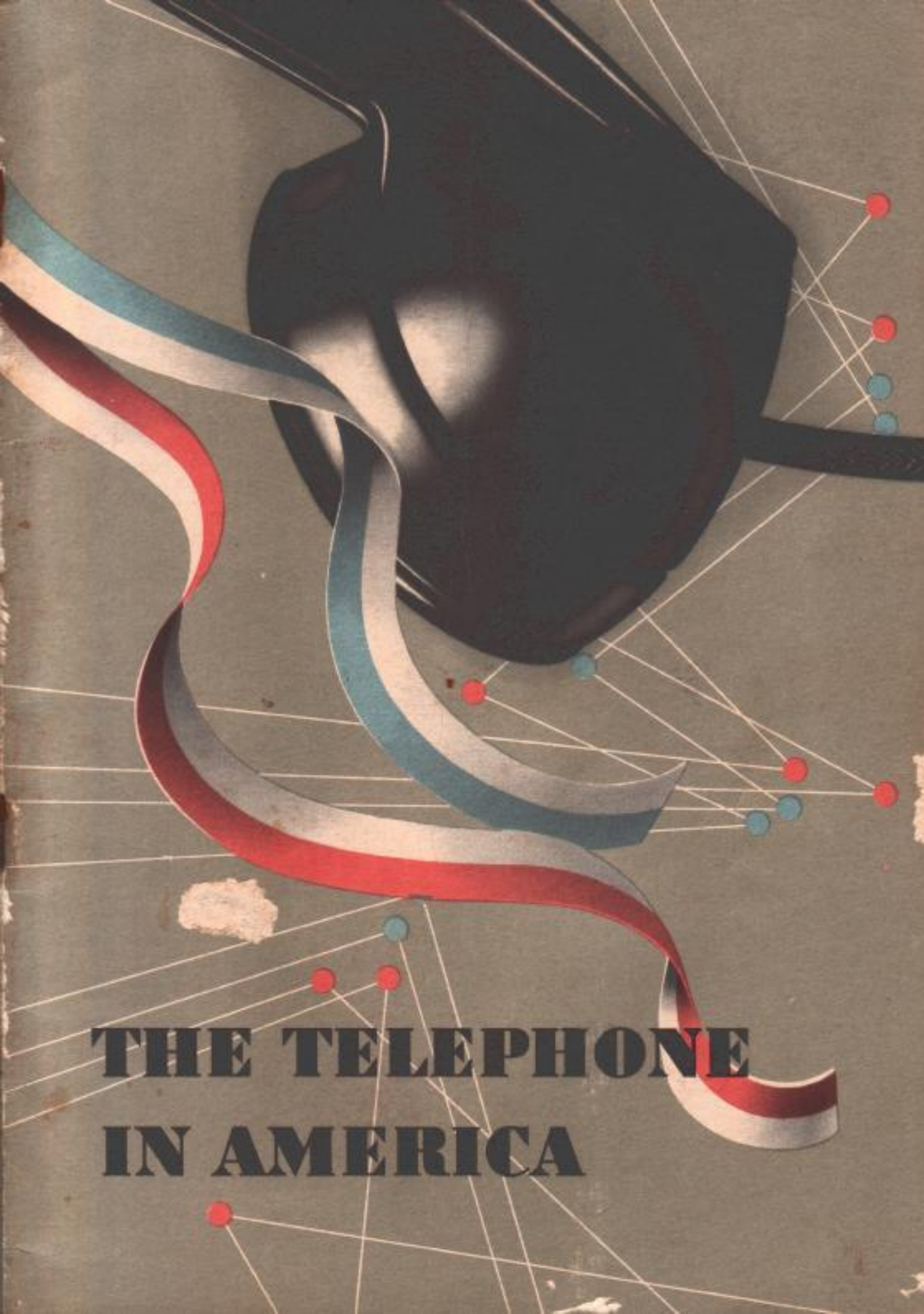
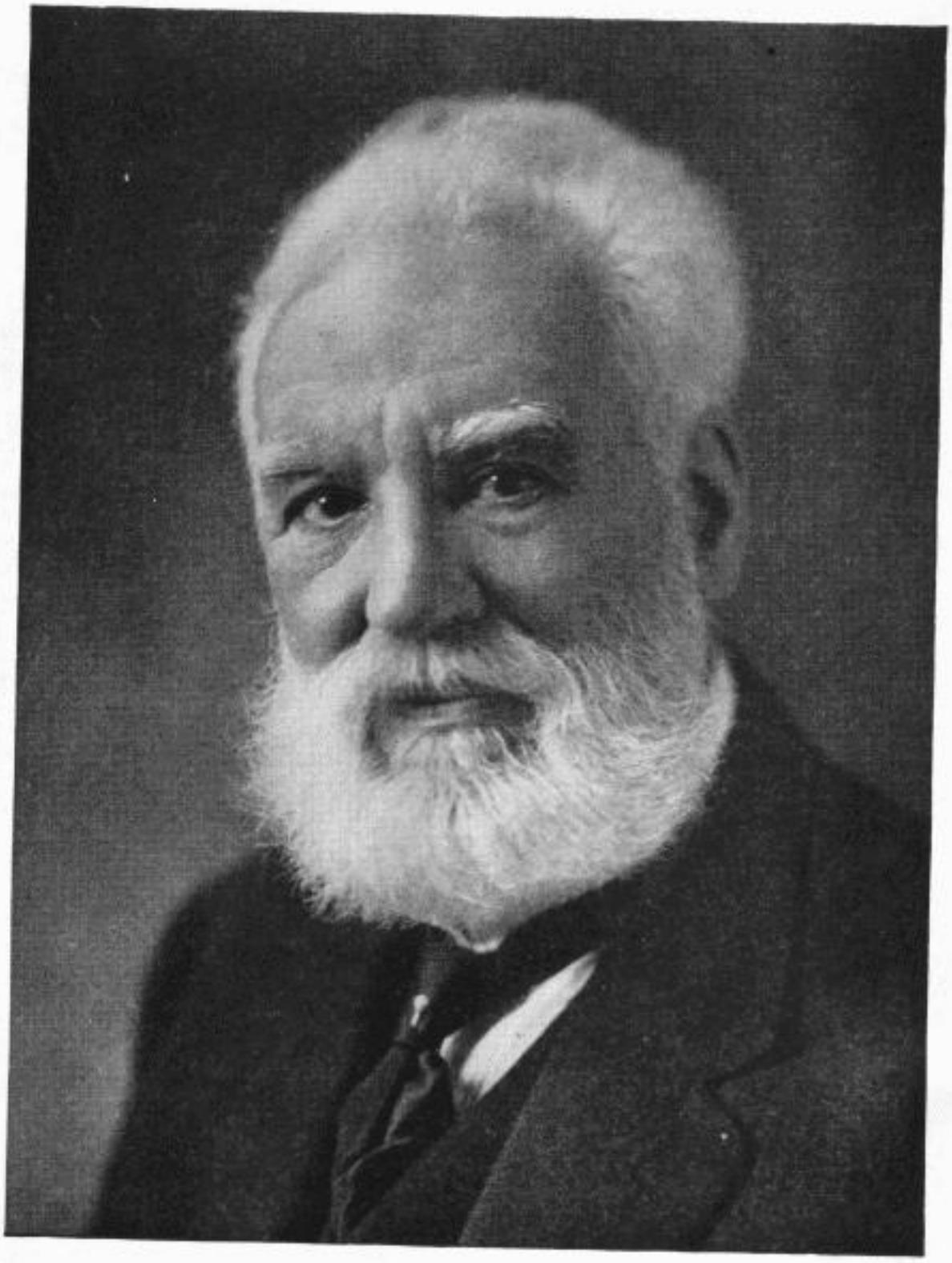


THE TELEPHONE IN AMERICA

THE TELEPHONE IN AMERICA

BELL TELEPHONE SYSTEM
1950



ALEXANDER GRAHAM BELL

1847-1922

Inventor of the Telephone

The Telephone in America

THE telephone was born in America and has reached its highest development in this country.

Since that day in 1876 when Alexander Graham Bell first talked successfully over his primitive telephone, there has grown a nation-wide system of voice highways that today links together more than 40 million telephones. Four-fifths of these are served by the Bell System, which is made up of a group of closely associated telephone companies, a research organization, a manufacturing and supply company, all headed by the American Telephone and Telegraph Company. The rest are owned and operated by some 5,700 other telephone companies and 60,000 rural or farmer lines outside of the Bell System but connecting with it.

Bell telephone service is home town service—backed by resources that are national in extent. The company that furnishes your service is a member of your own business community. Its operators, installers and other representatives are your neighbors; some may be your friends or relatives. Its departments are managed by your fellow citizens—men and women who have come up through the ranks to their present positions.

Nine out of every ten telephone calls handled by these home town folks are local calls. The tenth call may go across the continent or across the ocean. But wherever the calls go, they are sped on their way by means of an intricate yet marvelously ordered world of wires and cables and switchboards and dial apparatus and, above all, of people working as a team to render public service.

This booklet has been written to give you a personal glimpse into that world. Our story is the story of the Bell System, but it should be remembered that much that is said here applies as well to the other telephone companies which share the responsibility and the privilege of providing the people of America with the best, most reasonably priced telephone service in the world.

Behind Your Telephone

WHEN you lift your Bell telephone to make or receive a call, you have at your service the finest, most widespread communications system in the world—nation-wide in scope yet essentially local in its operations. In this system are:

—More than 33 million telephones interconnected by means of switching equipment in 8,200 telephone offices.

—More than 130 million miles of wire, three-fifths of it underground and 95 per cent of it in rugged cables, in which hundreds, even thousands of wires are enclosed in protective sheathing.

—Radiotelephone links to automobiles, trains, ships and countries overseas, and, for long distance telephone and television transmission, between a rapidly growing number of American cities.

—Literally billions of parts, each finely fashioned in itself and finely tuned to work in harmony with all the others.

—Sensitive devices that automatically warn telephone employees of "trouble" in the plant, or which insure the quality of transmission on the line over which you wish to talk; for example, gas pressure in long distance telephone cables to set off alarms and delay the effect of trouble if it develops, and resistors that compensate for the effect of temperature changes on electrical circuits.

—A veritable "city" of about 6,500 buildings, ranging in size from one-room structures to huge skyscrapers, all devoted to furnishing telephone service. In addition, space is leased in some 3,400 other buildings.

—More than 55,000 motor vehicles, most of them specially designed for telephone work.

—And a highly skilled organization of nearly 600,000 men and women who are busy day and night planning, designing, manufacturing, improving, building, operating—all to serve you.

Bell System buildings contribute to the character of the communities in which they are located, and harmonize with their surroundings. This telephone building is appropriate to the residential neighborhood which it serves.

In the Telephone Office

Each time you make a telephone call—either by giving the operator the number you want, or by dialing the number—you first reach the telephone central office. This is the nerve center of your local telephone system, for it contains the equipment through which your telephone may be connected with any other telephone that you want to reach.

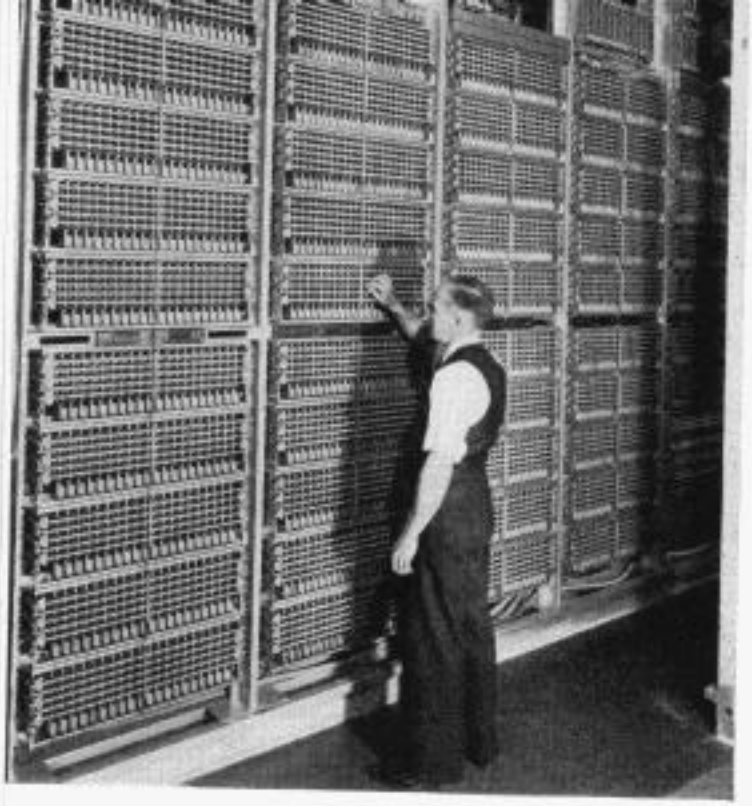
In a small community there may be only one such telephone office. In larger places there may be several, and in big cities there are many of them, all interconnected by trunk lines. The term "telephone exchange" is given to the whole local area served by one or more central offices.

Of the telephones served by the Bell System, more than two-thirds are dial-operated. In dial offices connections are made by machines which follow the electrical instructions sent to them by the caller as he rotates the dial on his telephone.

Before you dial a number, the apparatus will first announce its readiness to serve you by transmitting a "Hum-m-m-m"ing sound over your line. This is called the dial tone and serves the same purpose as the operator's "Number, please!"

It is important, of course, for you to listen and hear the tone before you start to dial the number you want.

Every one of the thousands of parts in a dial central office is precision-built and painstakingly adjusted to work with every other. Yet the dial



Frames of dial switches of the "cross-bar" type in an office of a large city.

system itself must be rugged enough to give service as trouble-free as possible for many years.

Telephones which are not dial-operated are connected with "manual" telephone offices, so named because operators seated at switchboards make the connections by hand. Switchboards differ greatly in size and capacity. In very small villages one or two operators may handle all the calls, while in large cities hundreds of operators work at huge multiple switchboards.

The multiple switchboard gets its name from the fact that each subscriber line that terminates at the switchboard is duplicated or "multipled" at intervals throughout the board. A switchboard equipped to serve 6,000 customer lines might have perhaps 20 appearances of each line or 120,000 points of connection. By this arrangement each operator, in answer to a call from any of the group of customers whose lines are assigned to her, can reach his line and connect it with any one of the 5,999 others.

The courteous, helpful service which telephone operators render is a traditional part of American life. Even where dial service is furnished, "the voice with a smile" is always on the job—to handle toll and long distance calls, to provide telephone numbers not yet included in the directory, and to give any other help which customers may desire.

"Dial Service Assistance" operators, who answer when you dial the numeral "O" (operator), are always ready to lend a hand if you need help in making a call from a dial telephone.

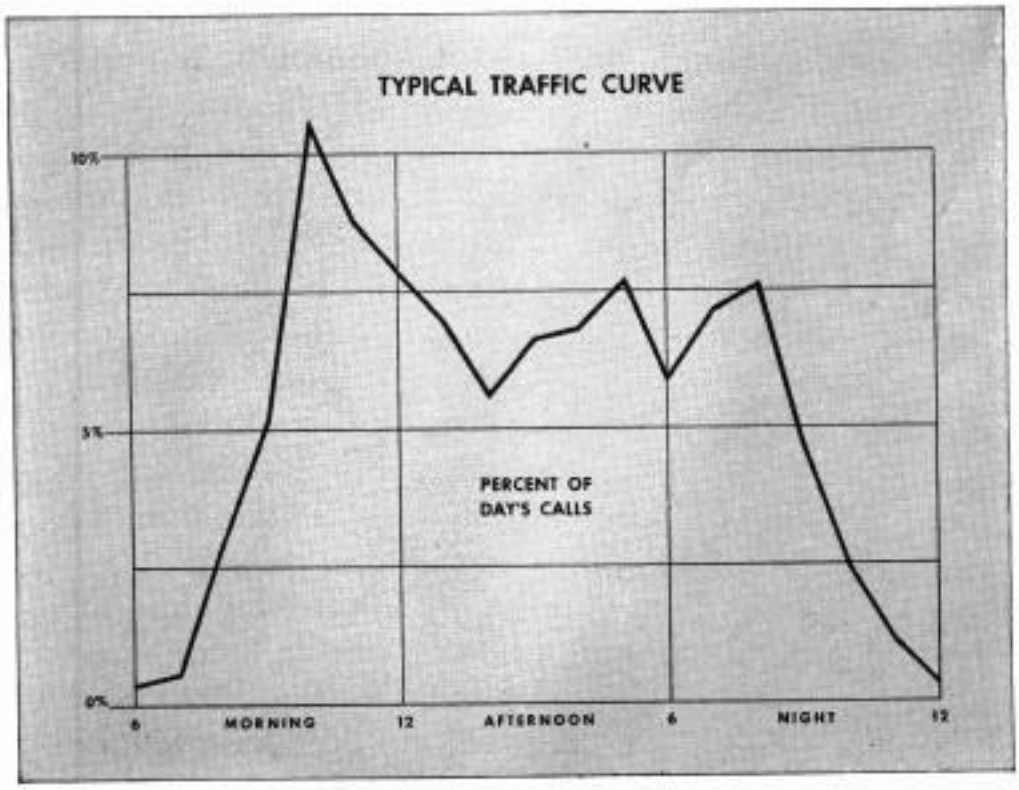
When People Call

The tide of telephone calling rises and falls with the business and social activities of the community. In general, it follows a certain uniform pattern. This is known to telephone people as the traffic curve.

In a typical city the highest point of the traffic curve is reached between 9 and 11 o'clock in the morning. This is when business gets into full swing and telephone switchboards in the business sections of the city are handling the maximum load. Other peaks, not quite so high, are reached in the afternoon between 4 and 5 and in the evening about 7.

But the traffic curve may, without warning, give a spectacular illustration of how sensitive it is to the public pulse. A big fire or accident will send thousands of anxious people to their telephones and the traffic curve will shoot upward. A stormy day that keeps people off the streets, or an interruption of transportation service, will greatly increase the number of telephone calls.

Telephone engineers design every central office so that the volume of calls during the busiest hour of the day can be handled efficiently. The work schedules of telephone operators are carefully planned so that an adequate force will be on duty at all times and dial apparatus, of course, is available to handle its full capacity of calls in emergencies which may occur at any time of the day or night.



How the tide of telephone calling rises and falls throughout the day.

Following the war, the Bell System installed new equipment in unprecedented quantities to meet the greatest demand ever experienced for new service. As this construction job was being pushed, central office facilities were made to carry the heaviest possible load in order to give service to as many people as possible.

This resulted in a greater proportion of party-line users than usual. They have found that spacing calls a few minutes apart, so that others may use the line in the intervals; educating youngsters to share the line "even-Stephen"; and giving party-line neighbors the right-of-way in case of sickness or accident are courtesies which assure good service for all concerned.

Where Do The Wires Go?

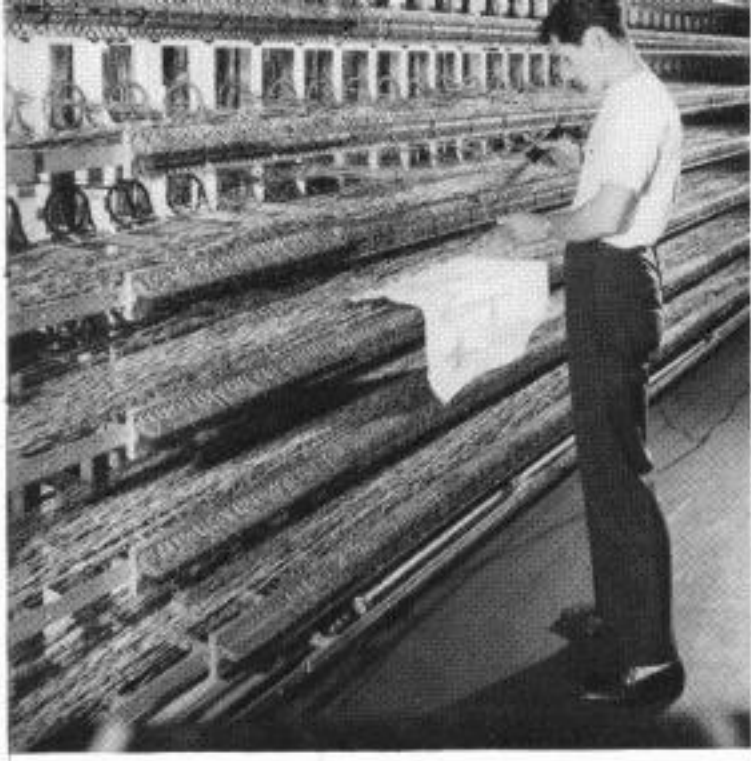
The wire plant that interconnects your telephone and those of your neighbors with the telephone office is something like a tree in the relationship of its parts.

Just as twigs lead to branches, branches to limbs, and limbs to the trunk, so do individual telephone wires come together in small distribution cables which, in turn, are brought together in feeder cables which increase in size as they run back toward the telephone office. Often as many as 2,121 pairs of fine copper wires enter the telephone office in main feeder cables no larger in diameter than a baseball bat.

Installer connects a drop wire to provide service for a new telephone subscriber.

Most of the wire in city telephone cables is placed underground in tile conduits and enters the telephone office through a cable vault in the basement. If the city is served by more than one telephone office, the offices are interconnected by trunk cables.

At each telephone office the cables are run to the terminal room where their hundreds or thousands of pairs of wires are fanned out to terminal blocks on one side of a



Left: Between the cables and the switching equipment, wires from customer's telephones are fanned out in this manner on distributing frames for easy access in making cross-connections. Right: Testmen checking for trouble in telephone plant at a test desk.

large distributing frame. Other wires run from the opposite side of the distributing frame to the switchboard or dial equipment. By making cross-connections on the distributing frame, it is possible to bring each telephone user's line to its proper terminal in the switching equipment.

In addition to wires, frames, and switching equipment, a telephone office contains many other things needed to keep the calls flowing smoothly.

First of all, there must be sources of electric power—direct current for talking, and both direct current and alternating current for signalling. The direct current comes from storage batteries. These are kept charged by generators driven by the regular current supplied by the power company, which also provides the electricity needed for other purposes. In addition, standby emergency generators, usually driven by gasoline or diesel engines, are provided in most large offices and in many smaller ones.

Ringing machines generate alternating current, usually 20 cycles, which operates the telephone bells and provides the various signals you hear in your telephone receiver. These machines are provided in pairs so that there will be no interruption of telephone service should one fail to operate properly for any reason.

Preventive maintenance, both inside and outside telephone offices, is a vital factor in furnishing dependable, satisfactory telephone service. Telephone men periodically check the condition of telephone plant.

Sorting toll tickets in the Accounting department of a Bell telephone company.

Customers transact their affairs with the telephone company in business offices which provide comfortable surroundings.

Often they discover faults and weaknesses and have them corrected before the customer is aware of them.

Test desks, where testmen also track down troubles in the telephone plant, are essential to giving good service. These are special switchboards, which have equipment that enables the testman to be connected with any customer's line, and meters which help him to determine the cause and location of the trouble.

Teamwork To Serve You Well

In addition to good equipment kept in good condition all the time, good telephone service depends on capable people who are well trained and skilled in their jobs.

Not only must these many people perform many different jobs to give you good service but they must work together as a team. In the Plant department, linemen, installers, cable splicers, repairmen and others build and maintain the plant so that the operators in the Traffic department can put your calls through as swiftly as possible. Similarly, the members

of the other departments of the company do their work in such a way that others are helped to do theirs.

As a further help, in every Bell telephone company there are staff people who are specialists in various phases of the over-all job. They assist the front-line forces in meeting day-to-day problems by finding better ways of doing things.

The purpose of all is to serve you well and with unfailing courtesy. Telephone people have a genuine desire to make the company a friendly and helpful institution. Because telephone men and women are good citizens of your community, they take pride in conducting the affairs of the company so that it, too, will be thought of by all as a good citizen.

A high proportion of the people in the Bell System are making a career of telephone work. Approximately 200,000 of them have been in the business over ten years. Wages are good, employment is steady and working conditions are pleasant. The System's Benefit and Pension Plan is one of the oldest and best in industry. It assists employees and their families to meet the problems that arise from sickness, accident, old age and death. Opportunity to advance in the organization is open to all on the basis of individual ability, and supervisory and management positions are filled from the ranks. In fact, the management and the employees are the same people, but at different stages of their careers.

Front and back of the Theodore N. Vail medal, in gold, silver and bronze.

Theodore N. Vail Medals are awarded to telephone people for acts of noteworthy public service.

A Nation-wide Organization

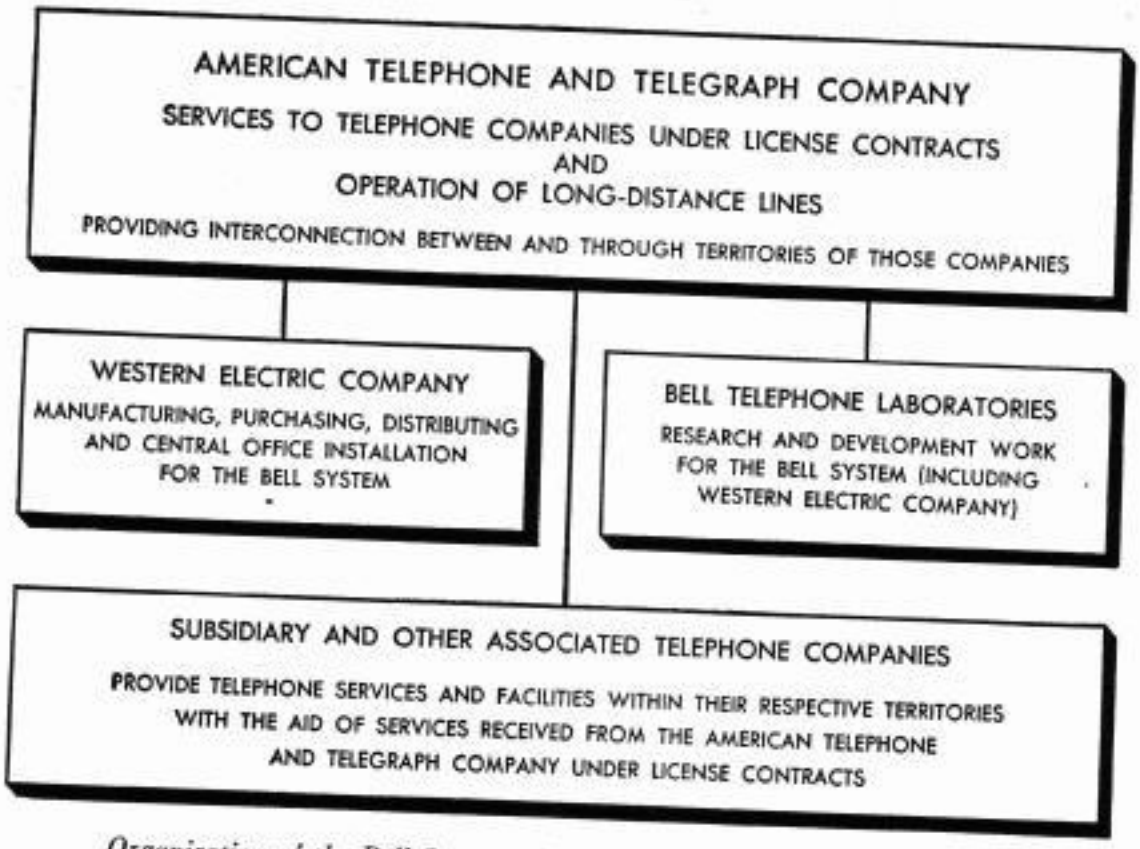
THE teamwork between telephone people and departments is reflected in the nation-wide organization of which your local Bell telephone company is a part. This is the Bell System, and this is what it contains:

1. A group of operating telephone companies, each serving its particular territory, as shown on the map. Each of these companies is known as an Associated Company.
2. The largest fully integrated industrial laboratory in the world, Bell Telephone Laboratories, devoted to research, development and design in the communications field to create apparatus and systems which will provide ever-improving service more efficiently and economically.
3. A supply organization, the Western Electric Company, which manufactures and purchases equipment and supplies for the System; distributes them and installs central office equipment.
4. A headquarters organization, the American Telephone and Telegraph Company, which coordinates the whole enterprise. The A. T. & T. Company owns most of the stock of most of the operating companies; it likewise owns the Western Electric Company, and with the latter shares ownership of Bell Telephone Laboratories. A. T. & T. also functions as a general staff to assist the operating companies, and it furnishes long distance telephone service and other services over the lines of its Long Lines Department.

This set-up has developed in a natural way over a period of many years. The American Bell Telephone Company, predecessor of A. T. & T., owned the original Bell patents and licensed local companies to rent Bell telephones to their subscribers. Ownership of the operating organizations by the headquarters company came about because of the need to finance their expanding operations, and to assure the best and cheapest universal service. Western Electric was bought by A. T. & T. in 1882 because it was the best manufacturer of telephone apparatus and a dependable source of supply was essential. The Bell Laboratories stemmed from the

THE BELL TELEPHONE SYSTEM

The principal telephone subsidiaries of American Telephone and Telegraph Company serve generally the areas shown. The Southern New England and Cincinnati and Suburban are associated but non-controlled companies. In nearly all areas other telephone companies operate and connect with Bell System lines.



Organization of the Bell System, showing the principal functions of the American Telephone and Telegraph Company and its major affiliates.

shop where Alexander Graham Bell's first telephone was made and has continued as an essential part of the Bell Telephone team to discover improvements in the art of telephony.

Let us take a quick look at this nation-wide set-up as it is today, starting with the Long Lines Department.

To Telephone Across the Land

We have seen how telephone lines and telephone offices are interconnected to handle calls within a town or city.

Communities also are interconnected by toll and long distance lines.

Your local telephone company provides intercity service within its own area. But nation-wide service is made possible through the facilities of the A. T. & T. Long Lines Department which interconnect the territories of the regional companies. Long Lines also operates the radiotelephone circuits to points overseas.

It handles more than 226 million long distance conversations a year. To do this, Long Lines employs:

—about 24,000 people—including operators, construction forces, engineers and maintenance men—in 40 states;

—well over 13 million miles of talking circuits;

—telephone plant, including almost 1,600 buildings, in all but two states;

—central office forces situated in 245 towns and cities.

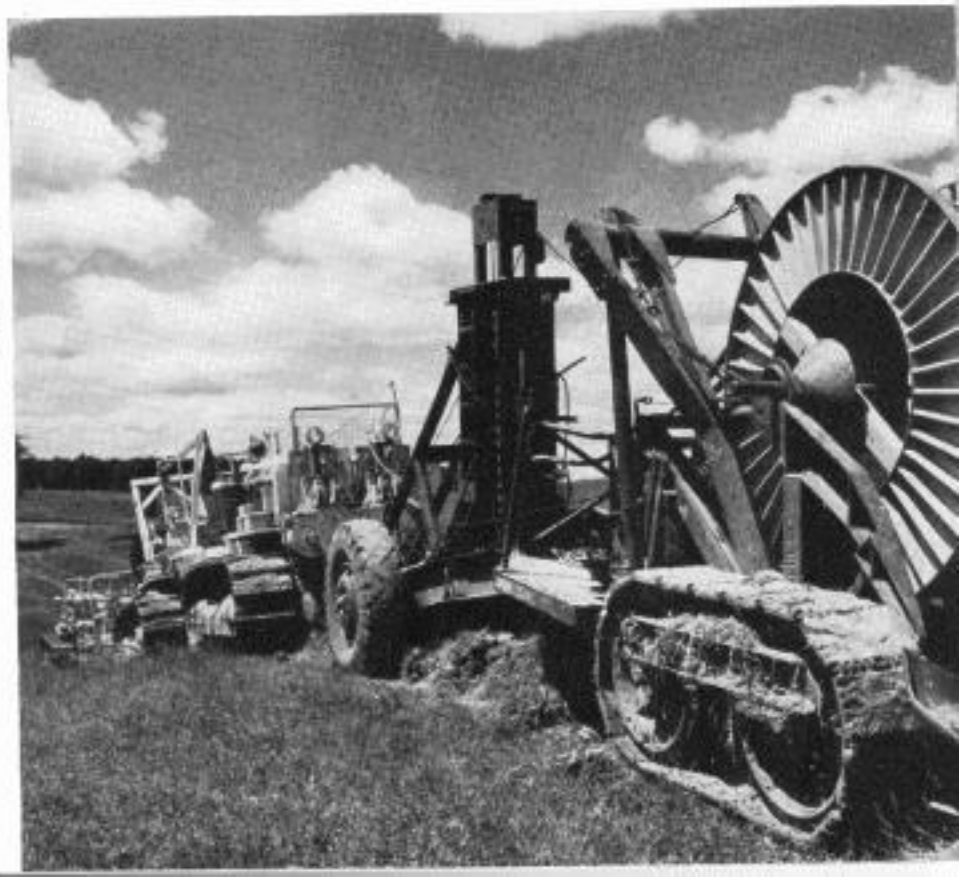
Nine years after the telephone's invention the A. T. & T. Company announced in its charter its plan to connect every place in the United States "by cable and other appropriate means with the rest of the world." At that time the farthest one could talk was from New York to Boston.

From a small number of eastern cities, bounded in 1889 by Boston, Buffalo and Washington, D. C., long distance lines were extended to Chicago in the fall of 1892. Little by little the technical difficulties of transmitting speech over long distances were overcome and in 1911 it became possible to talk from New York to Denver. By 1915, thanks to vacuum tube amplifiers developed by telephone scientists, which made it possible to step up the fading voice currents at regular intervals, one could speak all the way from New York to San Francisco.

—And to Lands Across the Sea

That year also, in October, overseas radiotelephony was first achieved on an experimental basis when speech was sent from the Arlington station, near Washington, D. C., across the Atlantic to the Eiffel Tower in Paris, and also across the American continent and the Pacific to Honolulu, Hawaiian Islands.

Although World War I delayed the development of overseas service, years of further experimenting and perfecting were rewarded in 1927 when regular overseas telephone service was opened between the United



A heavy tractor-powered plow train buries a long distance telephone cable well beneath the sod along the route of a new voice highway.

States and England. Since then service has been extended to both hemispheres and it is possible to reach nearly 96 per cent of the world's telephones in 87 countries and territories. Today, overseas messages are being handled at the rate of 625,000 a year.

Service is furnished through overseas terminals at New York, San Francisco, and Miami and calls are handled in much the same way as any other long distance call. To protect the privacy of these conversations special equipments convert spoken words into unintelligible jargon during their trip through the air.

Calls to overseas points are handled by operators at three Long Lines terminals. This operator is putting through a call to Japan at the San Francisco switchboard.

Radio, Television and Other Networks

Though you may not have realized it, network radio programs are sent over telephone channels from their points of origin to the stations which broadcast them locally. At present Long Lines operates more than 180,000 miles of program transmission circuits for the linking of radio and television stations. Although most of these are furnished by Long Lines, the operating companies also furnish some program transmission circuits within their own territories.

The Bell System's experience in furnishing radio broadcasting networks, which dates back to June, 1923, has been invaluable in helping it to prepare for the problems of providing circuits for transmitting television programs. The System

Monitoring a television program in a Long Lines network control center.

pioneered in sending television images from one place to another—both by wire and by radio—and now has linked major cities along the east coast and in the middle west for the simultaneous broadcasting of television programs. Facilities which will make possible nation-wide television network broadcasting are rapidly being provided.

Teletypewriter service, furnished by Long Lines and the regional operating companies, is a means of transmitting typewritten messages from one office to another whether in the same building or on opposite sides of the continent.

Long Lines control board and equipment for setting up radio broadcasting networks for transmission of programs over telephone circuits.

Teletypewriter exchange service permits the interconnection through switchboards of any subscriber's machine with any one of 26,000 others making up the nation-wide system for the interchange of typewritten messages.

Long Lines and the operating companies also provide extensive private line services which include telephone, teletypewriter, wire photo, and Morse telegraph to the government, the press, and to corporations large and small in a wide field of business. These may simply interconnect two instruments, or they may consist of far-flung networks with switching arrangements to permit interconnection of any of the instruments with any or all of the others.

"General Staff" Services Benefit All

Meeting the needs of the local communities which they serve is the specific responsibility of the Bell Telephone Companies. There are, however, general problems common to all the companies. That these may be handled economically and efficiently, the regional companies contract with the A. T. & T. Company for those things which can be done better and more economically by a centralized organization.

This contractual relationship is an outgrowth of the original licensing arrangement, whereby the first telephone companies secured instruments for the use of their subscribers. It was founded on the necessities of the

Bell System Headquarters. Principal offices of the American Telephone and Telegraph Company at 195 Broadway, New York City.

business. It still exists for the same reason.

To meet this responsibility, A. T. & T. has organized itself to perform services relating to engineering and operation, finance, accounting, and law, and to give such other assistance to the regional companies as may be helpful to them in conducting their business.

Through the headquarters company the benefit of patent rights, covering the results of Bell System research and other inventions in the field of communications, is made available to all the operating units of the System. It is the System's policy also to make patents covering such developments available to others outside the telephone industry upon reasonable terms on a non-exclusive basis.

There are many problems that the Bell Telephone companies share in common. The A. T. & T. staff services to them, which are classified as "operation and engineering", include the entire range of construction, operation, maintenance, and business practices.

New ideas for improved equipment and operating practices which originate anywhere in the System are constantly being studied by the General Staff of the headquarters company. These new ideas are developed and tested, usually in collaboration with Bell Telephone Laboratories, and the resulting improvements spread over the whole Bell System.

One group of the General Staff, for example, develops a new technique for the System's construction forces—a new and more economical method of placing cable and conduit, let us say, or details for plowing cross-country cable underground without the use of conduits.

Another group studies the System's collective experience with buildings and equipment and applies the knowledge to central office design.

A third group develops transmission standards which should be met to assure good service under differing conditions.

Another studies traffic operating methods and results, seeking always to increase the speed and accuracy with which calls are handled. Still another helps the regional companies to develop better business practices and office routines.

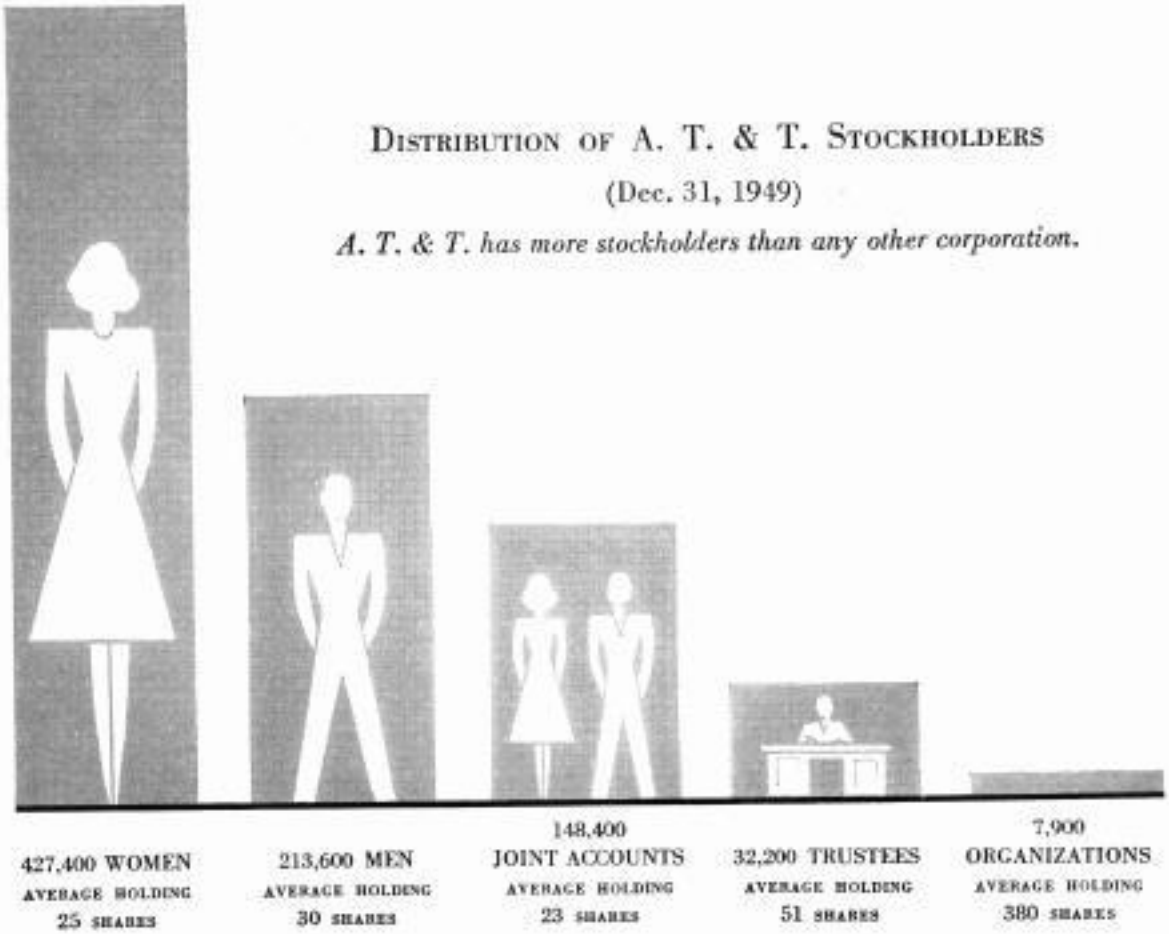
Other groups advise the companies as to the most efficient methods involved in accounting work, in the statistical analyses of the results of operation needed for local administrative purposes, in public relations and advertising activities, and in all the various phases of telephone operations.

No single regional company could make these studies for itself as economically.

Out of the Savings of the Many

Financial assistance to the Associated Companies is one of the A. T. & T. Company's most important services, particularly in periods of rapid growth like the present, when vast sums are needed for plant replacements and additions to meet the demands of the public for service.

The money to build new and improved plant is invested in the business by



people in all walks of life in cities, towns, and villages throughout America. It comes from the savings of the many rather than the wealth of the few. Most of it is invested in securities of the A. T. & T. Company, which in turn supplies funds to the regional companies as they need them.

There are now more than 940,000 owners of A. T. & T. stock, the largest number of stockholders in the Company's history. About one family in 50 now holds A. T. & T. stock. No state has fewer than 600 holders, six states have more than 50,000 stockholders each, and a majority of the states have more than 5,000 each.

Nearly one-third of the owners of A. T. & T. stock have held shares for 15 years or longer. The average number of shares held by all stockholders is less than 30, with no stockholder—individual or institution—holding as much as one-half of one per cent of the total stock outstanding.

Owners of from one to five shares each form approximately one-third of the total stock list, while 95 per cent hold less than 100 shares each. Holders of 100 shares or more total about 50,000 and include insurance companies and many other institutions representing large numbers of individuals.

More than 175,000 telephone employees are telephone stockholders. Many of these employees recently bought A. T. & T. stock under a payroll savings plan, while many more are now buying that way.

Such widespread confidence of investors helps make possible the good telephone service you get today.

Ideals and Aims of the Bell System

The management of the Bell System recognizes its responsibility to treat equitably the telephone users, the employees, and the stockholders, for it is fully aware that in the long run the interests of these three great groups of people, individually and collectively, are mutual and interdependent.

The aim and responsibility of the management is to see that the public receives the most and best possible service at the least cost consistent with good wages and working conditions for employees and a reasonable return for stockholders on their investment in the business.

"The most and best possible service," as interpreted by the Bell System, means a telephone service for the nation, free, so far as humanly possible, from imperfections, errors or delays; enabling anyone, anywhere, to pick up a telephone any time and talk to anyone else, anywhere else, clearly, quickly, and at reasonable cost.

Continuing Research to Provide Better Service

THE search never ends for ways to increase the efficiency of telephone apparatus and to widen the usefulness of telephone service to the public. This search began in the attic room on Court Street in Boston where Alexander Graham Bell carried on his first successful experiments on the "electric speaking telephone." From this tiny beginning has evolved the Bell Telephone Laboratories of today, where nearly 6,000 scientists, engineers, technicians and others continuously search for new devices, new tools, and new techniques to make telephone service ever more useful to more people, and to keep its cost low.

The work of Bell Telephone Laboratories is of four broad types:

Research of a fundamental character, not only in electricity but also in mathematics, physics and chemistry, explores the new and promising to ascertain its general field of application to communication.

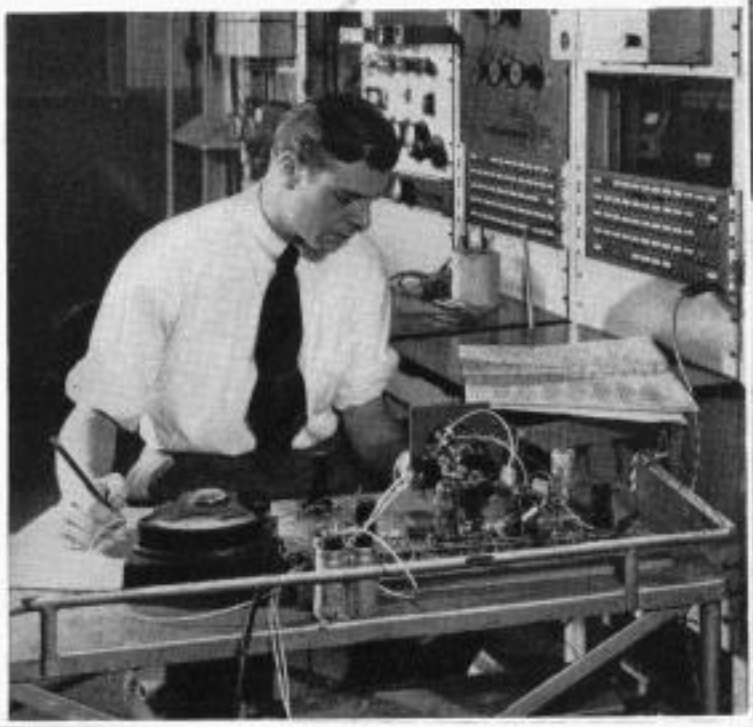
Apparatus Development, responsible for the design and proper functioning of the individual mechanisms in the telephone plant, scrutinizes the new facts turned up by research to see if they can be used to improve existing devices or to help create new ones.

Transmission Development, concerned with improvements in talking quality so that people can hear each other better regardless of distance, considers such things as loudness, intelligibility, naturalness and the various factors that make or mar them.

Switching development joins wires and apparatus into complete systems, so that telephone connections can be made quickly, accurately and economically between your telephone and any other.

Obviously, each of these functions merges into all of the others, and cooperation among these departments and between the Laboratories and the telephone companies and Western Electric must be extremely close.

A Bell Laboratories scientist tests how well people will hear over a long distance circuit containing a new item of equipment.



Some Results of Telephone Research

Here are some examples of the way research has extended telephony, improved it, and reduced its cost to users:

Many years ago, substitution of a pair of wires for a single grounded wire greatly improved transmission and made it possible to talk longer distances. This increased the demand for service and likewise increased the number of wires that had to be strung on poles.

Then the increasing number of wires on towering poles along city streets began to cast real shadows of doubt on the possibilities for further growth. Compact cables had to be developed and means found to run them underground. Years of painstaking study and trial accomplished this. Some exchange cables, smaller in diameter than a baseball bat, now contain as many as 2,121 pairs of wire.

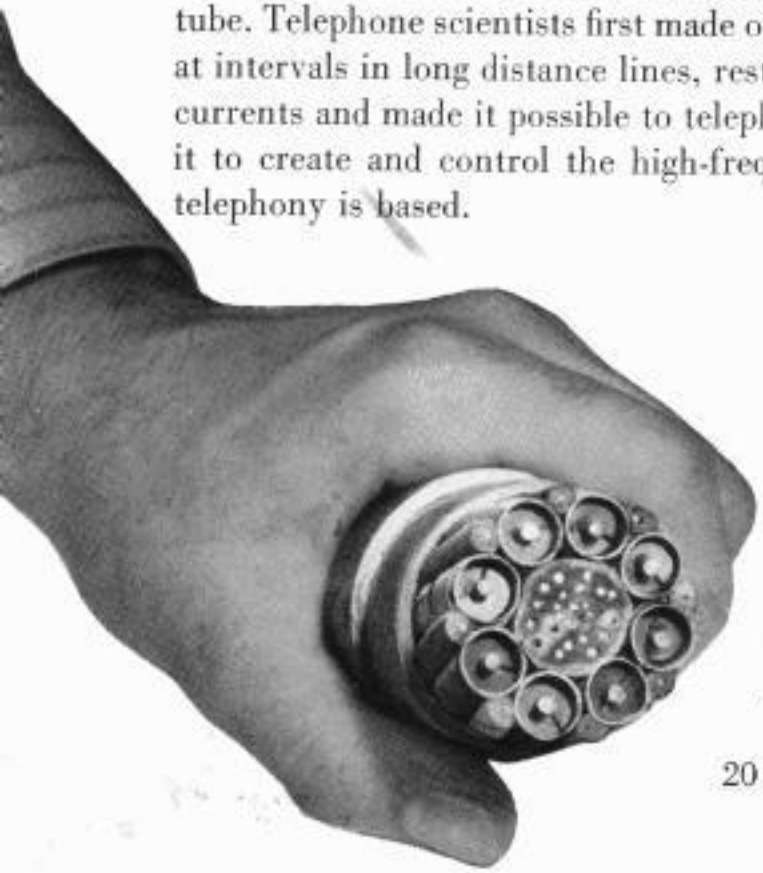
Wires thin enough to be packed in cables offer more resistance to electrical currents than thick wires. The use of cables therefore depended on the success of research to improve transmission.

Cable development illustrates concretely the dollar value of telephone research. The standard cable of 1888 contained 50 pairs of wires and cost more than $150 per pair-mile to install. In 1948, 2,121-pair cable was installed at a cost of about $12 per pair-mile.

Vacuum Tube Opens New Fields

No achievement of Bell Telephone Laboratories has had more far-reaching effects than its work in the development of the electronic vacuum tube. Telephone scientists first made of the tube an amplifier which, placed at intervals in long distance lines, restored the energy of weakening voice currents and made it possible to telephone from coast to coast. They used it to create and control the high-frequency oscillations on which radiotelephony is based.

Next, vacuum tubes were employed to transmit these high-frequency currents over wires. Through the use of complex filtering apparatus, also developed by Bell Laboratories, one high-frequency "carrier" telephone chan-



Little bigger than a man's wrist, this latest type of coaxial cable transmits hundreds of telephone conversations simultaneously or carries television programs over networks.

nel can carry several speech currents at the same time, and the various conversations can be sorted out at each end of the line. It has been largely because of the development of carrier telephony, whereby more messages can be sent over relatively fewer physical conductors, that the Bell System has been able to reduce greatly the cost of long distance telephone service and to provide the circuits needed to meet unprecedented demands during and after the war.

A radio relay station of the type now being built to transmit long distance calls and network television programs.

An extremely important advance in carrier telephony was the development of the coaxial cable. A coaxial unit is basically a copper tube about three-eighths of an inch in diameter, with a single wire slightly larger than a pencil lead inside it. Over two such units several hundred telephone messages may be transmitted simultaneously. When properly equipped, the coaxial system carries television programs over intercity networks.

In the last few years Bell Laboratories has made tremendous advances in generating and detecting radio currents of higher and higher frequency. These microwave currents can be formed into highly directional beams, and by means of relay stations can be transmitted over long distances. At these very high frequencies, there is little interference from static. The beams carry hundreds of telephone conversations or a television program.

A network made up of both coaxial cable and radio relay systems now links major cities along the east coast and in the middle west for the simultaneous broadcasting of the same television program. Similar facilities will be provided to increase the System's capacity to handle long distance calls and make possible nation-wide television network broadcasting.

New Paths Toward New Horizons

Some recent developments of Bell Telephone Laboratories which promise great benefits to telephone users are:

The Transistor, a tiny and amazingly simple electronic amplifier based on an entirely new principle which can perform many of the functions of an ordinary vacuum tube and do other things besides. It seems destined for many applications in telephony.

A new coaxial cable development which promises to increase greatly the capacity of a pair of coaxials, providing either 1800 telephone conversations or 600 telephone conversations and two television channels simultaneously.

Miniature tubes, made with watchmaker's precision, to save space and power and have a longer service life, for use in radio relay, mobile telephone service and other devices.

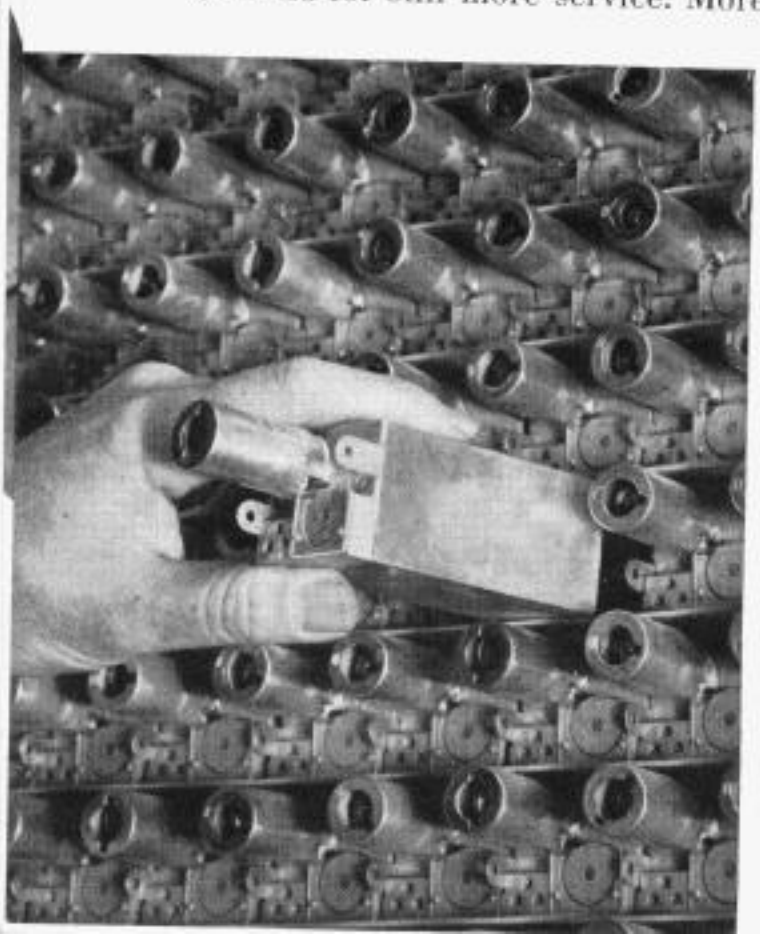
A new handset telephone that has better hearing and speaking qualities, a bell that the customer can adjust for volume, and an easier-to-read dial.

Voice amplifiers which will improve hearing on relatively long local circuits and short toll circuits.

Crystals, both identical with those found in nature and of a synthetic variety. These are being grown in the laboratory to supplement the limited supply of natural quartz crystals used in carrying a number of conversations over the same wire at the same time.

Improvements in telephone service rest on a foundation of continuous research. Even as new developments are being introduced, scientists at Bell Telephone Laboratories continue to open up still further opportunities for the years ahead.

But research is only the first step toward better service. Money to build improved facilities into the telephone plant must be provided by people who are willing to invest their savings in the business. As the plant improves the telephone user gets more for his money, and this creates public demand for still more service. More money then is required to build the steadily improving plant needed to meet this demand. Investors will put up the money needed to continue this cycle so long as they find the return on their investments attractive. Thus, together, effective research, improving service, and earnings adequate to attract the savings of investors, carry on the complex process of making telephone service more useful and more valuable to more people.



A new voice frequency amplifier is slipped into position in a bay which holds 600 of the tiny voice boosters.

Service of Manufacture and Supply

THE manufacture of reliable, standardized telephone apparatus is a major responsibility of still another unit of the Bell System—the Western Electric Company. It supplies to the operating companies telephone equipment of high quality at reasonable prices.

Western Electric also buys for the operating telephone companies large quantities of supplies which it does not itself produce. This arrangement results in important economies.

In addition, Western Electric speeds delivery to the telephone companies of the right equipment and materials at the right time from stocks maintained in distributing houses from coast to coast.

And specially trained Western Electric forces install for the Bell companies most of the complicated central office equipment required to interconnect all parts of the telephone system.

Experience has proved the great value of centering these responsibilities in an organization which works as a unit of the System toward the same goals as the telephone companies—a service steadily improving and increasing in value to more and more people.

Evolution of an Industry

In the first few years after the telephone was invented, apparatus for the Bell companies was made by six manufacturers. Each produced equipment of differing design and quality. It quickly became apparent that progress would depend upon standardized equipment of the best possible quality.

In 1882, the Bell System purchased the Western Electric Manufacturing Company because it was not only the largest manufacturer of telephone apparatus then in the business but the one which best met its needs. Western Electric, which had grown out of a partnership formed in 1869 by Enos M. Barton and Elisha Gray, had been reorganized in 1881 to bring into it some of the other makers of telephone instruments and switchboards. Ownership of Western Electric gave the System assurance of standardized equipment of high quality, reasonable prices and a dependable source of supply.

Growing with the System, Western Electric became an enterprise of national stature with its operations centered in three main works and various satellite plants.

From its Clinton Street shop in Chicago stemmed the great Hawthorne factory on the city's West Side. By 1924, even this proved inadequate and a second works, with the added advantage of sea transportation, was erected at Kearny, N. J. Later a third plant became necessary and, in 1929, the Point Breeze Works was built at Baltimore, Md. Since the war, Western has built a completely modern plant at Allentown, Pa., for the manufacture of electronic equipment. Another for the manufacture of telephone instruments is scheduled for completion in 1950 at Indianapolis, Ind.

A Complex Manufacturing Job

To produce what the telephone companies require, Western Electric's factories are set up to turn out some 150,000 different parts in whatever quantities they may be needed. In a recent year, it turned out some 47,000 different designs, most of them in small quantities. Some of these were new, some old, but all had to work harmoniously in telephone plant with a great variety of equipment.

This is quite different from the usual mass-production setup, though mass-production methods are used in manufacturing those items that can be made in large quantities—in all, about one per cent. This kind of tailor-made job makes it necessary for the supply unit to have intimate knowledge of Bell System plant everywhere.

Cut-away view of a modern combined-dial telephone set. This type of instrument contains 433 parts, each of which must meet rigid standards of accuracy, precision and endurance.

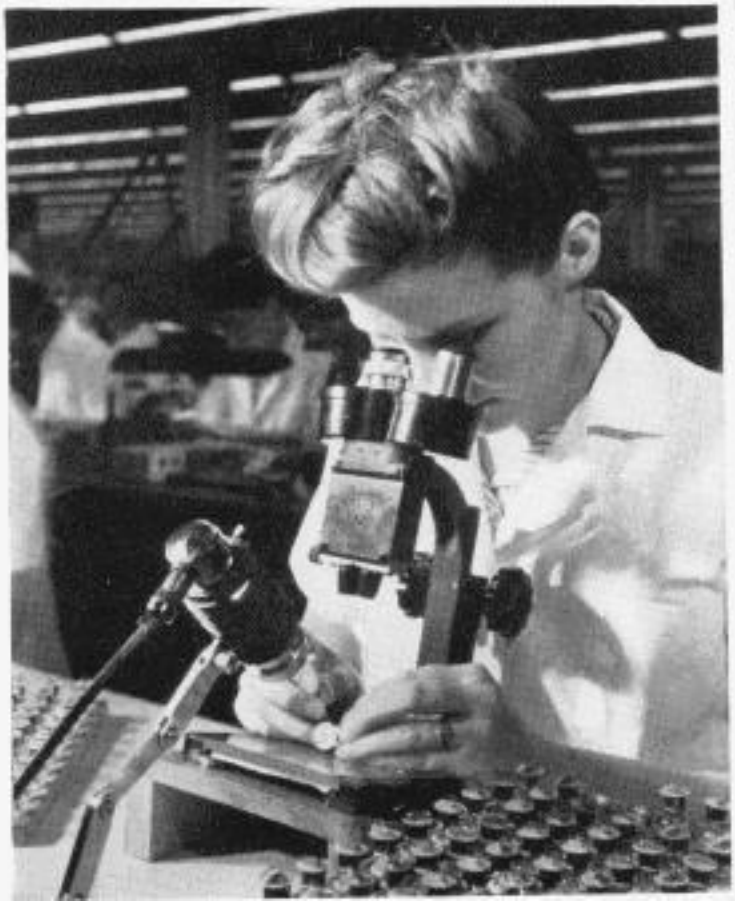
Applying lead sheathing to telephone cable in a Western Electric plant. The finished cable is guided onto the reel in the foreground.

Since telephone plants must give service as trouble free as possible twenty-four hours a day every day, telephone equipment must be of the highest quality and built to exact uniform standards. Experience has proved that the design, manufacture and operation of standard telephone equipment can be best accomplished when the designers, the makers, and the operating people work closely together on the same team.

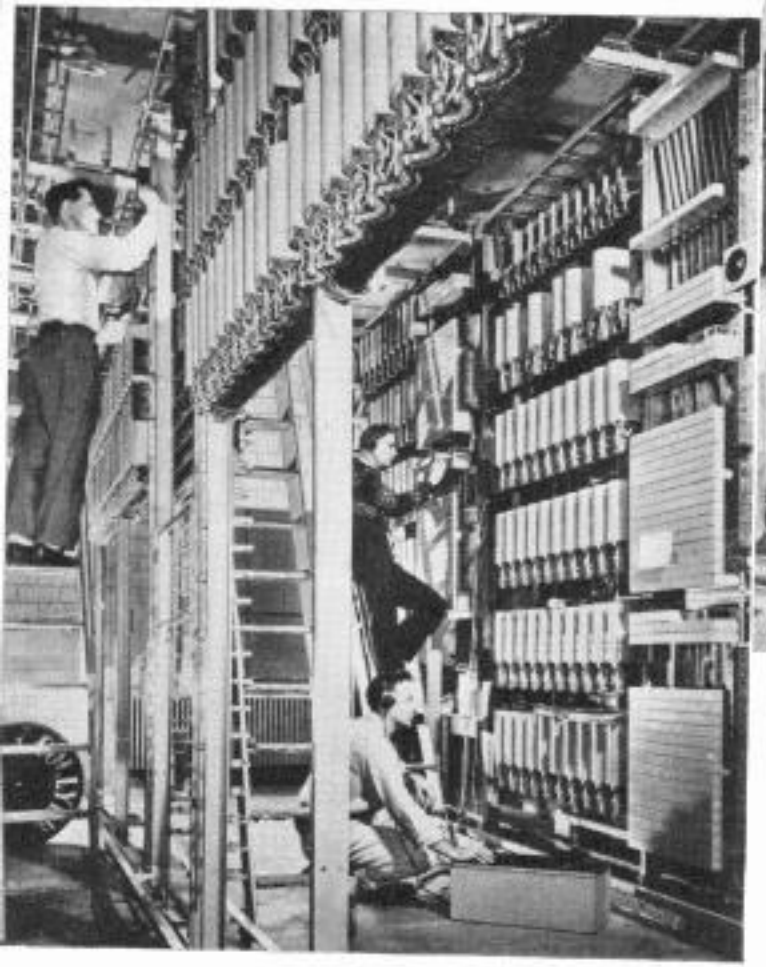
Supplies — When and Where Needed

Western Electric's purchasing people constantly study world markets, prices, and potential sources of new and old materials. It cooperates closely with suppliers who provide equipment and supplies which Western does not make itself, so that they may meet the Bell System's high standards. It also helps them evolve better production methods and better products.

In a recent year Western Electric purchased from 27,000 large and small suppliers located in 2,300 towns and cities in all the 48 states. It also made purchases in many foreign lands. Such purchases included, in addition to all kinds of raw materials used in the company's own factories, many finished products ranging from pen points to automobiles, from pencils to telephone



High-powered optical equipment is needed to maintain the hair-splitting tolerances necessary in the manufacture of miniature electron tubes at a Western Electric plant.



Stockmen in a Western Electric distributing house fill orders for equipment and supplies received from Bell Telephone companies.

Western Electric equipment installers put the finishing touches on a new installation of step-by-step dial switching equipment for a Bell Telephone company.

poles. Filling Western Electric orders keeps thousands of workers busy in mine and factory, in forest and office and on the farm.

Western Electric maintains 28 distributing houses through which materials flow to the Bell companies. Each is set up especially to meet the requirements of the telephone company it serves, and to work hand in hand with the telephone organization to deliver the goods as promptly and efficiently as possible.

Associated with each distributing house is a repair shop where used apparatus which has been removed from the telephone plant either is reconditioned so that it will give good service again, or dismantled so that usable materials may be salvaged.

Large forces of highly trained Western Electric men install central office equipment for the telephone companies. Such an installation force can perform most efficiently the over-all work of installing telephone central offices from coast to coast. At the same time, Western Electric is able to supervise all steps in making the equipment ready for use, from purchase of raw materials to finished installation. This assures the telephone companies that new apparatus will give the best possible service.

A National Asset

Time and again the unified service of supply within the Bell System has proved to be a national asset. After hurricanes, floods, ice storms, earthquakes and fires, when the men and women who build and operate the telephone plant go "all out" to furnish emergency service and restore damaged plant, Western Electric swings into action to deliver the needed equipment and supplies with all speed. And this equipment is standardized; it is familiar to all telephone people and can be installed quickly anywhere.

It was with such experience behind it that Western met the challenge of war. Its huge production capacity is geared to meet the public need, and is always ready in any national emergency. Throughout the conflict, all its resources were devoted to the needs of the United States and its allies for electronic and communications equipment. It was the nation's largest producer of such apparatus, including radar, sonar and various types of radio equipment.

Since the war Western Electric has produced record breaking quantities of equipment to meet America's telephone needs. It increased its production tremendously to meet the big demand for telephones, willingly undertaking the financial risks of a big expansion program to enable the operating companies to serve millions of people faster than otherwise would have been possible. At the same time, Western has produced new devices and systems—developed in cooperation with Bell Telephone Laboratories—to make telephone service more valuable to more people.

In a period of about four years after the war, products manufactured by Western Electric for the Bell System went up in price only 16 per cent over the 1935-39 average while prices of all other manufactured products increased 76 per cent.

Because it works as a unit of the System rather than toward a separate end of its own, Western Electric, maker of your Bell Telephone, plays an essential part in furnishing Americans with the best telephone service in the world at the lowest possible cost.

Telephone materials are flown into a storm-stricken area from supplies stocked in one of Western Electric's 28 distributing houses.

"Dr. Bell, I heard every word you said—distinctly!"

From Bell to Bell System

THE telephone we use today is very different in the details of its design from the first instrument invented by Alexander Graham Bell, but it works on the same principle. As soon as Bell proved his invention practical, he visualized it as an instrumentality of service which could link homes with offices, sweep aside the isolation of farms, and bind together cities and nations with the bonds of electrically transmitted speech.

Alexander Graham Bell had prepared himself to follow the professional footsteps of his father and grandfather in the teaching of proper articulation and the correction of speech defects and became a teacher of speech to the deaf. Early in his training, his investigations into the nature of sound led him to take up the study of electricity, particularly as related to telegraphy. It was out of this work, together with his understanding of how the organs of speech and hearing work, that his invention grew.

In the course of his experiments with a device called the harmonic telegraph, which he hoped would transmit several Morse messages over the same circuit simultaneously, Bell conceived the principle of the telephone.

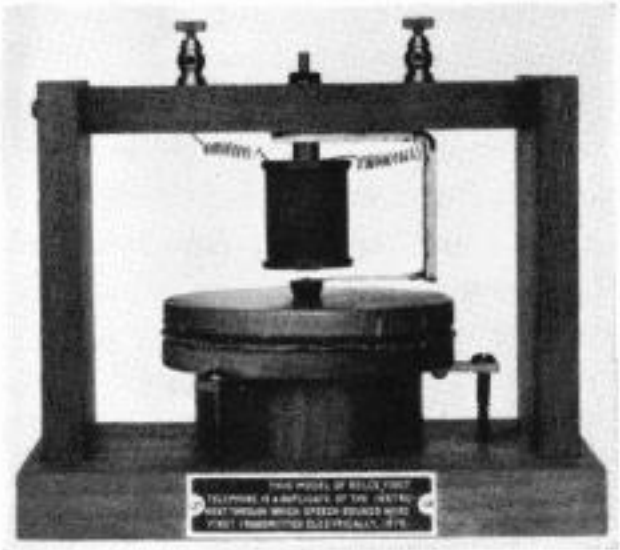
He outlined the principle to his young mechanical assistant, Thomas A. Watson, as follows:

"If I can get a mechanism which will make a current of electricity vary in intensity as the air varies in density when a sound is passing through it, I can telegraph any sound, even the sound of speech."

The Twang of a Reed

This conception was clear in Bell's mind by the summer of 1874, but he did not then know how to reduce it to practice. On June 2, 1875, he succeeded in doing so. In adjoining attic rooms at 109 Court Street, Boston, he and Watson were trying out several pairs of the telegraph instruments, each of which consisted of an electro-magnet with a steel organ reed mounted over it. As Watson plucked one reed with his finger to start it vibrating Bell heard the unusual sound and even recognized the characteristic pitch and quality of the twang of that vibrating reed! He knew then that, as Watson has put it, "he was hearing, for the first time in human history, the tones and overtones of a sound transmitted by electricity."

That afternoon Bell directed Watson to make the instrument that was to be the first Bell telephone. This instrument transmitted the tones of the voice, but it was not until March 10, 1876 that Bell, using a different experimental transmitter, first sent over an electric wire an intelligible sentence of speech.

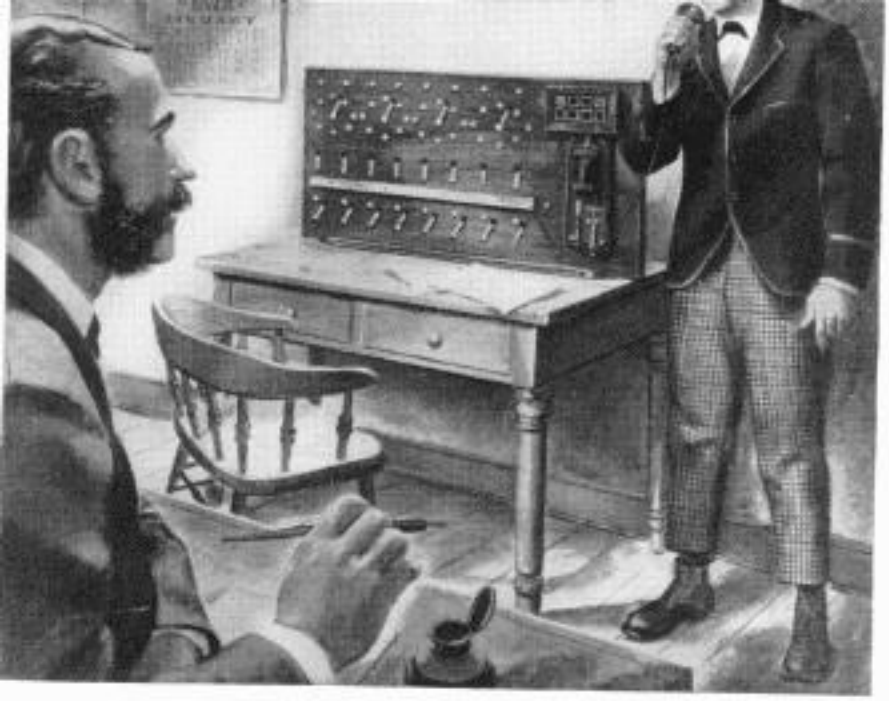


Bell's first telephone transmitted and received speech sounds but not words.

The Telephone Talks

On that evening as the young inventor was preparing his crude transmitter to try to send his voice over a wire to a room down the hall where Watson was listening, he upset the acid of a battery, spilling it over his clothes. Impulsively, Bell called out, "Mr. Watson, come here; I want you!" An instant later Watson burst into the room, shouting "Dr. Bell, I heard every word you said—distinctly!"

Bell's telephone was exhibited and demonstrated at the Philadelphia Centennial in June, 1876, where it was given the enthusiastic approval of



Artist's conception of the first commercial switchboard, which was placed in service to interconnect 21 subscribers in New Haven on January 28, 1878.

leaders in the scientific world. But the general public was apathetic. The young inventor had no financial backing other than that of Thomas Sanders and Gardiner G. Hubbard. In the fall of 1874 these men had agreed to supply funds for Bell's telegraph experiments in return for a share in whatever patent rights might result from his experimentation. His telephone patents were later included in this agreement.

Bell's first telephone patent had been granted on March 7, 1876, but was earning no return. Sanders and Hubbard had advanced all they could. In order to eke out his slender personal income as a teacher, and to provide funds for further experimentation, Bell began, early in 1877, to give lectures at which he demonstrated the telephone. These were well attended and accounts of them were widely published. A few forward-looking people began to realize the usefulness of the telephone and its possibilities as a business opportunity. In May, 1877, the first telephones were put into use on a commercial basis. Soon people throughout the country began to inquire about ways of getting into the telephone business.

How the Bell System Was Formed

The commercial development of the telephone had begun and the time had come for a more definite organization than the rather informal arrangement that had been made between Bell, Sanders and Hubbard, into which Watson had by this time been admitted.

This took the form of a trusteeship, instituted in July, 1877, by these four owners of the patents, with Hubbard as trustee and virtual executive head of the enterprise. It was he who inaugurated the policy of leasing instruments instead of selling them and who introduced the system of

licenses to authorized agents or licensees throughout the country for the commercial development of the telephone, thus laying the foundation for the telephone industry of today.

Telephones first were leased in pairs. The lessee put up his own wire to connect his telephone with that of a friend or neighbor, or ran the line between his home and place of business. At first, there was no way he could talk by telephone with others in the community who leased instruments.

The development of the telephone switchboard made possible the interconnection of these individuals and later of communities. The first switchboard was installed in the office of E. T. Holmes, in Boston, in May, 1877, and connected four banks and a manufacturing concern. It interconnected these few telephones by using wires in the daytime that were employed for a burglar alarm system at night.

New Haven, Connecticut, became the first city in the world to have a commercial telephone exchange. A switchboard interconnecting eight lines and 21 subscribers was placed in service there in January, 1878.

Two years later, in April, 1880, the American Bell Telephone Company was organized. It greatly developed the telephone organization and business throughout the country.

At the same time that local facilities were being developed and coordinated, the interconnection of telephone offices in different localities was getting under way. A line from Boston to Providence was built in 1881, and service between Boston and New York, 235 miles, was opened in 1884.

By 1892, Boston and New York were talking to Chicago, Milwaukee, Pittsburgh and Washington, D. C. One-half of the people in the United States had been put within talking distance of one another.

An important step toward the attainment of a nation-wide telephone service was the organization of the American Telephone and Telegraph Company in 1885. This company was formed to build and operate long distance lines to interconnect the regional companies that had developed, by merger and growth, from early licensee companies.

To realize the ideal of universal telephone service, it became increasingly important to extend the long distance lines even farther, to carry on the continuous investigation for the practical development of the telephone art, to make further progress toward the standardization of apparatus, equipment and methods, and to centralize administrative functions where such centralization would contribute to economical and efficient service. In 1900, therefore, the American Telephone and Telegraph Company took over the assets of the American Bell Telephone Company, becoming the headquarters company of the Bell System.

Progress—Past, Present and Future

YEAR after year, the Bell System has provided service of steadily increasing value to more and more people. In the years of boom, depression, war and post-war readjustment since 1920:

The number of Bell telephones has greatly increased: there are more than four times as many in service today;

There are also four times as many telephone conversations—an average of 132 million a day;

Fast and accurate dial service has been extended to nearly three-fourths of all Bell System telephones;

A network of sturdy cable lines has been built from border to border and coast to coast to make service on out-of-town calls faster, better, and more dependable;

Intercity telephone messages have shot up from over 325 million to almost 2,000 million a year;

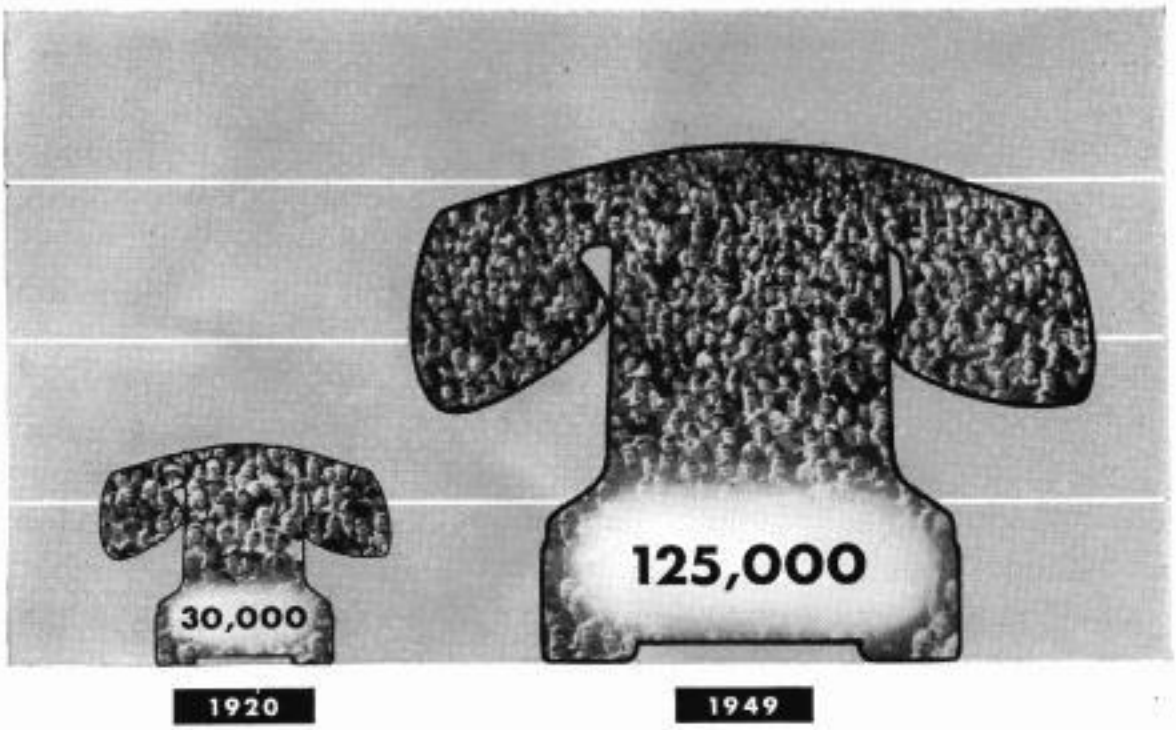
The average time to complete out-of-town calls has been reduced from 14 minutes to 1.5 minutes and the number of such calls put through while the caller remains at the telephone has increased from 10% to 95%.

Radio has been used increasingly to extend regular telephone service to lands overseas, to ocean liners, to coastal and inland watercraft, to vehicles and trains.

Bigger Value

Not only is telephone service much better now, but customers today can talk with a great many more people than they could in 1920. For

Operators dialing straight through to called telephones in distant places by pressing keys on the switchboard.



Telephone customers now are able to reach a great many more telephones at local rates than in 1920.

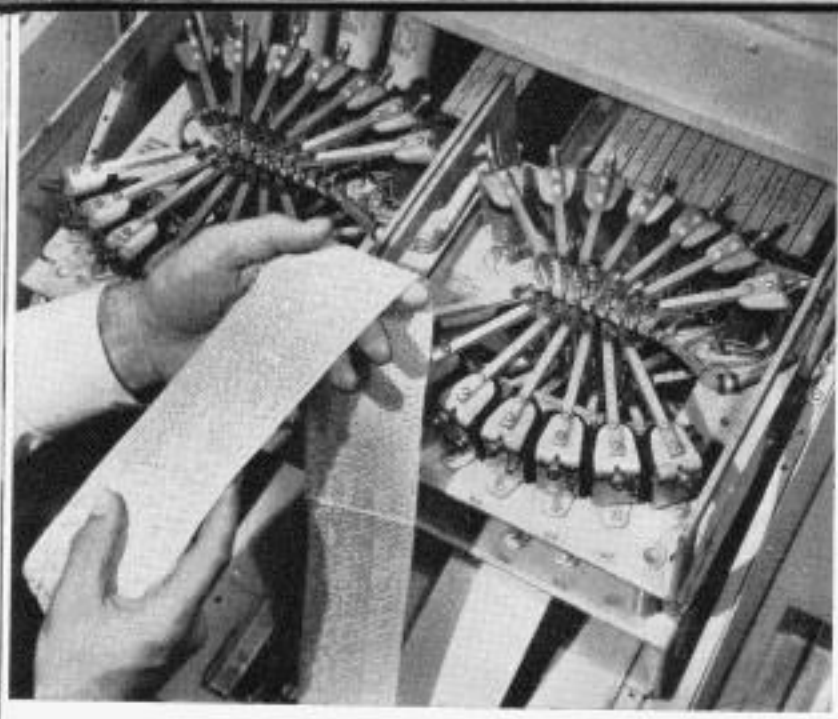
example, in the largest 170 cities in the United States, the average number of telephones that a customer can reach within the local calling area increased from 30,000 in 1920 to about 125,000 in 1949.

Also, long distance rates are much lower today than in 1920. The average station-to-station day rate between the largest 25 cities in the country is down from about $6.00 to less than $1.60. The transcontinental day rate for a station-to-station call has been reduced from $16.50 to $2.50. Overseas rates have been cut drastically since the service was opened in 1927; for example, a New York-London call which cost $75 in 1927 now costs only $12.

The Future Holds Great Promise

New devices, new systems and new services are being introduced to provide more and better service in the future than at any time in the past.

Fast, accurate dial service is rapidly being extended in cities, towns and rural areas. At the same time, new equipment and methods are enabling operators to dial many long distance calls straight through to distant telephones without the assistance of other operators along the route or at the distant places. Toll dialing networks now span the nation and reach out to more than 600 cities and more cities will be added every year.



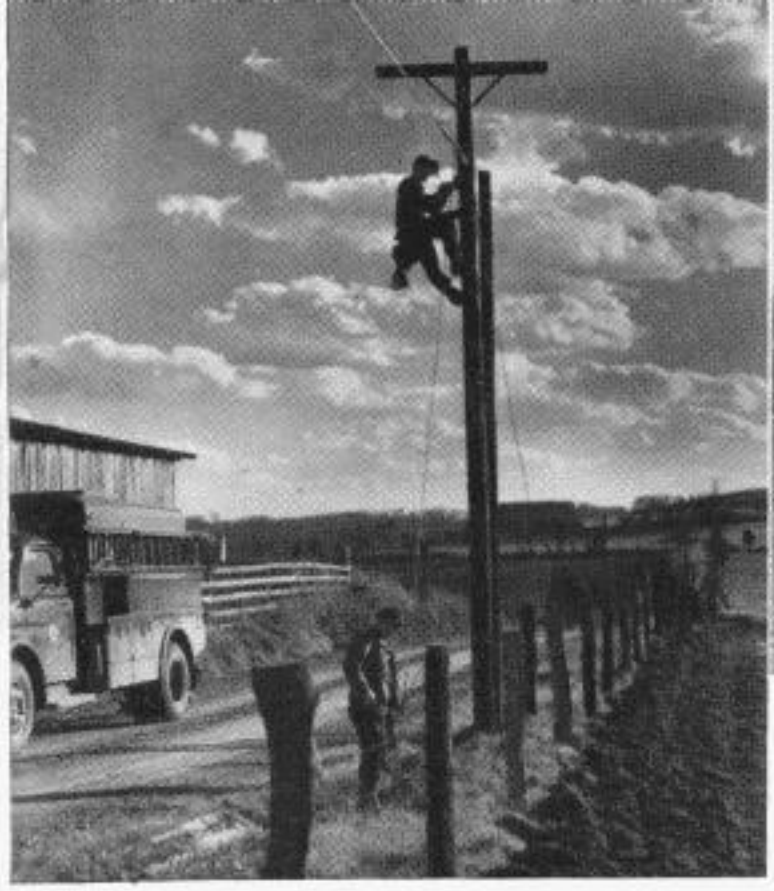
All the information necessary for billing toll calls is punched out in code on paper tape by this automatic message accounting machine.

In certain metropolitan areas, telephone customers can now dial calls to nearby communities just like local calls. This method is being further extended as new equipment developed by Bell Telephone Laboratories becomes available. Such apparatus employs an electrical "brain" to receive the dialed number and complete the call, while an automatic message accounting system gathers the information necessary for billing. As equipment of this kind comes into wider use, more customers will be able to dial straight through to out-of-town telephones, first nearby, then farther and farther away.

Bell System mobile telephone service is now a reality in most of the major cities and on many highways throughout the United States. There are several thousand of the "traveling telephones" in automobiles and many others on boats that ply coastal and inland waterways. Regular telephone service is being provided on an increasing number of passenger trains and new developments promise extension of the service to airways passengers. In addition, private mobile telephone systems, leased and serviced by the Bell Companies, are being used increasingly by police, utilities and industrial concerns.

Telephone service in rural

A great-granddaughter of Alexander Graham Bell, Miss Joan Blair, makes a call over a mobile telephone.



Power driven augers, as pictured above, help speed the construction of rural telephone lines. At left: Linemen string wires to serve more farm telephones.

areas is being extended and improved with the help of fast, economical construction methods and important new techniques. Power-driven augers quickly drill pole holes. Special plows bury wire and cover it, in one operation. Stronger wire makes it possible to set poles farther apart. Special equipment permits the same wires to provide both electric power and telephone service.

These methods have helped the army of telephone engineers and construction men engaged in the rural program to build rural telephone plant in the past four years at a rate three times as fast as ever before in history. They have set up literally tens of thousands of miles of new pole lines and strung more than 600,000 miles of wire—to say nothing of many new buildings and vast quantities of switchboards and other equipment. At the same time they have made great strides in improving the quality of service in rural areas.

The work goes right on, with the telephone companies continuing to provide still more and better telephone service just as fast as they can in rural as well as in urban areas and on inter-city routes.

Service to the Nation

NEITHER chance nor mere good fortune has brought this nation the finest telephone service in the world. The service Americans enjoy in such abundance is directly the product of their own imagination, enterprise and common sense.

They have learned more and more ways to use the telephone to advantage, and have continuously encouraged invention and initiative to find new paths toward new horizons. They have made the rendering of telephone service a public trust; at the same time, they have given the telephone companies, under regulation, the freedom and resources they must have to do their job as well as possible.

In this climate of freedom and responsibility, the Bell System has provided service of steadily increasing value to more and more people. In a little more than four years following World War II the Bell System added eleven million telephones—as many as were placed in service during the first 48 years of Bell System history. At the same time, the quality of the service was steadily improved.

To do this, the System has had to carry out the biggest construction program ever undertaken in a like period by any industry. The people of America have made this possible by investing more than three billion dollars of their savings in Bell System securities, to build new telephone plant.

There is a tremendous amount of work to be done in the near future and the System's technical and human resources to do it have never been better. Its physical equipment is the best in history, though still heavily loaded, and there are many new and improved facilities to incorporate in the plant. Employees are competent and courteous.

With these assets and with the traditional spirit of service to get the message through, the Bell System looks forward to providing for the people of America a service still better and more valuable in the future than at any time in the past.

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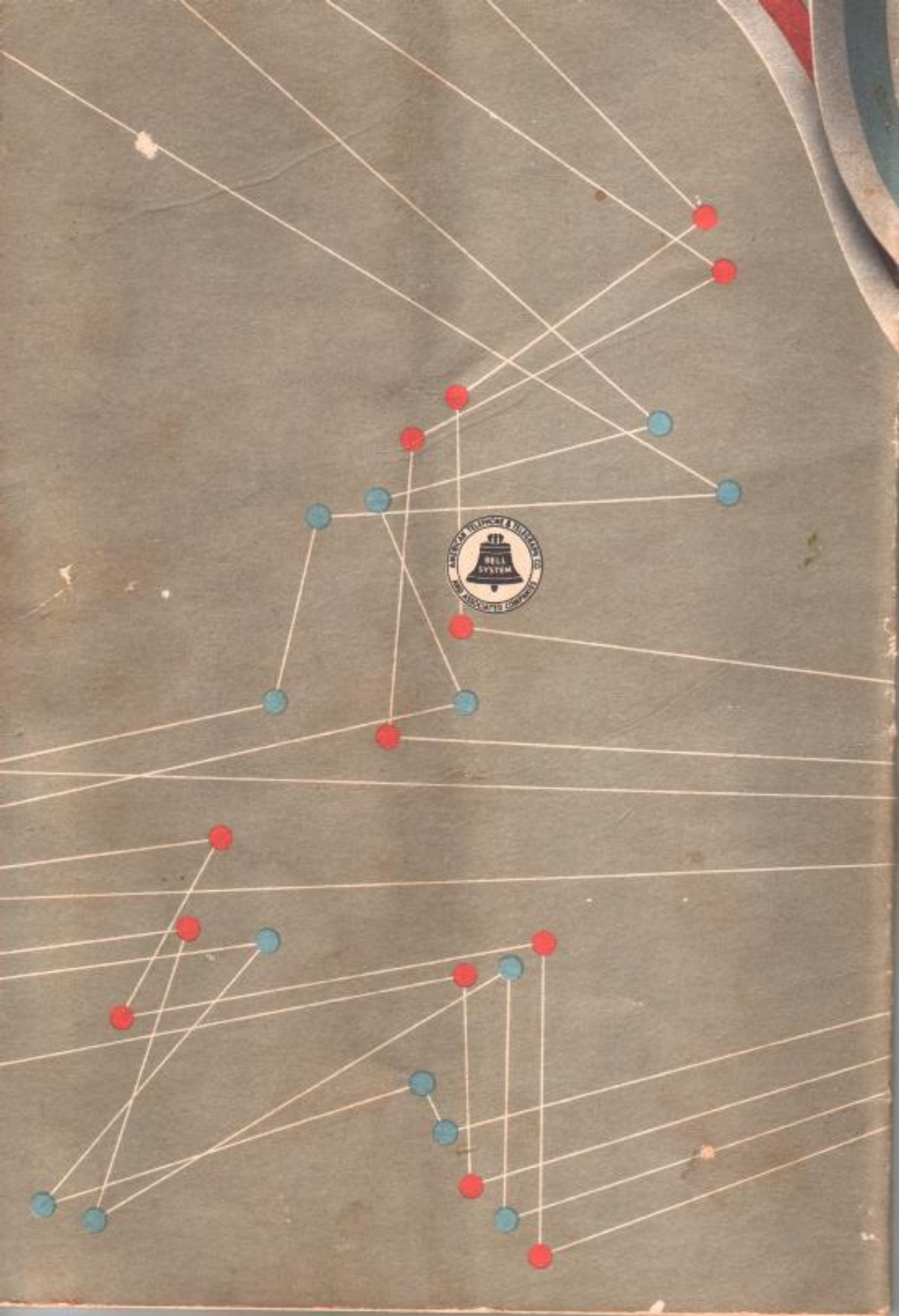
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