI

Another and oft repeated error is in stating that patentees have a practice of prolonging the life of their patents beyond the seventeen-year period. This is done, we are told, by taking out improvement patents. The text includes such expressions as "other inventions might be used to prolong their life" (p. 90); "so long as basic patents were periodically refreshed" (p. 110); "He may, by means of improvement, give to his grant a new lease of life" (p. 162).

The simple fact, of course, is that no patentee can prolong the life of his patent by so much as a single day. There can be no possible excuse for thus misstating the facts. It is a transparent attempt to mislead the reader into believing that patents are ready instruments of oppression and injustice.

When a patent has run its seventeen years, it ceases at once to be a bar to anyone in any way. The making, using, or selling of the thing covered by the patent is as free to one man as to another; and this is true whether improvement patents have been taken out or not.

And during the life of the patent one man as much as another is free to make and to patent improvements on the preceding invention. Of course, the man who makes the *best* improvement will, after the first patent expires, be in a better position to compete (so far as patents are concerned) than the man who makes a poor improvement, or none. If the same man who conducted a business under the first patent makes the best improvements he, of course, will have this competitive advantage; but this is the result of his effort and ability in making the improvements—not in any sense because of an extension of the monopoly of his old patent.

In this matter of making and patenting improvements there is a field of perfectly free competition. If the outsider, who wants to get in, has the ability and is willing to spend the time, money, and effort required to make and to patent the best improvements, he will hold the advantage in the business over the original patent owner when that patent expires. If he has not the ability or is not willing to make the effort, there is no reason why he should be permitted to take, free of cost, the improvements of someone else who has spent time, money, and effort in perfecting them.

If the author of Monograph 31 did not know and understand these simple and basic things about patents, he should have devoted some study to the subject before undertaking to instruct others.

VII

Another error repeatedly made is the assertion—either direct or implied—that the *assignment* of a patent diverts the patent right from its intended purpose and turns it to an unforeseen and undesirable end—often referred to as the "pursuit of gain" (see pp. 45, 46, 49, 133, 162 and elsewhere). Perhaps this is an error of conclusion rather than of fact, but a conclusion so obviously wrong that it is just as inexcusable. The author makes no effort to establish the point—he treats it as axiomatic, and upon it bases other wrong statements.

It seems almost too obvious to require stating that the very purpose of the patent law in granting an inventor a patent is *to enable him to reap a profit* on the invention. The chance to do that is his reward for contributing to the advancement of science and the useful arts by making and disclosing the invention. From the point of view of the public, it is of no importance at all whether the patentee makes the profit by manufacturing and selling the invention himself, or makes it by selling his exclusive right to someone else. If he sells his patent to someone else, the purchaser, whether a corporation or an individual, gets no rights which the original patentee did not have. The author of the monograph, when off guard, admits this parity between the inventor and assignee. On page 103 he writes, "The inventor—or his assignee—is worthy of his reward." In the next sentence he suggests that this "reward" is only the right to collect royalty, but that, of course, is simply not true. The patent right, by definition, is the right to *exclude* others. The right to *permit* others, in consideration of payments, is merely an *incident* of the patent right.

Obviously *either* the inventor or his assignee *may* use the patent unlawfully, just as he may use any other private property unlawfully. For example, he may make an agreement or combination in restraint of trade which involves his patent, just as such an agreement may involve his grain or his horses. But the cure for this is not to decry the *sale* of the patent or the grain or the horses, but to prosecute the perpetrator of the *agreement* (whether inventor or assignee) under the anti-trust laws if he transgresses those laws.

VIII

ANOTHER error, also in the nature of a conclusion and which the author also treats as axiomatic, is the assumption that a patentee, as distinct from the owner of other property, is under some special obligation to society (see, for example, pp. 52, 53, 152 and 153). The author, having read Article I, Section 8, of the Constitution and found that the granting of the patent is intended "to promote the progress of science and useful arts," jumps to the conclusion that it is the *patentee* upon whom falls the duty of promoting the progress of science and the useful arts. Of course, this is plain foolishness. The Constitution expressly states that it is *Congress* that is to promote the progress of science and the useful arts. And the precise *way* Congress is to promote them is stated, namely, "by securing for limited times to . . . inventors the exclusive right to their . . . discoveries." So, it is *the fact that the exclusive rights are granted* which promotes the progress of science and the useful arts, and not something the inventor is expected to do *after* the grant is made. Once made, the grant, like any other piece of property, is something belonging entirely to the grantee. It is intended for *his* benefit and with it he may, as with his horse or his grain, do just as he pleases. The patentee's obligation to society is no greater, and of course no less, than the obligation of the holder of any other piece of personal property. The patent is something he has bought by yielding the price specified by the Government, and there the transaction ends.

Of course, anyone so blind as to believe that human beings have already attained such perfection that we can now thrive and progress without the stimulus of any private ownership at all will object to the private ownership of the patent right, and, since it seems easier to vilify this right as a "monopoly" than it is the corresponding monopoly in one's horse or his grain, it is natural that such a person should pick on patent property for propaganda purposes. But our author should realize that he has not in himself as yet the power to amend the Constitution. What he really tries to do is to rewrite the pertinent clause of the Constitution to make it read: Congress shall secure for limited times to inventors the exclusive right to their discoveries, and the inventors shall thereupon use the grant to promote the progress of science and the useful arts and not for their own profit.

Time and space will not permit discussion and correction of all of the erroneous statements contained in the monograph, and, if it were to be done, few would have the patience to read these comments through. If the document is read in the light of the foregoing, it will be clear that practically everything in it, aside from pure historical recitation, is misdirected or erroneous.

The Relation of Patents to Free Enterprise

The author might perhaps have saved himself from some errors if he had thought of his subject as part of a more general case—as if the topic were "*Private Property* and Free Enterprise." Quite obviously, the right of any person in any private property does, to some extent, limit the freedom of others in conducting their business enterprises (and in other ways). If A owns a farm, B, of course, is not free to conduct an agricultural enterprise that would involve planting and cultivating A's acres. Just so, if A owns a patent on an invention, B is not free to conduct a manufacturing enterprise which would involve the making and selling of A's invention. And most certainly in neither case is there any reason why B should be "free" to do such a thing.

The American idea of free enterprise is not that a man should be free without permission to do business with the property of others, but that so long as he respects the property and other rights of his fellow men he shall be free to conduct whatever enterprise he will, wherever he will, and for such time and in such way as he may choose —and especially that he shall be free, so far as possible, from interference by the Government.

The basic relation between patents and free enterprise is so simple that it can be stated in one paragraph. It is precisely the same relation as between any other private property and free enterprise. While a man's, or a company's, ownership of private property is always in a true sense a monopoly of that property, and the control of it is often referred to as absolute, nevertheless it is also always true that the use of such property, whether it be patents, or grain, or horses, is subject to the general laws governing the use of property, as for example the antitrust laws. And while, as already noted, private ownership of property is necessarily a limitation on the activities of others, it is also true that private ownership and a complete control of the property involved not only promote free enterprise but are almost essential to it. No one can have a really free enterprise based upon a farm or a grocery store unless he has complete control of the farm or the store, and the same is true as to patents. The ownership of patents and the complete control they give of the invention covered are the cornerstones of hundreds of small enterprises in this country which are now free and thriving but which could not continue without the protection represented by the patents. If anyone doubts this, let him consult the testimony of the witnesses before the Congressional Committee in 1938 where a bill for compulsory licensing was being considered (O'Malley Committee hearing on H. R. 9259 et al., March, 1938).

To propose the destruction of useful property merely because it might be used as the subject of an agreement in restraint of trade, or otherwise in contravention of law, is childish. That, in substance, is what the author of Monograph 31 proposes as to patents. History indicates that oil is more likely to be used as the basis of combinations in restraint of trade than are alphabet blocks or tigers, but that is no reason for destroying or for denaturing the oil; and anyone who suggested that as the remedy would risk a trip to a clinic for mental observation.

Experience shows that patents, like oil, contribute to the public welfare. Let them remain as they are and continue their good work of promoting science and the useful arts. If owners of patents use them as the basis of agreements or combinations to get control of things which the patents themselves do not cover, the remedy is not to destroy the patent right but to enforce the anti-trust laws.

FOR THE RECORD

"THE BELL TELEPHONE SYSTEM"

A Book Review

"THE BELL TELEPHONE SYSTEM," by Arthur W. Page, vice president of the A. T. and T. Company in charge of the Information Department, is the first book of its kind. Not until now has there been a volume to which the average reader could turn for a concise account of the policies, organization, and performance of the Bell System in recent years, together with a reasoned estimate of what conditions are most likely to help or hinder the job of rendering telephone service in the future.

Mr. Page's method is first to show the System's character by stating the facts which reveal it. On the basis of this demonstrated character, he asks that the telephone companies be permitted to retain the freedom to go forward and do a constantly improving job. "Progress in the art, improvement in management and methods, preparedness for the future and liberty to act quickly and effectively and with undivided responsibility," he says, "are the positive factors from which the public may expect real benefits." Regulation by public authority is desirable and necessary so that management liberty to act will never be abused. But the taking over of management under the name of regulation is another matter. Under such circumstances, management initiative and responsibility will decline, and operating and service paralysis will be on the way.

It is impossible to read this book without obtaining a fresh realization that Bell System character is not just something to talk about, but is something real. "I am not talking about stage management—I am talking about character," Mr. Page remarks during his discussion of politeness and reasonableness as factors in good service. The reader will feel strongly that he is likewise talking about character when he discusses telephone rates, progress through research, wages and working conditions, and Bell System corporate relationships. In reviewing the reasonableness of telephone rates, he points out that had investors received one half of one per cent less on their investment in the years 1925–1940, the business would have incurred serious risk and danger while the saving to telephone users would have been less than two cents on the dollar. This saving to the consumer might well have meant the difference between good and inadequate service—or it might even have cost the consumer far more, ultimately, by jeopardizing the improved plant and methods from which future savings come. In short, only adequate earnings can give the System and the service the character they need.

The fundamental policy of the Bell System, as stated by Mr. Gifford at Dallas in 1927, is quoted at length. Mr. Page shows how the words of the policy have been sustained by deeds, and he forcibly suggests that this will continue if management is given the requisite freedom to act. If there has been doubt anywhere that the policy means what it says —to furnish the best possible telephone service at the least cost consistent with financial safety—this book ought to dispel it. The reader can look forward to a heartening demonstration that the Bell System not only sets its sights high, but is intent on hitting the mark.

Although Mr. Page is concerned from start to finish with the moralities of his subject—with the principles and philosophy of the System—it would be wrong to imply that this makes for heavy reading. The author is a plain-speaking man with an extraordinary gift for getting directly to the point. His language is simple and his word-pictures often have a homely charm—as, for example, when speaking of the need for a balance of routine and initiative in telephone operations, he remarks that "The bull in the china shop was full of initiative." In discussing random suggestions for rate reductions, he points out that no rate reduction by itself can produce improvement or economy in telephone service; the vital thing is the improved technique that produces the saving that makes the reduction possible.

Such appraisals rest on faith in human nature, which Mr. Page has. His book is not for cynics. It is a book for people who will believe what it is reasonable to believe, who will think well of that which deserves to be held in esteem, who have faith that real progress can be made and who are willing to share the responsibility for making it.

"The Bell Telephone System" was published by Harper & Brothers on October 1.

NEW DEFENSE POST FOR W. H. HARRISON

William H. Harrison, who has been on leave of absence as vice president and chief engineer of the A. T. and T. Company since July, 1940, was appointed director of the production division of the Office of Production Management on August 29. This is the third important defense post in which Mr. Harrison has served since he went on leave of absence. At that time he was appointed director of construction in the production division of the National Defense Advisory Commission. When the OPM was organized in January, 1941, Mr. Harrison became chief of shipbuilding, construction, and supplies in the production division of the new organization. In his new post, Mr. Harrison directs all activities of the OPM production division, one of the six divisions through which the OPM now functions. The other five are civilian allocations, headed by Leon Henderson; labor, Sidney Hillman; materials, William L. Batt; priorities, Donald M. Nelson; and purchases, Douglas L. MacKeachie.

L. G. WOODFORD APPOINTED CHIEF ENGINEER

L. G. Woodford was appointed chief engineer of the A. T. and T. Company on September 10. Mr. Woodford has been assistant vice president of the company since July, 1940, and has been in charge of the Department of Operation and Engineering during Mr. W. H. Harrison's absence in Washington. Pending the latter's return, Mr. Woodford will continue to report to Vice President C. P. Cooper. Mr. Woodford began his telephone career in Des Moines in 1911. After experience in the commercial and plant engineering department of the Iowa Telephone Company, he was appointed appraisal engineer of the Northwestern Bell Telephone Company, with headquarters at Omaha, Nebraska, in 1915. From 1921 to 1923 he was engineer of costs and practices for the Northwestern Company. In the latter year he joined the department of operation and engineering of the A. T. and T. Company at New York. Here he became plant inventory and costs engineer in 1927, plant extension engineer in 1933, operating results engineer in 1937, plant operation engineer in 1939, and in 1940 was appointed assistant vice president.

NEW RECORDS SET IN SEPTEMBER

September of 1941 established new records for the number of telephones installed, the number of telephones in service, and the use of overseas radio telephone service.

There was a gain of about 142,400 telephones in service in the principal telephone subsidiaries of the American Telephone and Telegraph Company included in the Bell System during the month. This was the largest increase for any month in the history of the Bell System. The largest previous gain for a single month was 129,200, recorded in January, 1941. The net gain for nine months of this year totals 1,007,900, which is greater than the entire 1940 gain of 950,000, the largest increase for any year up to now.

The gain for August of this year was 110,400, and for September, 1940, was 109,200. The net gain for nine months in 1940 was 646,900. At the end of September this year there were about 18,489,300 telephones in the Bell System.

Overseas telephone traffic for the month of September soared to its highest level in the history of the service. The calls handled over the radio telephone facilities of the Bell System during the month showed an 85 per cent increase over September of 1940.

This level has been reached through the increase in transpacific and Pan American communications, despite the decline in European traffic because of war conditions. Telephone calls to important outposts of this country in Panama, Puerto Rico, and Hawaii also contributed to the record-breaking rise. Since the outbreak of war, traffic with Puerto Rico has doubled, with Hawaii has increased four-fold, and with Panama six-fold.

Overseas service is now available with 47 countries, of which 28 are reached by direct circuits. Although European traffic is only about 50 per cent of its prewar volume, direct transatlantic circuits are maintained to London, Berne, Berlin, Rome, Madrid, and Lisbon.

To meet the unprecedented increases in overseas traffic the A. T. and T. Company has been speeding up measures to improve and augment the world network of radio telephone facilities radiating from the United States. During the last two years, additional facilities have been provided to Argentina, Brazil, Panama, Netherlands Indies, and the Philippines. Within the next few months, additional facilities also will be provided with Puerto Rico and Hawaii, as well as another circuit to Brazil.

INDEX TO VOLUME XX AVAILABLE

An Index to Volume XX (1941) 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

After four years as a field and laboratory entomologist with the U. S. Department of Agriculture while also attending Washington University for three years, Hervey Roberts went into newspaper work in 1925 as a reporter on the St. Louis *Post-Dispatch.* In 1927 he became editor of *The Lumber Manufacturer and Dealer,* a lumber trade journal published in St. Louis, and *The Chicago Lumberman,* a Chicago affiliate, spending alternate two-week periods in those two cities. The following year he joined the Southwestern Bell Telephone Company as a copy writer in the Eastern Missouri-Arkansas area advertising department, and in 1929 was transferred to the company's general advertising department. He became advertising assistant in 1935, copy supervisor in 1938, and in 1939 was made editor of the company's employee magazine, *The Southwestern Telephone News.* In this capacity he has recently spent much time in the field covering defense activities in the Southwestern Bell territory such as his article describes. His interest in photography is an asset to his editorial duties, and some of the accompanying photographs are from his camera.

After attending Washington University, St. Louis, Mo., Horace H. Nance joined the St. Louis staff of the Long Lines Department of the A. T. and T. Company in 1910 as an equipment attendant. In 1916 he went to Denver as district plant chief, and two years later was transferred to Washington, D. C. After absence in military service, he rejoined the Long Lines Department as a technical employee in New York. In 1919 he was appointed division superintendent of equipment construction at Chicago. A year later he was made division plant engineer in Atlanta, and in 1922 was transferred to Philadelphia in the same capacity. He was made Engineer of Transmission in New York in 1924, and in 1928 was appointed to the post of Plant Extension Engineer. For the next twelve years he was responsible for studies and plans for extending Long Lines plant facilities, and it was during this period that plans for the transcontinental cable matured. The preparation of much of the background data and the engineering studies touched on in the article of which he is the author came under his personal direction. In February of this year he was made Engineer of the Long Lines Department.

Starting his Bell System career in 1903 in the accounting department of the New York Telephone Company, James F. Behan transferred to the A. T. and T. Company in 1912 as an accountant, and in 1919 became Chief Accountant. A year later he was appointed Assistant Comptroller, and in 1933 was elected Treasurer. Always important in the work of the Treasury Department are the day-to-day contacts—by mail, by telephone, and in person—with that sizable section of the public which includes A. T. & T. security holders. During times of special activity, such as the recent convertible bond issue Mr. Behan describes, these contacts greatly multiply.

Returning to Harvard University in 1919 after serving with the American Red Cross during the World War, Gaius W. Merwin received his A.B. degree in 1920 as of the class of 1918. In November following his graduation he joined the rate section of the Commercial Division of the American Telephone and Telegraph Company, and continued in rate work until 1925, when he transferred to the operation results section. After a year and a half, he returned to the rate section as a group head, first on toll rates and later on exchange rates. In 1929 he attended the Public Utility Course at the summer session of the Graduate School of Business Administration of Harvard University. He was made Staff Engineer in Administration–M Department in 1936, where he handles patent licensing activities and keeps in touch with new services —such as the ship telephone service he describes. He contributed "The Telephone Goes Down to the Sea in Ships" to the July, 1938, issue of the Bell Telephone Quarterly.

Experience with patent matters began for William R. Ballard with his appointment as assistant examiner in the United States Patent Office in 1904. He served at different times in divisions of that Office concerned with applications for patents relating to tools, electrical apparatus, and textiles. During the later years there he was Solicitor for the Patent Office, representing it in numerous cases before the courts, and for a time was a Special Assistant to the United States District Attorney for the Southern District of New York in connection with litigation there relating to patent matters. He holds the degree of LL.B. from George Washington University. He was admitted to the Bar of the United States Supreme Court in 1911, and is also a member of the New York State Bar and the Bars of several of the federal district courts of the country. He joined the A. T. and T. Company in 1917 as patent attorney, and has taken an active part in most of the patent litigation involving the company since that time. In 1937 Mr. Ballard was made General Patent Attorney for the American Telephone and Telegraph Company, the position he now holds.

PRINTED IN U. S. A.