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VICE PRESIDENT

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TO ALL MANAGEMENT EMPLOYEES

"Western Electric And The Bell System" has been published to provide reference material for employees entering supervisory, engineering and other management positions. Its purpose is to bring together, under a single source, significant information about our business that might not otherwise be clarified during the early stages of a manager's career. It is my view that employees embarking on such careers should develop a thorough knowledge of the Company as a sound foundation for directing their own activities and to better represent the Company to other employees, to their community, to friends or professional associates and, as the occasion arises, to the general public.

I feel that, as incumbents in like positions, you will want to have your own copy. I hope it will aid you in helping others to understand and appreciate the role of Western Electric in the Bell System.

Att.



MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

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Western Electric
and the
Bell System



Western Electric and the Bell System



A SURVEY OF SERVICE

Edited By Albert B. Iardella

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**WESTERN ELECTRIC AND THE BELL SYSTEM
A SURVEY OF SERVICE**

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Preface

This book is intended primarily for Western Electric men and women entering management positions, and has as its purpose the presentation of information that will contribute to a clear understanding of what the Western Electric Company represents and what it is seeking to accomplish.

The book has been designed to provide a convenient source of information concerning the foundations, objectives, achievements and operations of Western Electric. It is hoped that this survey will show how the company and each of its parts contribute to the fulfillment of our two major goals:

- (1) Assisting the Bell System to bring into being increasingly better, faster, more reliable and more versatile communications, and
- (2) Aiding the United States Government in its defense and space activities.

The Bell System — a Concept in Action

I

The telephone is so basic a convenience today it is hard to realize that the invention is less than a century old. In this brief span of time, the Bell System has grown from an imaginative concept of "universal service" into a reliable and versatile reality which provides America with the finest communications in the world.

All this has come about as the result of the integrated and co-operative efforts of the Bell System units constantly to improve the quality and increase the variety of communications services offered to the public. It is the concept of service to the public which unifies the Bell System, and in realizing this concept, Western Electric has played a leading part.

Growth, to help the Bell System meet the growing need for communications services, has been a constant factor in Western Electric for the more than 82 years the company has been a member of the Bell System. The details of this growth, cited later in this book, show how Western Electric has continually redefined responsibilities and re-focused efforts to achieve more effective concentration on its main goal: providing the Bell Telephone companies with the means whereby each can offer new, improved and expanded communications to the public it serves.

As the Bell System has grown in service, it has grown in size. The success of the Bell Telephone companies in supplying reliable and versatile communications at reasonable cost has resulted in the introduction of new types of communications. As Theodore N. Vail — the man who conceived of the Bell System as a nationwide network — said many years ago, "The Bell System is strong because we are all tied up together; and the success of one is therefore the concern of all."

Curiously, the Bell System's dedication to service has tended in

effect to disguise the complexity of the job involved. Today telephone service is so reliable that most people take it for granted. The subscriber expects to reach the one he is dialing in a matter of seconds whether the call is across the town or across the country. It is doubtful if most people are aware that the Bell System's nationwide network must be capable of handling two and one-half million-billion inter-connections to link each of the more than 80 million telephones in the United States with all the others.

The nation-wide Bell System network, which has been described as the largest computer in the world, is the result of teamwork by people at AT&T, Bell Telephone Laboratories, Western Electric, and the Bell Telephone companies. Close cooperation between Western Electric and Bell Laboratories engineers has resulted in the introduction of countless communications products and services. Similarly, the close relationships between Western Electric and each of the operating companies embody a spirit of united service to the public.

Evidence of this teamwork is everywhere. Nation-wide Direct Distance Dialing is a tribute to it. New telephone products like the Panel phone and the telephone sets for TOUCH-TONE® service result from it. The habit of teamwork accounts for the speed with which telephone service is restored in the wake of hurricane or flood. But, far and away, the most important if least spectacular evidences of teamwork can be found in the day-to-day operation of the business. It is the reliability of Bell System communications as much as their versatility and flexibility which justifies the motto used in many Western Electric advertisements: We work best because we work together.

No single organization chart covers the entire Bell System. From an organization standpoint, each Bell Telephone company is an independent corporate enterprise. Each has its own Board of Directors, responsible for directing each company's affairs. AT&T's relations with these companies come primarily from stock ownership and the voice in the affairs of the corporation that naturally and legally is extended to every stockholding interest. There are also important contractual relations between each of the associated companies and the parent company, AT&T, based on the agreements with the original local companies licensing the use of the Bell patents.¹

Similarly, the manufacturing and supply organization — Western Electric — which likewise exists as a distinct corporate organization,

¹ When many of these local companies merged into the present associated companies, the new companies assumed the contractual obligations of the original licensee companies, in most cases without appreciably changing the original agreements, in some cases with new license contracts similar in form.

has supply contracts with the associated companies that define its obligations to them. In the same way, Bell Telephone Laboratories is a distinct corporate organization. Each differs from an operating company in that it is entirely functional rather than territorial and is not a public utility.

The Bell System is, therefore, a product of evolution as well as innovation. To see how the structure has grown so that all units combine their efforts for the common goal of service, this survey of Western Electric and the Bell System opens with a history and description of AT&T. After this review of the parent company, Bell Laboratories functions are described and then those of the Bell Telephone companies.

Part I:
Our Bell System
“Partners”

The American Telephone and Telegraph Company

II

CORPORATE DEVELOPMENT OF AT&T

Ideas are elusive. It is hard to say just when Alexander Graham Bell conceived the possibility of transmitting intelligible speech over wires. It is easier to pinpoint the date when Bell felt his work far enough advanced to seek to protect it by patent. On March 6, 1876 he and two backers, Thomas Sanders and Gardiner G. Hubbard, formed the Bell Patent Association. The following day, the United States Patent Office issued patent number 174,465, called "improvement in telegraphy" in answer to Bell's application. This patent contained specifications for the telephone instrument. By January 30, 1877, the Bell Patent Association held four fundamental patents and was ready to market the new device. In July, in Boston, the first telephone company was formed as "Bell Telephone Company, Gardiner G. Hubbard, Trustee." The name of the company seems a bit peculiar today but the trustee system was common in those days, particularly in New England.

To spread the use of the invention, Hubbard offered licenses to form telephone companies to any accredited organization that would agree to finance and conduct such a business.

About the same time, Sanders interested a group of Massachusetts and Rhode Island financiers in the telephone. This group formed the New England Telephone Company (not connected with the present New England Telephone and Telegraph Company) and agreed both to buy their telephones from the Bell Company and to lease them to their subscribers. The two companies also agreed to provide connecting lines between their territories.

The success of the venture led the Bell group to form another company to lease telephones in the rest of the country. The trustee arrangement was ended and a Massachusetts corporation was formed as the

Bell Telephone Company. Patent rights were assigned to the New England Company for their states and to the Bell Telephone Company for the rest of the country. However, within a year the two companies had merged to form the National Bell Telephone Company. It, too, had headquarters in Boston but unlike its predecessors it was the first telephone company to achieve any real prominence.

On March 20, 1880, the Bell interests formed the American Bell Telephone Company, a Massachusetts corporation with a capitalization of \$10,000,000, in response to the need for more capital. By the articles of incorporation, this company was permitted to own stock in other companies. It was about this time that stock ownership began to spread. In December, 1880 there were 540 shareholders. On January 1, 1881, the first dividend — \$3.00 a share — was declared.

By 1881 a clear policy of licensing had been established. The parent company furnished the telephones and retained the right to provide connecting links between territories so as to form intercommunicating systems. Eventually these licenses became permanent and, in addition to confirming territorial rights, included the right to participate in all future inventions as well as those existing at the time. Each of the territorial companies paid rental to the parent company and the parent company was represented in each as a stockholder. Gradually the parent company acquired substantial holdings in these companies as a result of providing financial assistance for expansion.

There were now about 300 telephone companies operating under American Bell Telephone Company licenses. Many held licenses only for a city. Each operated fairly independently, without the benefit of knowing how similar problems had been solved in other locations and there was a danger that quality standards would vary from place to place. Moreover, the growing popularity of the telephone indicated that it could increase in service greatly through interconnection of exchanges.

WESTERN ELECTRIC ENTERS THE BELL SYSTEM

Western Electric's entry into the Bell System in 1882 provided a source for compatible telephone equipment of high quality. In 1885 the American Telephone and Telegraph Company was formed in New York (as a subsidiary of American Bell) to build the lines needed to connect the scattered exchanges "in each and every city, town, or place . . . with one or more points in each and every other city, town, or place . . . of the United States, and in Canada, and Mexico . . . and also by cable and other appropriate means with the rest of the world." —

essentially the function now performed by the Long Lines Department of AT&T.

This was the goal as stated by Theodore N. Vail, at that time general manager of the American Bell Telephone Company, and subsequently first president of AT&T. More than any other man, Vail was responsible for the conception and realization of the Bell System network. His enthusiasm evoked a predictable response. There were some who shared his enthusiasm; others praised his vision and let it go at that; and many others shook their heads in practical disbelief.

At their annual meeting in March, 1900, American Bell stockholders voted to make AT&T the central organization of the Bell System. American Bell conveyed its assets to AT&T, which served as the coordinator of activities among the operating companies and also retained operation of interconnecting networks.

In 1911, AT&T announced its plans to reorganize operating companies into state-wide or larger territorial units. "Each associated company . . . will become an autonomous whole, with its own local control and identity, and within the limits of the general policy and authority, absolute on matters pertaining to or which affect only that territory," the AT&T annual report stated. This policy continues to guide Bell System operations today.

In December, 1913, AT&T agreed to provide long distance connection of Bell System lines to the numerous independent telephone systems which had developed after the expiration of the Bell Patents.² This arrangement contributed to the development of the entire telephone industry in the United States and it is because of this access to the Bell System's nation-wide network that each of America's telephones may be connected to all the others.

REGULATORY AGENCIES

As early as 1910, by means of the Mann-Elkins Act, the Federal Government vested certain interstate telephone tollrate authority in the Interstate Commerce Commission. In 1934, this commission was superseded by the Federal Communications Commission, which had broad regulatory authority and which continues today as the body regulating the interstate rates and services of the Bell System. In addition, since almost the beginning of the century, state regulatory bodies, usually

²The terms of the agreement are contained in the so-called "Kingsbury Commitment," a letter to the U.S. Attorney General dated December 13, 1913 and signed by Nathan C. Kingsbury, at that time vice president of AT&T. Elsewhere in this letter, AT&T announced its intention of disposing of such telegraph stock as it owned and noted that the company would not acquire any more competing telephone companies.

called Public Service Commissions or the like, have regulated the intrastate rates and services of telephone companies. In Texas rates are regulated by various city bodies.

Both Federal and state regulatory bodies exercise direct control over the accounting, rates and services of the Bell Telephone companies and indirect control of Western Electric's prices and profits.

AT&T's ROLE IN THE BELL SYSTEM

The American Telephone and Telegraph Company, the Bell System's parent organization, acts as an operating unit and a service group. Before examining the activities these functions require, however, it seems wise to make two points concerning the use of words.

First of all, the term "Bell System" refers mainly to a concept of service rather than a sharply defined entity. It is rather like the British Commonwealth, and a little like Dixie in this respect. The Bell System provides communications services through the actions and operations of the Bell Telephone companies and AT&T's Long Lines Department. Use of the term "Bell System" is a convenience to suggest the common purpose and shared responsibility of the various companies contributing to the operation, growth, and improvement of the whole nationwide network and the international connecting links.

Note also that terms denoting parts of the corporate structure vary from company to company. In Western Electric, for example, the word "Division" is used to identify basic functions such as manufacturing, engineering and legal. In AT&T, however, the word "Department" is used for this purpose. With this in mind, let us look at the relationship of AT&T to other Bell System members and also examine the company's structure.

AT&T's basic relationship to other units of the Bell System has five aspects.

1. AT&T owns 99.82 per cent of Western Electric stock. The equipment, services, and supplies that Western Electric furnishes the operating units of the Bell System are characterized by their compatibility, their reliability, uniform high quality and reasonable cost.
2. AT&T shares ownership of Bell Telephone Laboratories with Western Electric. Bell Telephone Laboratories carries on an intensive program of basic research and develops prototype designs for new communications equipment. This equipment, when manufactured in volume to uniform standards, enables the 23 Bell Telephone companies to furnish their subscribers with top quality communications services.
3. Of the 23 Bell Telephone companies, 21 are majority-owned sub-

subsidiaries of AT&T, which holds a substantial minority interest in the remaining two.

4. To assist in and coordinate the activities of these operating companies, AT&T undertakes various studies and furnishes various services from its General Departments which are of System-wide application and which would therefore involve substantial duplication of effort if carried out individually by the separate companies.

5. The Long Lines Department of AT&T interconnects the local facilities into a continental network. The same network carries radio and television programs and a variety of other communications across the nation. Long Lines also provides the Bell System with overseas service to 160 foreign countries.

The basic relationship between AT&T and the operating companies is defined by the license contract.

The term "license contract" dates from the early days of the Bell System when local companies were first licensed to use Bell telephones. Universal service results from a division of responsibilities, some filled by AT&T and some by the associated operating companies according to where and how the work can be done best. To reimburse AT&T for the services it provides under the license contract, the operating companies pay one per cent of their operating revenues (excluding certain minor items).

The concept of teamwork which unites all units of the Bell System results in practice in an active interplay of activities by all the component units, AT&T incurring major expense to assure the increasing efficiency, versatility and utility of the companies in which it owns stock. As the goal of service is common to all Bell System "partners," so shared responsibility is the means whereby these companies have worked together to realize the goal.

CORPORATE STRUCTURE

The basic policy of AT&T is determined by the Board of Directors. Members of the Board are elected to one year terms by AT&T shareowners at each annual meeting. The number of these directors may vary, according to the by-laws, from 15 to 19, with the exact number at any one time established by the Board itself. The Chairman of the Board also serves as the Chief Executive Officer of the company. One or two other AT&T officials are also members of the Board.

Most of the directors are men of national reputation in business or education who are otherwise unconnected with the Bell System. The Board's basic responsibility is to assure sound management of the company in terms of present operations and long-term plans; in general,

detailed technical aspects of operating the business are not of direct concern to them.

To the Chief Executive Officer, however, they are of great concern. As the top man in management, his task is to direct the activities of a company that is divided functionally into two basic organizations, the General Departments and Long Lines.

THE GENERAL DEPARTMENTS

The General Departments, employ about 3,000 people. The two largest of these departments are Operations and Engineering. In general, the operating companies deal directly with the appropriate General Department except in matters of general Bell System policy which are referred to the AT&T president and his cabinet of vice presidents.

Operating companies turn to the AT&T Engineering Department for performance and cost information and advice regarding types of equipment and systems. This department sets technical requirements for new equipment and systems, and establishes the operation and performance objectives followed by Bell Laboratories and Western Electric in their development and manufacturing work. Additionally, Engineering coordinates other System units — Bell Laboratories, Western Electric and operating companies — in the introduction of new equipment and methods and maintains data needed by an operating company to determine comparative costs of alternative installations. It also assists operating companies on depreciation matters, and on procedures for studies of telephone plant, revenues and expenses.

The Operations Department includes several divisions, each interested in a specific, essential aspect of providing communications service locally. These tend to parallel the departmental structure of the operating companies. The Plant Division, for example, develops methods and routines for putting in and maintaining all apparatus and equipment within an operating company's jurisdiction. This Division additionally advises the companies on the purchase and use of necessary tools and vehicles. The Traffic Division is mainly devoted to finding ways for operating companies to improve service and reduce the costs of providing it. Traffic measures are developed that operating companies can use in analyzing and interpreting traffic results and trends. In addition, Traffic explores new operating methods and facilities, and provides ways by which an operating company can determine what sort of equipment would best suit its purposes.

The Rate Division within AT&T's Operations Department advises operating companies on ways to realize the widest practical use of

telephone services through overall treatment of rates and regulations. The Commercial Division helps operating companies establish good relations with its existing customers through sound methods, practices and procedures. In addition, it helps with estimates of future service demands.

Other divisions of the Operations Department advise operating companies regarding special communications requirements of government agencies, and prepare System-wide operating results for operating companies to use in improving performance.

A department that has grown in importance in recent years deals with Marketing matters. This unit has three divisions, Marketing Development, Sales, and Data Communications Training. The first, Marketing Development, analyzes information relating to customer wants and needs, plans products to meet those needs, and then helps the operating companies evaluate sales results. The Sales Division advises and assists the operating companies in setting up sales programs, while the Training Division develops training material and provides instruction on data communications for operating company engineers and marketing personnel.

Financial, accounting and statistical experts staff the Departments reporting to the Comptroller and the Treasurer. A prime function of the Comptroller's organization is arranging for temporary funding for operating companies pending final cash advances of one sort or another. The Department also assists the operating companies in tax matters, and arranges to have each company audited annually by independent public accountants. Comptroller's also furnishes advice and information to operating companies regarding accounting and actuarial matters connected with License Contract costs, separations and revenue divisions, rate cases, and accrual rates for service pensions. The Treasury Department keeps operating companies abreast of factors influencing Bell System financing, as well as handling the many details related to that financing.

The Legal Department provides assistance and advice to operating company counsel on matters of general Bell System interest, and represents the operating companies before certain governmental courts and commissions. Other General Departments assess the System's dealings with the public, personnel and the rest of the business community, and formulate System-wide programs designed to enhance the relationship. In addition, these units continually conduct new studies related to their work, and survey other authoritative material in order to make it available to the entire System.

The various General Departments also receive in a steady stream

copies of reports made by the operating companies concerning local activities pertinent to their interest. This material is evaluated by the appropriate organization and is compiled with similar studies by the operating companies themselves into over-all comparative performance indexes for both the AT&T management and for operating companies to use in improving operational effectiveness.

LONG LINES DEPARTMENT

The purpose for which AT&T was originally formed in 1885 — interconnecting various intrastate telephone exchanges — is the responsibility of AT&T Long Lines Department. The extensive switching equipment, cables, microwave systems and associated equipment that comprise Long Lines' interstate network makes possible telephone service across the nation and around the world. But this is only a part of the story. Long Lines also provides teletypewriter exchange service (TWX), transmits TV and radio programs from city to city and coast to coast along with coded data, telephotographs and messages using private line telephone and telegraph facilities.

Long Lines has the autonomy of an operating company even though it is organizationally a part of AT&T. Its Board of Directors, consisting of AT&T vice presidents and Long Lines operating heads, set the general operational policy that is implemented by the Chief Executive Officer through the organizations headed by his operational aides.

Long Lines is organized geographically as four areas. Each of these areas — Eastern, Central, Southwestern and Western — has its own plant, traffic, commercial, engineering and staff organizations as extensions of the Long Lines headquarters in New York City.

There are about 28,000 Long Lines employees working in 43 states and the District of Columbia. Plant investment represents about nine per cent of the Bell System total. Responding to the increasing demand for its service, Long Lines has made substantial increases to its investment in recent years.

Interstate networks exceed 76 million circuit miles and consist principally of cable, radio and open wire. In addition there are under-seas cables connecting the U.S. mainland with Jamaica, Puerto Rico, Hawaii, the British Isles and the European Mainland. From Hawaii a trans-Pacific cable forms a link with Japan. Other overseas communications are transmitted via radio.

OWNERS OF THE BELL SYSTEM

Some 2,250,000 people own an interest in the Bell System through their investments in AT&T stock. Of these, over 300,000 are Bell System

employees who have purchased shares through payroll allotments. AT&T has more than twice as many common stockholders as any other corporation in the United States — more than the next two companies combined in fact.

Just about every type of American is represented in this assembly, including farmers, clerks, lawyers, clergymen, mechanics, civil servants, teachers, merchants, widows and retired people. The man who became AT&T's two millionth shareowner in 1961, for instance, was a small town druggist in Kansas.

These investors have supplied a good part of the capital that has been required to realize the Bell System's potential of growth. They have invested in the company in expectation of receiving a reasonable rate of return and, indeed, AT&T dividends have a well deserved reputation for their uninterrupted regularity since 1881. The dividends have risen, too. For about 15 years ending in 1921, for instance, the rate was \$8.00 per share per year. From 1922 to 1959, the rate was \$9.00 a share. When the stock was split three-for-one in April, 1959, the rate was set at \$3.30 (equivalent to \$9.90 on the old basis). Following stockholder approval in April, 1964, the stock was again split two-for-one with a dividend rate of \$2.00 established for the new shares.

Geographically, AT&T stock is more widely held than the stock of any other corporation, and it is distributed in general accord with the investment wealth of the country, with a somewhat higher ratio in New England where the telephone was invented and originally financed.

At the end of 1901, shortly after AT&T had succeeded American Bell as parent company of the Bell System, 87 per cent of the owners were located in New England. As increasing amounts of new capital were required, the distribution of AT&T owners extended more and more into the Eastern states. Starting in 1915 — when the long distance lines reached the West Coast, the Central and Pacific states began to be represented more definitely in the AT&T shareowner family. By 1930, the approximate present-day geographical distribution was achieved: New England 20 per cent; Eastern 40 per cent; Central 15 per cent; Pacific 10 per cent; all others 15 per cent.

There were 7,536 shareowners of AT&T in 1900. Within 12 years the 50,000th owner joined the company family. Just six years later — 1918 — the 100,000 mark was passed. By late 1930 the number of owners had climbed to a half million. The one millionth milestone was reached in May, 1951 within a few weeks of the 75th anniversary of the invention of the telephone. The two millionth shareowner was added to the list just 10 years later, in June, 1961.

Approximately 28 per cent of the shareowners have held their

AT&T stock for 10 years or more. And 15 per cent have been share-owners for at least 15 years.

Some 803,000 accounts are in the names of women. As individual owners, women outnumber men two to one. Furthermore, 600,000 share-owners are represented by joint accounts — usually man and wife.

Each year, AT&T reports its 30 largest shareowners to the Federal Communications Commission. A recent report reveals that this group is comprised of 22 bank nominees (who may hold stock for hundreds of customers in each account), three brokers, two insurance companies and three banking firms. The aggregate holdings of these 30 accounts represent only 5.65 per cent of the total stock; each of these accounts holds stock in a fiduciary, or trust capacity.

Only one shareowner, a brokerage house holding many thousands of accounts for its clients, has slightly more than one per cent of the total stock outstanding. The maximum ownership of any individual is less than one-thirtieth of one per cent.

Bell Telephone Laboratories III

The gradual evolution of Bell Telephone Laboratories as a separate entity in the Bell System and its subsequent history reflect the ever-increasing importance of creative technology in communications. As early as 1883, the American Bell Telephone Company maintained an experimental shop in Boston to supplement the activities of its Electrical and Patent Department. In 1884, this organization was officially recognized as the Mechanical Department, though the function it performed would today be called research and development.

By 1907, the Mechanical Department had become the Engineering Department of AT&T and was broadly responsible for Bell System engineering, development, and research work. This department established engineering standards for plant design, prepared central office specifications and advised the associated companies on current plant and traffic problems. It also tested and inspected all telephones and apparatus manufactured by Western Electric, whether in Chicago or New York. However, Western Electric also maintained laboratories in Boston for work connected with the development of equipment and apparatus, the basic design of which was supplied by the AT&T Engineering Department.

In 1907, the Western Electric and AT&T research and development staffs were consolidated as the Western Electric Engineering Department at 463 West Street, New York. AT&T's Engineering Department retained its general responsibility for the compatibility of the growing Bell System as to equipment and service and Western Electric assumed responsibility for the testing and inspection of its telephones and apparatus. The research and development activities consolidated at West Street gradually expanded in response to the pressing need for improvement and advance in telephony.

Increasing importance of basic research in the development of

communications during the early 20's led to the consolidation of Western Electric Engineering Department and a part of the AT&T engineering department as Bell Telephone Laboratories on January 1, 1925. Ownership of the new company was shared equally by AT&T and Western Electric with the Board of Directors chosen from executives of each of the owner companies. This arrangement emphasizes the Laboratories dual function in serving the specific needs of both Western Electric and the Bell Telephone companies.

To this end, Bell Telephone Laboratories performs at cost scientific research and development work for the Bell System in communications in two broad areas. AT&T authorizes and pays for research and fundamental development projects in such fields as physics, chemistry, metallurgy, electronics, acoustics and mathematics which relate to the science of communications and for systems engineering projects which seek to develop applications of technological advances in these fields in terms of Bell System service. Western Electric authorizes and pays for development and design of new apparatus and equipment and works with the Laboratories to develop a means of translating the designs into items capable of economical production in quantity. In addition, work performed for the U.S. Government by Bell Laboratories is authorized by Western Electric and by Bellcomm Inc.

Since inception, Bell Laboratories has been pre-eminent in communications technology. At first a good part of the Laboratories' effort went into hardware development to increase the reliability and life of the equipment Western Electric produced and the operating companies used. A further large effort has been devoted to developing ways to increase the efficiency of Bell System equipment. An example of this is TASI (Time Assignment Speech Interpolation), a Laboratories development that doubled the capacity of the first two trans-Atlantic cables by utilizing the milliseconds of silence in ordinary speech for further transmission.

Today the technical work of the Laboratories is divided into three major fields: Research, Systems Engineering, and Development.

Research represents the search for new knowledge, for new scientific principles. Although carried out in scientific disciplines which closely relate to the art of communication, research is not aimed at specific changes in the telephone system. Rather it is concerned with trying "to outguess the future" as to where the unexplored areas of science may yield discoveries of value to the telephone industry and exploring these areas in depth.

Although the Research Departments comprise only about 12 per cent of the technical staff of the Laboratories, they represent the

fountainhead from which have flowed thousands of discoveries that have shaped the character of today's and tomorrow's communications systems. In 1937, Dr. Clinton J. Davisson received a Nobel Prize and, in 1956, three others — Drs. W. H. Brattain, W. Shockley and J. Bardeen — shared another; hundreds of others have received awards and honors representing major distinction in their fields.

Systems Engineering represents a relatively recent addition to the Laboratories' organizational structure, but the function itself goes back many years. Systems engineers have intimate knowledge of telephone plant and operations and maintain close contact with telephone company engineers concerning the Bell System's needs and opportunities for economy and improvement. Systems engineers also keep in close touch with Labs' research and fundamental development. Their function is to match new knowledge and new approaches to the needs. They outline a broad technical plan for a development (such as electronic switching, communications satellites or T-1 carrier), its objectives, and its economic and service worth or military value.

The Systems Engineering Departments together comprise about 17 per cent of the Labs' technical staff.

Largest of the technical groupings are the Development Departments, totaling about 70 per cent of the technical personnel. Slightly less than a third of these are located in Branch Laboratories in Western Electric manufacturing locations at Burlington, Winston-Salem and Greensboro, North Carolina; Allentown and Laureldale, Pennsylvania; Columbus, Ohio; Merrimack Valley, Massachusetts; Indianapolis, Indiana; Kearny, New Jersey; and Baltimore, Maryland.

Development engineers have the responsibility of carrying out the project, creating detailed plans, developing hardware and equipment as needed, and providing WE with the designs and specifications for manufacture or purchase. Development work covers such areas as transmission, switching, electronic components, telephones and other customer products, power systems, data communications, outside plant, switchboards, and a number of developments for the Defense Department — including the Nike family of missile systems, radio command guidance, and underwater sound systems.

In practice, of course, research, systems engineering, and development all work very closely together and with Western Electric and the Bell Telephone companies. Feedback from manufacturing, for example, often is an important factor in determining paths of scientific inquiry pursued in Research, as well as being a major consideration in Systems Engineering and Development. And, of course, the needs of the telephone companies are controlling in establishing objectives for

both Bell Telephone Laboratories and the Western Electric Company.

The interrelationship of groups in the Laboratories is illustrated by the transistor. Discovery of the transistor effect came out of research into the nature of semiconductors. Its perfection as a device was carried on by the Development organization concerned with electronic components. When it had reached a stage of development, in terms of performance and economical manufacture, that made it feasible for use in the telephone system, Systems engineers begin to design communications around it. These systems were then carried through to working hardware by the Development engineers and into manufacture by Western Electric.

For many years, both Bell Laboratories and Western Electric concentrated their cooperative effort on helping the Bell Telephone companies make telephone service available to more and more Americans. In recent years, however, the Bell System network has been used to transmit more kinds of communications. AT&T and the operating companies, therefore, now look more than ever to Bell Laboratories for innovations and improvements resulting from technological advance.

Most Bell Laboratories activities are carried on at four locations in New York and Northern New Jersey:

463 West Street, New York — now principally used for administrative and staff work.

Murray Hill, New Jersey — the main center of research work and of much of the work in electronic component development and transmission systems and development.

Whippany, New Jersey — the center for military research and development work.

Holmdel, New Jersey — a laboratory opened in 1962, with work going on in such fields as electronic switching, data communications transmission and switching, and new types of telephone equipment for the customer.

In Spring, 1964, Bell Laboratories announced plans to build a new center for development work on electronic switching systems near Naperville, Illinois fairly close to WE's Hawthorne Works. About 1,200 people are scheduled to work at the laboratory when it is completed in 1966, including the electronic switching organization at Holmdel and a small number of WE engineers from Hawthorne Works and the Systems Equipment Engineering organization.

The Bell Telephone Companies IV

The communications research and development programs carried on at Bell Laboratories . . . the equipment and services that Western Electric supplies . . . and the coordination of the entire Bell System effort provided by AT&T continue only so that the Bell Telephone company subscriber receives the variety of reliable communications service he desires. The Bell Telephone companies are the last link in a chain of service which joins together all these other efforts. Their success in meeting the needs of their subscribers measures the effectiveness of the entire Bell System.

The responsibility for satisfying the subscriber is not only an obligation which the Bell Telephone companies have accepted for themselves. It is recognized by law. Forty-seven state commissions, and city councils in Texas regulate the activities of the operating companies in the territories they serve and evaluate their effectiveness in serving. Under these regulations, the operating companies must carry on their business in terms of local needs. Expansion programs have to be planned and engineered to be worthwhile to the local customers. Rates for service must be justified on the basis that the revenues are necessary to meet the costs of doing business within a particular area. Since they are accountable under regulation and speak for the customer, the Bell Telephone companies, naturally enough, have a great deal of influence in setting the course of the whole Bell System.

There are 23 Bell Telephone companies, of which 21 are subsidiaries in which AT&T owns more than 50 per cent of the capital stock. These 23 companies are:

New England Telephone and Telegraph Company
New York Telephone Company
New Jersey Bell Telephone Company

Bell Telephone Company of Pennsylvania
 Diamond State Telephone Company (which serves Delaware)
 Chesapeake and Potomac Telephone Company (which serves Washington, D.C.)
 Chesapeake and Potomac Telephone Company of Maryland
 Chesapeake and Potomac Telephone Company of Virginia
 Chesapeake and Potomac Telephone Company of West Virginia
 Southern Bell Telephone and Telegraph Company
 Ohio Bell Telephone Company
 Michigan Bell Telephone Company
 Indiana Bell Telephone Company
 Wisconsin Bell Telephone Company
 Illinois Bell Telephone Company
 Northwestern Bell Telephone Company
 Southwestern Bell Telephone Company
 Mountain States Telephone and Telegraph Company
 Pacific Northwest Bell Telephone Company
 Pacific Telephone and Telegraph Company
 Bell Telephone Company of Nevada (a wholly owned subsidiary of Pacific Tel. & Tel.)
 Southern New England Telephone Company (in which AT&T owns less than 20 per cent of the capital stock)
 Cincinnati and Suburban Bell Telephone Company (in which AT&T owns just under 30 per cent of the capital stock)

(AT&T also owns less than three per cent of Bell Telephone Company of Canada stock. Personnel of these two companies exchange pertinent information, and AT&T provides services to Bell Telephone of Canada under a license contract.)

The relationship between AT&T and the operating companies could be misunderstood, particularly by those who automatically equate stock ownership with ironbound controls. The wide variety of local conditions existing in so large a nation as ours make close surveillance impractical. Service arrangements and equipment requirements vary markedly from one part of the country to another.

And even within the territory of a particular operating company, needs can vary markedly from year to year, from place to place. These needs can best be evaluated by men on the spot who can foresee special service requirements resulting from a mushrooming suburban community, for instance, or who can estimate the growth pattern of a community and therefore determine the necessity and location for additional central offices.

Each of the Bell Telephone companies has a Board of Directors

composed of business men, educators and other prominent persons familiar with the problems and possibilities of their local area. The particular corporate structure varies slightly in details from one operating company to another, but we can describe the management organization of a typical (and hypothetical) operating company.

Reporting to the Board of Directors of such a company, and responsible for its operations is the president. Reporting directly to the president are company officers heading organizations equivalent to Western Electric Divisions, although in most operating companies' terminology they are described as departments. These generally include the following: operating, personnel, information (or public relations), secretary, legal, treasurer, and comptroller. A vice president and general manager heads the operating department which includes the functions and services of the general plant manager (including construction and plant engineering), the general traffic manager (including central office and PBX operators), the general commercial manager (including rates and telephone development studies, business office activities and the servicing of public telephones) and the chief engineer (including building equipment, outside plant and radio transmission).

Essentially, AT&T asks only that the operating companies be well run, that they provide good service, treat employees equitably, maintain a favorable image among the public they serve and return reasonable profits on the money invested in their operations. How these things are done, by and large, is left to the operating companies.

AT&T naturally keeps close watch on trends which seem to be developing in a way that could affect the business. AT&T is the Bell System's contact with Federal Agencies such as the FCC, and there are many special services performed by AT&T under the terms of the license contract already discussed. Without such centralized coordination by AT&T, achievements like the nation-wide changeover to dial TWX service in September, 1962 and the continuing System-wide move toward total Direct Distance Dialing would be impossible.

The contractual relationships between Western Electric and the Bell Telephone companies is embodied in the Standard Supply Contract that Western Electric has with each of the operating companies.

These contracts outline the materials and services that Western Electric will provide to the operating telephone companies at their request and include the terms and conditions upon which these materials and services are provided.

One of the provisions of the Standard Supply Contract succinctly explains the uniqueness of the relationship between WE and the tele-

phone companies. This is the one that states "nothing herein contained obligates the Telephone Company to purchase any materials from the (Western) Electric Company." WE can retain their business only by virtue of the quality of its products and services and its low prices.

That our company does supply much of the Bell Telephone companies' needs is tacit recognition of the resourcefulness of WE people in meeting the requirements of the operating companies and a validation of the concept of teamwork which unifies the Bell System's efforts.

Part Two:
Western Electric

History of Western Electric

V

In January, 1869, a laconic entry in the *Journal of the Telegraph* announced that the firm of Shawk and Barton had been formed in Cleveland, Ohio for the manufacture of fire and burglar alarms and other electrical devices. This was the acorn of enterprise.

Today, Western Electric is one of the top dozen corporations in American industry. Growth to help the Bell System meet growing public demand for its services has been a constant factor in Western Electric's history.

At the outset it was a small company, a shoestring enterprise of which the physical plant comprised the equipment of the former Western Union repair shop in Cleveland. George Shawk had been the foreman of the shop. Learning it was to be up for sale, he looked for a partner to share the purchase with him. The man he found was Enos M. Barton, a 27-year-old telegrapher from Rochester, N.Y. They opened for business in January, 1869.

Among the new firm's customers was a former Oberlin College physics professor, Elisha Gray. An inventor, Gray used the small company as a source for parts and models for his experiments. He and Barton soon found they shared a common enthusiasm for the future of electrical apparatus — particularly telegraphic devices. Barton foresaw a long-range development for the company in which he had invested all of his meagre capital. He looked to make it into a manufacturing plant capable of playing a leading part in the dawning electrical age, and Gray soon came to share his convictions. Shawk, however, felt such plans were too ambitious and offered to sell his half-interest to Gray.

Both Gray and Barton were acquainted with Anson Stager, former

Chief of the U.S. Military Telegraphs during the Civil War. Learning of their plans, Stager advanced Gray the money needed to buy the half interest and also agreed to become an equal partner at such time as the two men could arrange to move the business to Chicago. An agreement to this effect was signed on November 18, 1869 and by the end of the year the firm of Gray and Barton was open for business in Chicago.

From the first, the company gained a reputation for integrity and quality workmanship in the manufacture of telegraph apparatus, fire and burglar alarms, the Gray telegraph printer and other devices. Then the great fire of 1871 ravaged Chicago. The fire was extinguished within two blocks of the Gray and Barton shop and their emergency service in producing equipment to restore communications in the stricken city won public approval and brought unprecedented business in supplying apparatus for the permanent replacement of equipment consumed by the flames. In 1872, the \$150,000 Western Electric Manufacturing Company was organized as successor to Gray and Barton. It soon became a major manufacturer of Morse instruments and began greater production of the Gray printer telegraph.

By 1876, the Western Electric trademark, affixed to a wide variety of electrical equipment, had gained high prestige — gratifying progress for a firm less than 10 years old that numbered but 65 people on the payroll. At the Centennial Exposition held that year in Philadelphia, Western Electric won five gold medals for devices of its own manufacture.

At the same exposition, Alexander Graham Bell demonstrated a device which he called the telephone. His patent for the telephone, U.S. No. 174,465, had been issued four months before, on March 7.

On January 28, 1878, the first commercial telephone exchange in the world opened for service at New Haven. The first directory appeared a month later. It listed 50 names.

The popularity of the telephone had grown to such an extent that by the end of 1881 there were 70,000 telephones in service. On January 12 of that year, the Inter State Telephone Company opened the first commercially successful long distance line spanning the 45 miles between Providence and Boston. Almost every month new exchanges were opening and much experimentation was being carried on concerning long distance transmission. The quality of service varied markedly, however, and there was no attempt at standardization by the various telephone companies.

It was apparent to the American Bell Telephone Company that common standards and a common purpose shared by the people who made telephone equipment and those who operated it would prove es-

sential to the orderly development of the telephone. Since Western Electric had pioneered much electrical equipment and telephone apparatus — the Scribner switchboard, for example — the company was clearly well qualified to manufacture Bell Telephone equipment. Moreover it has a reputation for high quality products built to offer reliable, long-lived service.

WESTERN ELECTRIC ENTERS THE BELL SYSTEM

Thus early in 1881, General Stager, Western Electric president, and Theodore N. Vail, at that time general manager of the American Bell Telephone Company, explored the possibility of Western Electric becoming the manufacturing unit of the Bell System. As a result, the Bell company acquired an interest in Western Electric Manufacturing Company.

Further capital expansion was required and as a result, in late November, 1881 the company was reorganized as the Western Electric Company of Illinois with a capitalization of \$1,000,000 in which the American Bell Company had a major interest. The first manufacturing contract between the parent organization and Western Electric was signed on February 6, 1882.

Western Electric's entry into the Bell System was the capstone to General Stager's career. In January, 1885 failing health made it necessary for him to resign the presidency of the company. In March, a month before his 60th birthday, he died. William S. Smoot, of the Remington Arms Company, succeeded Stager as president but died within a year, to be succeeded by Enos M. Barton. At his accession, the firm he had helped to found 17 years before had become one of the largest units in the Bell System.

These early years of Western Electric's existence had been an era of expansion for the whole American economy. So vast the scope of growth, so rapid the rate, it was difficult for anyone to assess the change. With pride in achievement, there was a growing desire by Americans to exhibit their progress to the world. The four hundredth anniversary of the discovery of the New World provided an excuse for such an exhibit.

In 1890, the announcement that a world fair was to be held in Chicago two years later provoked a frenzy of activity by businessmen anxious to display the superiority of their wares. The Bell System designed and constructed a record-breaking 900-mile circuit between New York and Chicago. The circuit was personally opened by Alexander Graham Bell early in 1892 and was in full operation for several months

before the delayed World Columbian Exposition finally opened.

By 1900, increasing business had created for the company a substantial competence in purchasing. To Harry B. Thayer, manager of the company's New York branch, it was evident that if the items required by the various Bell Telephone companies could be purchased through Western Electric it would greatly simplify the task of insuring uniformity of quality and compatibility throughout the whole expanding network.

BUYING FOR THE BELL SYSTEM

Thayer discussed the idea with Theodore Spencer, general superintendent of the Bell Telephone Company of Philadelphia. The first supply contract was signed by WE and the Philadelphia company in 1901. By 1913, supply contracts had been executed with all the associated companies in the Bell System. Since then, supply of items needed by Bell System companies for their operations has become a major part of WE's activity.

In 1897, the company constructed a building at 463 West Street, New York as Eastern headquarters of the business and to house the New York shop. About the same time, WE introduced some major innovations in business that have since become standard throughout industry. These included dimensional drawings of piece parts, the use of personnel records, specification and quality standards, and the establishment of training courses for college graduates who had come to the company. Many new distributing houses were also opened. In 1903 Barton authorized the construction of the first buildings of the Hawthorne Works at Cicero, Illinois.

By 1906, there were over 4,000,000 telephones in the country. In the same year, 1906, Western Electric established a pension plan for employees — one of the earliest in American industry.

When, in 1907, Theodore N. Vail became president of the American Telephone and Telegraph Company, he undertook a reorganization of finances, general management, and engineering and research work. In the summer of that year, AT&T development personnel moved their laboratory from Boston to New York and merged with a similar group of Western Electric people. At the same time a number of WE development engineers in Chicago relocated in New York to form a part of the new centralized unit. Up to this time, all telephones and apparatus made by Western Electric, whether in Chicago or New York, had been inspected in Boston by a section of AT&T headquarters engineering. Now, inspection was taken over by Western Electric as a new function of its manufacturing activities.

The increasing responsibilities of the business as well as the advance of years had undermined Barton's health. In 1908, at the age of 66, he sought a less active role. Thayer was elected president to succeed him and Barton became chairman of the board, retaining this office until his death seven years later at the age of 73. By now the nation had well over 6,000,000 telephones and WE's Hawthorne plant had continued to expand through the construction of additional buildings to meet the demands of the Bell Telephone companies.

The increasing demand for communications equipment required concentration on this job. Accordingly, the company disposed of its power apparatus manufacturing business in 1909.

"ONE POLICY, ONE SYSTEM, UNIVERSAL SERVICE"

In the fall of 1908, AT&T first made use of national advertising to tell the story of the Bell System as an institution of American life. The theme of the message was "one policy, one system, universal service" and the parent company was to devote much energy in the years ahead realizing this end.

Impelled by the goal of a nation-wide network, Bell System engineers pursued scientific developments eagerly, seeking knowledge for practical application. Late in 1912 Dr. Lee De Forest demonstrated a revolutionary device to a group of Western Electric and AT&T engineers. It was an improved version of the prototype vacuum tube he had first conceived in 1906 and could, under some circuit conditions operate as a true amplifier. One of the Bell System engineers at the demonstration, H. D. Arnold, set out to produce a higher vacuum tube. His success made the three-element tube a reliable amplifying tool.

About the same time the oscillating capabilities of the vacuum tube were discovered independently by De Forest and E. H. Armstrong, and vast possibilities in carrier systems and in radio-telephone systems were opened up. By mid-1914 these possibilities were put into practical realization. Moreover, regarding audio breakthroughs in all respects, dependable engineering let life's activities have impact surprising by one's ordinary knowledge.

On October 21, 1915 the first trans-Atlantic radio telephone call was placed between Arlington, Virginia, and Paris. The brief conversation was also picked up in Honolulu. Earlier in the year telephone service over wires had spanned the country from coast to coast; now trans-Atlantic radio telephony had been proved to be possible.

In 1916, engineers of Western Electric and AT&T in cooperation with the United States Navy conducted a mobilization test and estab-

lished a nation-wide communications network of telephone, telegraph, radio and teletypewriter service among points on the continent and ships deployed in the adjacent waters. This communications network proved to be of great value when the United States entered the war in April, 1917. One of its first off-shoots was the ship-to-shore radio telephone equipment which Western Electric supplied the Navy in quantity.

The emergence of aircraft as an effective military weapon resulted in the need for air-to-ground communications and here again Western Electric was a pioneer. WE also supplied U.S. Army cantonments, throughout the country with telephone equipment while the company's British branch developed a submarine detector, the "Nash Fish," for which its inventor, G. Howard Nash, was decorated by the British Government. WE's total sales during the war amounted to \$31,918,000.

THE NETWORK GROWS IN SERVICE

With the Armistice, Western Electric refocused its interest on contributing to the Bell System network. There were now 10,000,000 Bell System and connecting telephones in the country. The figure had doubled in just ten years. In 1919, the Bell System announced plans for the introduction of dial telephone service. This was to prove a major undertaking for the Bell System's manufacturing and supply unit.

In 1922 Western Electric organizations handling Bell System telephone business were separated organizationally from those concerned with its electrical supply business.

In 1923 construction began on the Kearny Works. The first production there was of telephone cable, in 1925.

The Bell System's rapid growth during the '20's and the consequent need for enormous quantities of apparatus and equipment made it quite clear that serving the growing nation-wide Bell System network had become a full time responsibility for Western Electric. Consequently, in 1925, WE formed the Graybar Electric Company, named in honor of Enos M. Barton and Elisha Gray, for the purpose of handling its electrical supply business. The increasing responsibility of Bell System requirements dictated a further separation and, in 1928, Graybar's common stock was sold to its employees — a new departure in large corporation ownership. WE's interest in Graybar was limited to preferred stock, the last shares of which were retired in 1941.

During 1918 Western Electric's various foreign operations had been regrouped in a subsidiary called International Western Electric Company. In 1925, as an additional step in its effort to concentrate on serving the needs of the expanding Bell Telephone network, WE sold

the subsidiary. Earlier in the same year, the Western Electric engineering department at West Street, New York, was incorporated as the Bell Telephone Laboratories.⁸

As an outgrowth of its research in telephony, Bell Laboratories developed and Western Electric produced, in 1926, the equipment that made sound motion pictures practicable. Early in 1927 Bell Laboratories gave the first public demonstration of television by wire when the then Secretary of State, Herbert Hoover, engaged in a brief conversation with AT&T president Walter S. Gifford on a relay between Washington and New York.

A bit earlier in the year, commercial radiotelephone service opened between New York and London — with Western Electric equipment providing the means. Then came the formal opening of telephone service between the United States and Mexico.

As the Bell Telephone network continued to expand, Western Electric concentrated on the production of step-by-step and panel dial switching equipment to replace manual central office equipment. In 1929 work began on a third great manufacturing location, the present Baltimore Works. At mid-year, the country had never seemed more prosperous — nor had any of the other units of the Bell System. The number of telephones in the nation now stood at 20,000,000.

On October 29, 1929, some 16,000,000 shares of stock changed hands on the New York Stock Exchange. In a stark demonstration that the science of economics also observes the law of gravity, values of corporate stock plummeted \$15,000,000,000 by the end of the year. Ahead lay long years of near-paralysis for the American economy. Western Electric was to operate in the red for three years.

In 1931, the Bell System inaugurated teletypewriter exchange service whereby any subscriber in the TWX network could be switched to any other subscriber. Equipment for this purpose was provided by Western Electric's subsidiary, the Teletype Corporation.

On November 1, 1931 Western Electric acquired the Nassau Smelting and Refining Company at Tottenville, on Staten Island, New York. By this means, the company obtained a facility adequate to permit it to handle Bell System scrap, centralize scrap reclamation and assure the System of a dependable supply of secondary non-ferrous metals.

INNOVATION FOR DEVELOPMENT

The long-range development of the Bell System continued despite the Great Depression. In particular, overseas telephone service was expanded to many parts of the globe. In 1930, for example, Poland,

⁸ See Chapter III.

Finland, Argentina, and Australia — among other distant lands — were linked to the United States by telephone. In 1931, Indonesia, Roumania, Brazil, and the Hawaiian Islands were some of the points added; in 1933, India, Yugoslavia, the Mandate of Palestine, and Nicaragua; and in 1934, Syria and Japan.

Then, on April 25, 1935, Walter Gifford, AT&T president, called T. G. Miller, vice-president — Long Lines. The call from one office to another at 32 Avenue of the Americas travelled over a 23,000 mile circuit to become the first round-the-world telephone conversation.

During the same year, Bell Laboratories and WE engineers began development work that was to change the shape of America's telephones. This was the design of the combined handset telephone. Called the 300 desk set, it was introduced commercially by the Bell System in 1937.

There were innovations of major significance in equipment, too. The first coaxial cable, used initially for multi-channel telephone tests, was installed between New York and Philadelphia in 1936. Toward the end of the year, a demonstration of the capabilities of coaxial cable was held for the press by Bell Telephone Laboratories. Less than a year later, in October, 1937, the trial began of a new type of central office switching equipment — crossbar — that greatly improved the speed of telephone calls and made direct dialing a reality. Shortly afterwards, WE installers began work on a crossbar office at Troy Avenue in Brooklyn, New York. This office, the nation's first commercial crossbar installation, cut into service on February 13, 1938.

WESTERN ELECTRIC IN WORLD WAR II

Begun in economic disaster, the '30s ended in War. As Germany once again prepared to overrun Europe, America began to arm. In June, 1939 the Federal Government authorized Western Electric to proceed with the manufacture of Signal Corps test sets. This order for more than \$700,000 of equipment was WE's first major government contract of World War II.

To be ready for the worst, the United States rapidly sought to develop effective armed forces. A vast chain of new military camps and bases came into being, each requiring extensive communications facilities. At the same time, American industry faced the familiar war-time problems of scarcity of men, materials, and equipment. In addition to a primary responsibility to supply communications equipment and services to the Bell Telephone companies, the needs of the Government became increasingly important. The skills acquired in serving the Bell System enabled WE to help meet these needs. In 1940, total

WE sales to the Government reached \$3,500,000. At the end of 1941, the figure stood at \$41,000,000.

With Pearl Harbor, the United States found itself engaged in a conflict of unparalleled scope. From the beginning of hostilities the Army and Navy indicated their confidence in the company's manufacturing and engineering skills by entrusting Western Electric with the development and production of numerous electronic devices—gun directors, bomb release computers, radar systems and underwater warfare equipments.

As the war progressed, an increasing proportion of the company's manufactures for the Government consisted of radar and associated equipment. In all, WE supplied 70 different types of radar during World War II. Their dollar volume equalled half of all the radar purchases made by the Government.

By utilizing peacetime facilities to the utmost, by subcontracting, and by extensive leasing of existing plant facilities, Western Electric was able to limit its emergency plant investment to less than \$6,000,000. This policy not only shortened the interval between development and production but also avoided construction expense that would otherwise have added to the overall burden on the nation's war economy. From 1942 through 1945, Western Electric supplied the Government with more than \$2,300,000,000 worth of equipment for the Armed Forces.

Service to the nation's defense effort was by no means concluded with the end of World War II. Development work on the Nike missile had begun before the end of the war and in periods of crisis ever since, notably during the Korean Conflict, the company has hastened to respond to emergency needs. The history of WE since 1945 is replete with contributions to the nation's defense and space programs, examples of which are cited later in this book.

POST WAR RECONVERSION

When victory came, America found there were problems in returning to peace. For Western Electric, reconversion proved a formidable task. The Hawthorne Works had to reconvert 90 per cent of its manufacturing area. At Kearny, reconversion was involved to the extent of about 50 per cent of the telephone shops. The third WE Works at Baltimore required little reconversion as the normal wire and cable facilities there were used during the war for materials of similar character required by the Armed Forces.

Western Electric's contribution to victory had necessarily resulted in a concentration on war work largely to the exclusion of its normal

effort in serving the Bell System. The War Production Board had permitted only those additions and improvements to Bell System facilities that were necessary to the conduct of the war or for the repair and maintenance of essential civilian communications.

The shift in Western Electric activity from war emergency to the demands of peace can be clearly seen in the figures for 1945. Of total Bell Telephone sales of \$188,916,000, about 37 per cent occurred during the final quarter of the year. In these first months of peace, Western Electric delivered 600,000 telephones — 60 per cent of the company's total telephone production for the year. It represented a higher production rate than at any previous time in history.

At the end of 1945, there were 27,946,000 telephones in the United States of which 22,446,000 were Bell Telephones. At the end of 1961 — the year the number of AT&T shareowners passed two million — there were 84,450,000 telephones in the United States of which 68,640,000 were Bell.

Yet numbers can only suggest the whole story of accomplishment. Today, the flexibility and versatility of the Bell System communications services which Americans make use of and depend on — and the array of instruments, apparatus, and equipment providing them — are far and away the finest in the world.

NEW PLANTS, NEW PRODUCTS, NEW PEOPLE

In helping make this so, virtually a new Western Electric has come into being since World War II. At the end of 1945, company investment in plant stood at \$168,143,000. Included in this figure were \$5,771,505 representing war emergency plant. There were 80,029 employees. Just 18 years later, investment in plant and equipment exceeded \$906,183,000 and there were more than 147,000 WE people. Well over two-thirds of all employees are now engaged in the manufacture of products which did not exist at the end of World War II. Of the 11 Western Electric locations designated as Works — Hawthorne, Kearny, Baltimore, Allentown, Indianapolis, North Carolina, Merrimack Valley, Omaha, Columbus, Oklahoma City, and Kansas City — all but the first three have been built since 1947, and all of the three pre-war Works have been so enlarged and renovated as, in effect, to qualify as new facilities.

In the spring of 1946, the first multi-channel ultra-high frequency microwave system in the Bell System was placed in service in Southern California. Six weeks later, another microwave system linking Nantucket with the Massachusetts mainland opened for service. These two events foreshadowed the Bell System's intricate and widespread web

of microwave systems which have since become a standard part of the integrated Bell Telephone network.

In the following year, a major manufacturing development was announced which also helped provide the means for Bell Telephone companies to meet the demands for communications. The product was called Alpeth cable, an acronym indicating that aluminum and polyethylene comprise the cable sheathing. It came about, characteristically, as a result of Western Electric's search for better ways of making products of high quality at low cost.

It was in 1947, too that WE's manufacturing division devoted considerable effort to the development of engineering techniques for the production of No. 5 crossbar — initially designed for use in telephone company offices adjacent to metropolitan areas. Other new products developed about the same time: No. 4 toll crossbar, Automatic Message Accounting (AMA) equipment and the 555 PBX.

The country's first No. 5 crossbar office cut into service at Media, Pennsylvania on July 11, 1948. Twelve days earlier, on June 29, the 30,000,000th Bell telephone was installed in Marshalltown, Iowa. The following day at Murray Hill, New Jersey, Bell Telephone Laboratories held the first public demonstration of a device that was to usher in the new era of electronics. This was the transistor.

The fortnight of firsts symbolizes the concerted efforts of Western Electric and its Bell System teammates in meeting the immediate requirements and building for the long-term development of the nationwide Bell Telephone network. In effect, it has proved to be a cycle of progress. As the component members of the Bell System worked together to provide more and better communications services, their success in this respect stimulated further demand, calling for a larger effort that, in turn, has induced a still greater demand.

The increase in the use of coaxial cable illustrates this trend. On October 1, 1948, a \$12,500,000 coaxial cable system opened to link the East and Midwest. During 1949, this network was extended 7,600 miles. A decade later there were 83,000 miles of Bell System TV circuits. And the product has been steadily improved, too. The coaxial cable which Western Electric now makes contains 12 coaxial units that can carry 11,160 conversations at the same time, or — with a lesser number of conversations — a variety of other communications like DATAPHONE service and TV.

(Needless to say, it hasn't been roses all the way. As a member of the American industrial community, Western Electric has naturally shared in the downturns as well as the rises in the economy. In fact, history has shown that the demands of the telephone companies are

quite volatile and WE must expand and contract its production to meet the needs of the Bell System. Western Electric's fluctuations in Bell business volume and earnings have been as great as those experienced by other manufacturers who serve a variety of customers.)

During 1950, the kinds of telephones offered the public by the Bell Telephone companies increased. In response to the goal of service, for example, the "500" desk set telephone was brought into production at the company's newly opened Indianapolis Works. During the same year, production began on the volume control telephone, designed for the benefit of the hard of hearing.

Then came the nite-light telephone, the Speakerphone, the CALL DIRECTOR® (1958) and the PRINCESS® telephone (1960). Production of color telephones began in 1954 and soon outpaced the regular black sets. The CARD DIALER® moved from the Indianapolis Works' model shop, where new telephone designs are produced for preliminary test and evaluation, to a regular production line in 1961, and then came the TRIMLINE® telephone and the telephone set for TOUCH-TONE® service in 1963.

But more significantly, the current of change altered products made by Western Electric of which the average Bell Telephone company subscriber is hardly aware. This is the vital, unseen switching equipment that enables him to call any of the millions of telephones in the United States in a matter of seconds, and reach the majority of other telephones in the world.

In 1952 Western Electric shipped the first 4A crossbar switching equipment, a key element in the nation-wide long distance operator toll dialing program. Direct Distance Dialing, first demonstrated in 1951 with a cross-country call from the Mayor of Englewood, New Jersey, to the Mayor of Alameda, California, has grown in service so that at present well over half of all Bell Telephones can reach a distant number without the need for operator assistance.

During the late '50s and early '60s development work progressed on a new concept of switching which will gradually supersede electro-mechanical switching in the Bell System. Initial production on two Electronic Switching Systems (ESS) began in 1963. One of these is for central offices and the other for private branch exchange use. The first commercial central office was scheduled for service at Succasunna, New Jersey, in July, 1965, and the second, in Baltimore, about the same time. The first commercial system for private branch exchange use was installed at Cocoa Beach, Florida in 1963.

Toll transmission has altered greatly, too. In 1949, for example, only radio carried overseas calls; cable was the backbone of the tele-

phone network stretching across the continent.

Today, an intricate web of radio relay systems now provides routes for many of the daily toll telephone calls and for most of the network television transmission while underseas cable systems span oceans.

The Bell System's recent underseas cables make use of a repeater (developed by Bell Laboratories and manufactured by Western Electric) which enables a single cable to transmit in both directions. Hitherto, the Bell System used separate cables. Thus, through the Bell Laboratories - Western Electric teamwork, underseas cable repeaters were designed and produced to span the Atlantic. And, through the continuing research for better ways of serving, these repeaters, of revolutionary design when first produced in 1955, were superseded just seven years later by equipment of new design which afforded improved service.

NEW AND BETTER WAYS OF SERVING

The list of new communications products and services that have come into being through Bell System teamwork is a long and satisfying one. Western Electric's contributions to this team effort have taken the form of an intensive search for better, faster and more economical service to the operating companies.

To maintain the lowest possible prices and at the same time maintain the traditionally high level of Bell System quality, Western Electric people constantly seek new and more efficient means of doing business. To this end, they have devised new manufacturing processes and machines, developed new materials handling and storage, making ever more effective use of special skills and working with 40,000 suppliers to determine how best to use the products and services they supply. There is scarcely a single operation in the company's manufacturing, service and supply activities that cannot support evidence of how basic the quest for innovation is to Western Electric's concept of serving the Bell Telephone companies.

SERVICE TO THE NATION

As a result of work undertaken by Bell Telephone Laboratories and Western Electric at the request of the military, Nike Ajax became the United States' first operational ground-to-air anti-aircraft missile in 1954. In 1958, Nike-Hercules became operational. It has three times the range of Ajax, is able to intercept intruders at altitudes from less than 1,000 feet to over 100,000 feet, and can also destroy certain types of short-range tactical missiles. Next came development work on Nike Zeus, designed to help protect the nation from attack by ICBM's, with

the still more advanced and efficient Nike X presently under development. Western Electric and Bell Laboratories also worked together to produce the guidance system for the nuclear-warhead Titan I ICBM.

Other major defense contributions made by Western Electric in recent years include the DEW (Distant Early Warning) Line and its extensions; White Alice, a 3,000-mile communications system which ties together far-flung Alaskan defenses; the Aleutian Communications System; SAGE (Semi-Automatic Ground Environment) System; BMEWS (Ballistic Missile Early Warning System); a military under-sea cable system, MILS (Missile Impact Locating System); and of course, the world-wide network for Project Mercury which has served America's astronauts so well. Significantly, each of these projects requires co-ordination efforts of great magnitude to realize the challenge of reliability and the urgency of deadline. All were delivered, fully operational, on schedule.

THE CONSENT DECREE

On January 24, 1956, a Final Judgment restricting, with certain exceptions, AT&T and its operating subsidiaries to furnishing regulated common carrier communications services and furnishing services or facilities for the Government but preserving the long-standing relationships between the manufacturing, research and operating members of the Bell System, was entered in the United States District Court in Newark, New Jersey. This Judgment brought to a close the Justice Department's seven-year-long antitrust suit against Western Electric and AT&T that sought to separate the Bell System's manufacturing from its operating and research functions.

Western Electric is limited, with certain exceptions, to the manufacture of equipment of a type manufactured for sale to the companies of the Bell System for common carrier communications services, and to any business of a character or type engaged in for the Bell System. (These limitations, however, do not apply to the manufacture of equipment for the Government or to any business engaged in for the Government.) This restriction applies to the activities of WE subsidiaries as well.

The Judgment also requires that any applicant be licensed for any equipment under all existing or future United States patents of the Bell System. Such patents issued prior to the date of the Judgment must be licensed on a royalty-free basis. Any patents issued subsequent to that date must be licensed at reasonable and non-discriminatory royalties.

The Judgment also requires Western Electric to furnish to any

applicant (other than foreigners or companies controlled by foreign interests) who is licensed under the Judgment, manufacturing drawings and specifications relating to any licensed equipment that WE manufactures for sale to Bell System companies, and furnish them at a reasonable charge or charges.'

THE EVE OF ADVANCE

In reviewing any record of achievement as notable as that which summarizes Western Electric activities in recent years, there is a danger that the details of accomplishment will obscure the total design of which they form a part. Many more examples could easily be adduced, many more figures cited, to demonstrate that since World War II, the company has undergone a period of major innovation. But though citations support, they do not explain, and Western Electric's effort has been only a means to an end.

The success with which the company has provided better and more economical equipment and service is not the result of separate actions aimed at coping with a series of individual requests, nor has it been a passive response to the urgency of Bell System needs.

Rather the initiative of Western Electric's continuing contribution to the improvement and expansion of the Bell Telephone network results from the close cooperation and shared responsibility of WE people and their Bell System teammates in meeting their common purpose. It is because we are a member of the Bell System that Western Electric has concentrated always on the long-range development of communications. In this sense, even our records of the '50s and '60s are of interest not as accomplishments in themselves but as preparations for further development. The past is prologue.

⁴ The full text of the Judgment appears as the appendix of this book.

Structure of Western Electric VI

Western Electric's basic job is much the same today as it was in 1882 — to provide the Bell System with a reliable source of high quality communications equipment. In 1882, however, there were only 60,000 Bell telephones in the country and a nation-wide network existed only as an ultimate (and to some scoffers, an unlikely) aspiration. Eighty-two years later, in 1964, the Bell Telephone network linked each of over 70 million Bell telephones with all the others — and the number keeps rising. That this network exists as a flexible, versatile, and reliable reality, that it continues to grow in service, is due in large measure to the complex and compatible communications equipment and the supporting services supplied by Western Electric.

Needless to say, the volume of present-day Bell Systems communications has greatly altered the ways in which Western Electric fills its function as the manufacturing and supply unit of the Bell System. Yet volume of demand does not alone establish the challenge and define the responsibilities that Western Electric accepts in fulfilling this function.

As we have seen, "new arts" in telephony have greatly changed the course of communications since World War II. They will continue to do so, creating for Western Electric the further challenge of providing new equipment and better service in an era of industry-wide technological advance.

But manufacturing products and supplying supporting services, though basic and major aspects of WE's total activity, are not the whole story. They are, after all, parts of a sum of activity which in its totality gives Western Electric a place unique in American industry. The uniqueness derives from the concept of service to the Bell Telephone companies. This concept is fundamental to the personality of

Western Electric, unifying the efforts of WE people in the six areas of the company's function for the Bell System: manufacturing, systems equipment engineering, installation, distribution, repair, and purchasing.

A detailed description of how and where WE people work within the organizational structure of the company to fill their common goal of service comprises the next chapter. The nine company divisions in their particularity provide the means whereby the company fulfills its mission in the Bell System and serves the defense and space communications needs of the Government.

Before examining the details of operations, however, it is reasonable to survey the formal structure of management in Western Electric and to review the basic concepts and objectives that company management seeks to implement. These concepts and objectives define the mission of service to the Bell System. Also in this chapter it is appropriate to summarize the standing committees which establish the procedures for general implementation of the policies that guide the management of the company's affairs in the continuing performance of the job.

BASIC OBJECTIVES AND CONCEPT OF MANAGEMENT

The Bell System exists to furnish communications services to meet the public demand, and the contribution it makes to the national welfare in meeting this demand depends upon the speed, quality, volume, responsiveness, and cost of its service. The System developed integrated research-development and manufacturing-supply units to meet its needs. Western Electric, as its manufacturing and supply unit, has the responsibility to provide the operating companies with all materials and supplies they may order from Western, when required, at the lowest cost consistent with required quality and reliability.

WE management is charged with the responsibility for carrying out company objectives with "the highest degree of performance of which it is capable and in a manner consistent with the best industrial practices anywhere." There are seven objectives in evaluating the effectiveness of management action in carrying out this responsibility:

First — Service, Quality and Cost — Nothing less than good service, high quality and reasonable costs will be satisfactory.

Second — Earnings — The business must realize adequate earnings. It must be kept financially healthy so that it can do those things required to insure service, quality and cost objectives.

- Third — Treatment and Performance** — Fair treatment of the customer and pleasant performance must be the rule at all times, under all circumstances.
- Fourth — Balanced Consideration** — Consideration of the customer, the employee, the public and the shareholder must be in sound balance and eminently fair to all.
- Fifth — Research and Development** — There must be constant and adequate effort on research and development in all fields of our endeavors for progress in production, quality and employment conditions.
- Sixth — Long Range Planning** — The importance of the long pull must never be overlooked in the solution of current problems. Long range planning is essential to continued success.
- Seventh — Stature as a Management** — Integrity and dignity by all concerned are vital to successful management.

THE STRUCTURE OF MANAGEMENT

These seven considerations are constants to which general and specific company policies ever refer. It was, for instance, the desire to integrate service operations and increase their value in terms of the changing needs of the Bell System that led to the creation of the Service Division in a major company reorganization announced on August 1, 1962. Similarly, WE's continuing and searching cost reduction program, which affects every aspect of operations, derives from and is supported by the obligation of management to maintain reasonable costs. Also, these seven goals are of equal import, each serving to support the others.

Long-range planning, for example, both requires and encourages vigorous research and development programs, contributes to earnings and seeks to continue the tradition of superlative service, high quality and low cost that is the bedrock of our business.

It is a challenging program, indeed, for management. The question is, who is management?

In the sense that each of us performs his job with maximum efficiency and effectiveness, we are all managers. However, in an organization as large and complex as Western Electric, it is sometimes difficult to see how all the activities of all employees inter-relate and contribute to an ultimate end. This being so, management can sometimes seem to exist as only a very vague "they." Yet the structure of WE management, following the normal corporate hierarchy, is quite clear in pattern and based on the logic of review and delegation.

Western Electric is 99.82 per cent owned by the American Telephone and Telegraph Company. Like the other Bell System companies, basic direction is invested in a board of directors. In 1964, there were 14 Directors: six prominent business leaders, one educator and seven officers of the company.

The Board in its discretion appoints various of its members to its Executive Committee. The Executive Committee can exercise most of the powers of the Board of Directors in the management of the affairs of the company during the intervals between meetings of the Board of Directors. However, the Executive Committee does not have power to do a number of things, including the filling of vacancies on the Board or on any committee of the Board. Also, it may not amend the by-laws of the company.

As Chief Executive Officer of the company, the President supervises, directs, and controls, subject to the control of the Board of Directors, the business and affairs of the company.

THE EXECUTIVE POLICY COMMITTEE

The Executive Policy Committee is not the same as the Executive Committee of the Board of Directors, although there may be company Vice Presidents who are members of both.

The Executive Policy Committee is composed of Vice Presidents appointed by the President to review recommendations of company-wide significance submitted by divisions, officers and regular or special committees, and to take appropriate action on these recommendations. On its own initiative, the Executive Policy Committee can originate special studies relating to broad outlines of company policy and operations and to assign topics for consideration and recommendations to appropriate committees or divisions.

The management of the company is undertaken through nine divisions, each under the direction of a Vice President, and each in turn responsible to the President.

The management of the various divisions is autonomous within the limits of the company policy, and those limits are prompted by sound consideration of company results and objectives. (There are some exceptions in specific areas where the President or Board of Directors has delegated the authority and responsibility to one division or to one officer to act for another division or for the entire company.)

In addition to the Executive Officers and certain administrative officers who are among the officers elected by the Board of Directors there are some 100 Administrative Officers and Assistant Administrative Officers, who are appointed. In this group are the heads of

major organizations at headquarters, the managers at various locations and their major assistants. These men implement company policy through the various divisions and through a number of standing and special committees.

Like most large corporations, Western Electric does much of its planning through committees as a convenient means for establishing procedures to implement policies. As noted, some are appointed by the Board of Directors, others by the President or other officers of the company. These committees operate within specified areas. In policy matters or matters of company significance which require action broader than the prescribed authority of the particular committee, the committee's recommendations are presented to the Executive Policy Committee for consideration and action.

There are a number of important committees that warrant mention here. These are made up largely of Executive Officers and Administrative Officers and their functions are described in the GI series issued by Secretary's Organization.⁵

These committees are: Employee Benefit Committee; General Personnel Committee; Labor Relations Committee; Realty Committee; Contributions and Memberships Committee; Publications Committee; Research and Development Committee; Management Development Advisory Committee; Vail Medal Committee of Award.

THE CHAIN OF SUPERVISION

The various line and staff organizations reporting to the Vice Presidents and Administrative Officers will be described in detail in the next chapter. As this point, in the discussion of WE Management it might be wise to outline the structure of supervision: Chief Executive Officer; Executive Officer; Administrative Officer; Assistant Administrative Officer; Superintendent; Assistant Superintendent; Department Chief; Section Chief.

The functions of the Chief Executive Officer and Executive, Administrative and Assistant Administrative Officers have been noted above. The superintendent level is usually referred to as the fourth level of management in Western Electric. Included in this group are man-

⁵ It may be noted here that company directives and instructions are published in three forms. (1) General Instructions are the principal information on which all other directions or instructions are based. Basically they cover three areas: the duties, responsibilities and authority of Executive and Administrative Officers; descriptive charts showing the general structure of organization; the membership and duties of major committees. (2) Directives are issued to establish the duties and responsibilities of company officers and the policies which they implement. (3) Instructions are issued to inform organizations of the subject matter of the GI's and the Directives.

agers of Distributing Houses, Installation Areas and Manufacturing Shops as well as certain managers in staff organizations at headquarters. At all company locations except major Works and Plants and Headquarters the superintendent is the chief management man on the spot.

A typical superintendent has three assistant superintendents reporting to him. In turn the typical assistant superintendent has three department chiefs reporting to him. Departments vary in size from location to location and from division to division. Some manufacturing locations have departments of more than 100 people working on a single component. Other departments, particularly in engineering and staff organizations may have as few as two people because of the highly technical or professional nature of the work performed.

At most locations, the section chief is the first level of management.⁶

The installation organization of the Service Division has a unique problem in conducting work at thousands of different locations every year. On small jobs, where it is not feasible to have a full time supervisor at the site, an "in charge" man is frequently named. He has certain supervisory functions to perform between visits from his designated job supervisor.

⁶ At some older locations, there are also group chiefs, who report to the section chiefs. There are relatively small numbers of these, however.

The Nine Divisions

VII

This chapter summarizes the activities carried on by the nine Western Electric Divisions, and is, therefore, necessarily replete with detail. There is consequently a danger that the concentration on detail will obscure the focus of the overall purpose of this complex of activity. For this reason it might be well to preface the descriptions that follow with a general observation and a brief review.

The general observation comes close to being a truism; it is simply this: activities are not carried on for their own sake.

Each activity undertaken by an employee is a contribution to the company's ultimate objectives and the value of any effort, therefore, depends not just on the care with which it is performed as a particular operation but on the contribution it makes to the overall excellence of the whole endeavor. For this reason, it is well to bear in mind that all the activities of all WE organizations are carried on to further the common purpose, just as all the members of the Bell System work together.

Within Western Electric, the concepts and objectives of management, as outlined in the previous chapter, provide the general direction for the company's effort in providing the products and services wanted by the Bell Telephone companies. The same values enable the company to fill its other mission of service to the nation.

The various committees supply general procedures for implementing policies prompted by WE's objectives and for managing the company's affairs. The supervisory hierarchy provides the means of translating objectives and procedures into action, evaluating the response, and assuring the common purpose of effort. And all of these operate to organize the activities of each of the nine Divisions into which the complex of Western Electric is divided administratively.

These Divisions, each headed by a Vice President, are: Manufacturing, Service, Administration, Engineering, Defense Activities, Legal and Patent, Finance, Personnel and Public Relations, and Organization Planning.

Three of these Divisions — Manufacturing, Service, and Defense Activities — employ about 95 per cent of WE people and are directly concerned with the fulfillment of WE's mission.

The component organizations and groups within each of these Divisions require a wide range of job skills and interests to carry on their particular operations. Not everyone in Manufacturing actually produces a product or directs those who do. To operate a Works or Distributing House or carry out installation work calls for supporting services in wide array: engineers, draftsmen, accountants, industrial, labor and public relations personnel, nurses, guards, stenographers, and planning people, to name but a few. Because they are employed at a particular location in a particular Division, they are carried as members of that Division.

The other six WE Divisions — Administration, Engineering, Legal and Patent, Finance, Personnel and Public Relations, and Organization Planning — are chiefly concerned with providing direction, advice, and assistance in their particular fields of interests as defined in their delegations, and most — but not all — of the people in these Divisions are located at company Headquarters in New York.

MANUFACTURING

In terms of employees, this is by far the largest of the nine Divisions. The total number of employees accounts for about 63 per cent of all WE people.

The array of products and their component parts manufactured in Western Electric totals some 50,000 different items. The list covers everything from telephones (and a score of different types of telephones are manufactured at Indianapolis Works) and switchboards, switching equipment, wire and cable, microwave systems, to many of their component parts. A good number of these items are made in quantity — about seven million telephones a year, for instance, and billions of feet of wire and cable. Many others, however, are made only in the hundreds or thousands during the course of the year to perform highly specialized functions or to maintain the serviceability of Bell System equipment which has been long in use though still reliable in operation.

There is similar contrast in size: crossbar frames over eight feet high and thermistors so small they are nearly invisible. Some WE products like coils and certain mechanical switches are relatively sim-

ple to understand; others are so complex in assembly, so special in function as to seem at first glance incapable of uniform quality production. The underseas repeaters that Western Electric produces to provide two-way transmission over a single underseas cable, for example, consist of painfully precise assemblies of 5,000 parts built to provide at least 20 years of continuous service.

One thing is common to all these items despite their diversity of size, volume, and function: the mark of uniform high quality.

Supported by the tradition of craftsmanship which dates from the founding of the company, maintained by the quest for continuing innovation in product and service, Western Electric quality is compounded from fine materials, engineering skills and the efforts of able personnel. Of equal importance is the concerted effort by all WE people to provide equipment and services at the most reasonable cost possible.

The scale of the job in itself makes this an immense challenge. To meet the challenge so that all parts of WE's total manufacturing effort contribute to the company's overall goals, the Manufacturing Division, under the direction of a Vice President, has four major subdivisions, each headed by a Vice President.

These subdivisions are:

Vice President—Manufacturing—Area A has reporting to him Baltimore Works, Indianapolis Works, Kearny Works and the Buffalo Plant. He also is responsible for supervision of the company's interest in Nassau Smelting and Refining Company, Inc. (see Chapter 8).

Vice President—Manufacturing—Area B has reporting to him Columbus Works, Hawthorne Works, Oklahoma City Works and Omaha Works. He is also responsible for supervision of the company's interest in Teletype Corporation and Manufacturer's Junction Railway Company (both discussed in Chapter 8).

Vice President—Manufacturing—Area C has reporting to him Allentown Works, (and the Laureldale Plant), Kansas City Works, Merrimack Valley Works, and North Carolina Works.

Vice President—Manufacturing Staff has reporting to him the Division Comptroller and Engineer of Manufacture.

The general and specific duties, responsibilities, and authorities of this management are listed in detail in the G.I. 2 series, published by the Secretary's organization. At this point it might be more helpful to survey the various items produced at each of the locations in the three Manufacturing Areas, and then review briefly the functions performed by the organizations reporting to the Vice President—Manufacturing Staff.

An understanding of the organization of the Manufacturing Divi-

sion requires a brief digression into intracompany terminology. It's a question of semantics, really. Words like "Plant," "Works," and "Shops," when capitalized have specific meanings at WE, though the reasons may not always be clear and the distinctions do not necessarily apply elsewhere in the Bell System.

To take one example, Webster's defines "plant" as "... the machinery, apparatus, fixtures, etc., sometimes the real estate employed in carrying on a trade or mechanical or other industrial business." In Western Electric usage, "Plant" has a more limited meaning. Strictly speaking, there are only two WE Plants—with a capital P. One is at Buffalo, New York; the other in Laureldale, Pennsylvania.

Specifically, "Plant" refers to a separate, medium-sized manufacturing facility, encompassing several "Shops." "Shop" is used to describe a manufacturing unit under the direction of a superintendent, that produces one particular product family, like crossbar equipment or cable. Major manufacturing facilities, which comprise many Shops, are designated Works. There are 11 WE Works and they are responsible for the great bulk of the company's manufacturing output.

Five of these Works operate satellite Shops with large manufacturing facilities employing sizable numbers of people and located physically apart from the Works to which each reports. The Burlington Shops, for example, where the Speakerphone and ground radar and missile guidance equipment for the armed forces are made, covers well over 700,000 square feet of manufacturing space.

With these distinctions in mind, the constitution of the three Manufacturing Areas is easier to understand. It is as follows:

Manufacturing—Area A

Facility	Principal Products
BALTIMORE WORKS	
Baltimore, Md.	Toll, exchange, coaxial, and submarine cable
Occupied 1930	Telephone cords and plugs
	Cable terminals
	Terminal strips and protectors
	Rubber-covered wire
BUFFALO PLANT	
Tonawanda, N. Y.	Equipment wiring cable
Occupied 1946	Telephone cords
	Enameled wire
	Insulated wire

INDIANAPOLIS WORKS (Main Plant) Indianapolis, Ind. Occupied 1950	Telephone sets and components
Washington Street Shop Indianapolis, Ind. Occupied 1957	Miscellaneous subscriber apparatus
KEARNY WORKS (Main Plant) Kearny, N. J. Occupied 1925	Switchboards and consoles Key equipment Cable, wire Miscellaneous wired equipment Relays, jacks, keys
Marion Shops Jersey City, N. J. Occupied 1947	Portable test sets Rectifiers Power equipment
Fair Lawn Shops Fair Lawn, N. J. Occupied 1956	Coils, resistors, transformers, keys
Clark Shop Clark Township, N. J. Occupied 1959	Submarine cable repeaters and components
Queensboro Shop Middle Village, N. Y. Occupied 1929	Miscellaneous woodwork

Manufacturing—Area B

Facility	Principal Products
COLUMBUS WORKS Columbus, Ohio Occupied 1959	Crossbar and electronic switching equipment Relays, including wire spring type Inductors, transformers, networks
HAWTHORNE WORKS (Main Plant) Chicago, Illinois Occupied 1905	Step-by-step, panel, and electronic PBX switching equipment; announcement systems, power equipment, cable, wire Relays, capacitors, switches, jacks, keys Transformers, inductors, networks Ferrites, tools

Clearing Shops Bedford Pk., Illinois Occupied 1937	Steel strand Pole line hardware
Montgomery Shops Montgomery, Illinois Occupied 1955	<i>Data-Phone</i> data sets Wire spring relays Test sets
OKLAHOMA CITY WORKS Oklahoma City, Okla. Occupied 1960	Crossbar switching equipment Coin telephones Relays Resistors
OMAHA WORKS Omaha, Neb. Occupied 1958	Crossbar and PBX switching equipment Relays, including wire spring type Cable and wire

Manufacturing—Area C

Facility	Principal Products
ALLENTOWN WORKS Allentown, Pa. Occupied 1948	Semiconductors Electron tubes Dry reed and mercury switches Mercury relays Switchboard lamps
KANSAS CITY WORKS Lee's Summit, Mo. Occupied 1961	Semiconductors Electron tubes and switchboard lamps Dry reed and mercury switches Telephone repeaters Carrier and microwave radio relay equipment
LAURELDALE PLANT Laureldale, Pa. Occupied 1952	Semiconductors Electron tubes
MERRIMACK VALLEY WORKS (Main Plant) North Andover, Mass. Occupied 1956	Carrier and radio relay, telephone, telegraph and television transmission equipment Telephone and telegraph repeaters, coils, transformers, capacitors, resistors, ferrites; Synthetic quartz crystal

Lawrence Shop Lawrence, Mass. Occupied 1957	BELLBOY® receivers Telephone repeaters and carrier
NORTH CAROLINA WORKS (Main Plant) Winston-Salem, N. C. Occupied 1954	Transmission equipment In-band signaling units Wage guide type equipment
Chatham Road Shops Winston-Salem, N. C. Occupied 1946	Military equipment
Waightown Street Shops Winston-Salem, N. C. Occupied 1947	Military relays, deposited carbon resistors, capacitors Missile guidance equipment
Burlington Shops Burlington, N. C. Occupied 1946	Military equipment Speakerphone
Greensboro Shops Greensboro, N. C. Occupied 1950	Missile guidance equipment Printed wiring boards Data transmission systems Precision gears and servo mechanisms

Manufacturing-Staff

The Manufacturing-Staff organization, comprising the Division Comptroller and his staff and the Engineer of Manufacture and his staff, is located at company headquarters in New York and carries on the following principal functions: coordinating manufacturing engineering and cost reduction programs, preparing capital budgets, allocating production programs, analyzing operating performance, coordinating labor and industrial relations and handling relations with WE subsidiaries.

Division Comptroller

Basically, the Division Comptroller's group acts as a consulting and service organization for other parts of the Manufacturing Division. Among the assignments carried out on a continuing basis is an aggressive development program involving application to business procedures of electronic data processing and other new or evolving data and method research techniques and clerical practices. The staff members also:

1. Develop, interpret and distribute Divisional instructions.
2. Coordinate, analyze and publish financial and cost accounting data relating to the Division, and advise and assist on effective auditing procedures.
3. Advise and assist on various methods of inventory control including coordinating requirements and authorizing purchase of centrally purchased raw materials, and authorizing the redistribution of raw materials or parts in restricted supply.
4. Supply advice and assistance to manufacturing locations on labor relations matters and coordinate them within the Division and with other divisions and assist in the formulation of general labor relations policies, and provide much the same advice and assistance as regards industrial relations matters.
5. Analyze and coordinate quarterly production estimates submitted by the Administration Division, allocate production among the Works and arrange for firm quarterly production estimates by each location.

While this description is by no means inclusive of all areas of interest to the Manufacturing Division Comptroller, it does serve to indicate the range and depth of liaison carried out by this organization within the Manufacturing Division and on behalf of Manufacturing with other organizations within the company.

Engineer of Manufacture

Similarly, the Engineer of Manufacture organization directs and coordinates the wide range of engineering activities carried on within the Manufacturing Division. To this end, the Engineer of Manufacture and his staff:

1. Collaborate with Bell Telephone Laboratories on materials, processes and product designs that will be the responsibility of the Manufacturing Division.
2. Allocate and coordinate the development of manufacturing processes, practices, and facilities.
3. Determine long-range space requirements for manufacturing locations.
4. Maintain and coordinate a vigilant cost reduction program in all its aspects.
5. Collect and prepare technical information concerning Manufacturing Division products for sale to licensees.
6. Negotiate contracts between the Manufacturing Division and the U.S. Government covering manufacturing facilities to be provided or

financed by the Government for the manufacture of products for the Government.

7. Collaborate with the Engineering Division to determine whether a new product under development will be purchased or manufactured, and on broad aspects of Western Electric-Bell Telephone Laboratories relationships, coordination, and planning.

SERVICE

The Service Division and the Administration Division were created on August 1, 1962 in a reorganization designed to assure the continuing responsiveness through changing times by Western Electric to the needs for its services by the Bell Telephone companies.

Reporting to the Vice President-Service are: Vice President-Service-East, in New York; Vice President-Service-West, in Chicago; General Manager-Systems Equipment Engineering, in Newark, New Jersey; General Manager-Staff, located in New York.

Reporting to the Vice President-Service-East are the General Managers of the Northeastern Region, Eastern Region and Southern Region. Reporting to the Vice President-Service-West are the General Managers of the Southwestern Region, Mountain-Northwest Region, Pacific Region and Central Region.

At the time the reorganization was announced, WE President H. I. Romnes said, "Western Electric has three basic missions — production, service to Bell Telephone companies and national defense. In the company's new structure these basic missions are directly reflected in the responsibilities assigned. . . .

"The new Service Division, by linking Distribution, Repair, Installation and Equipment Engineering on a regional basis, will bring us closer to the people we serve. This is especially important at a time when telephone technology is changing so fast. Assuring the quality and delivery of the many new and complex Bell System services requires close working relationships on a continuing basis. The regional organization of the Service Division should provide us as close a liaison with the operating units of the Bell System as the Branch Laboratories in our factories do with the System's research and development unit."

Previous to the creation of the Service Division, distribution and installation activities were carried on by separate nationwide organizations joined structurally under the title Telephone Sales. Although now integrated with Systems Equipment Engineering and organized managerially into seven geographical regions, they provide fairly distinct functions. A review of what WE people concerned with distribu-

tion, installation, and Systems Equipment Engineering do, therefore, seems in order.

Distribution

Thirty-five Distributing Houses link WE to the Bell Telephone companies we serve. These Houses, most of which have been built or replaced since World War II, serve as both supply centers and repair shops.

WE's first Distributing House was established in Philadelphia in 1901 when the first standard supply contract was signed. Before then, Bell Telephone Companies placed their orders directly on WE factories. The company did no reconditioning work. The growth of the Bell System network, however, created a need for Western Electric to increase its scope of service. More than that, the advantages of a centralized supply service on a day-to-day basis and during emergencies were clearly demonstrated by the operation. The repair and reconditioning of equipment by the company for the Bell Telephone companies was a natural adjunct to the supply service. The following table illustrates the growth of Distributing Houses since 1901.

House	Inaugurated
Pennsylvania (formerly Philadelphia) ..	1901
St. Louis ..	1902
Denver .	1903
Kansas City ..	1903
San Francisco ..	1903
Illinois ...	1904
Cincinnati .	1904
New York ..	1904
Pittsburgh ..	1904
Atlanta ..	1905
Indiana .	1906
Los Angeles ..	1906
Minneapolis .	1907
Seattle ...	1907
Boston	1908
Dallas ...	1908
Michigan .	1908
Portland ...	1910
Cleveland .	1912
Houston	1912
New Orleans ...	1912

Connecticut (formerly New Haven)	1913
Washington	1923
Milwaukee	1924
Long Island (formerly Brooklyn).....	1926
New Jersey (formerly Newark).. ..	1926
Jacksonville	1927
Syracuse	1953
Nashville	1955
Carolinas	1958
Phoenix	1958
Miami	1960
Westchester	1961
Salt Lake City.. . . .	1962
Omaha	1963

As noted above, the majority of the Distributing Houses are now located in quarters built since World War II. In some cases, the new quarters have been relocated some miles from the cities where they were originally established. As a result, some of the names have changed. For example, when distribution people in Illinois moved from Chicago to West Chicago, the name was changed to the Illinois Distributing House. The same holds true for the former Newark House, now called the New Jersey House and located in the town of Union; the Pennsylvania Distributing House, now located in the Philadelphia suburb of King of Prussia; the Indiana House at Indianapolis; the Carolinas House at Charlotte, North Carolina, and the Connecticut House, Orange, Connecticut.

Typically, a WE Distributing House stocks about 10,000 different items including materials of WE manufacture and the many supplies — from stationery to lineman's tools — that the company purchases and stocks for the Bell Telephone companies. Some 10,000,000 telephone sets are reconditioned in the Distributing House repair shops annually, along with many other types of communications apparatus, such as teletypewriter equipment, switchboards, and central office and electronic equipment.

At each Distributing House, the physical plant, shipping, repair functions and billing procedures are based on the concept of service. To this end, WE people strive constantly to improve their service through reduction of costs and the shortening of intervals between order and delivery.

Despite the immensity of the job, more than 98 per cent of all materials ordered through these Distributing Houses by the Bell Telephone companies is delivered on schedule — and WE is actively seek-

ing to better even this record. As a result, there has been a marked increase in "same day" deliveries during recent years. In the same spirit, distribution and repair costs have been reduced close to 20 per cent over the past decade, despite increases in operating costs and labor.

Space in every Distributing House is reserved for use by the local Bell Telephone company, and special areas are engineered and equipped for telephone company truck loading in most houses. Illustrating Bell System teamwork, distribution people work side by side with telephone company personnel to get the job done economically, swiftly and accurately. The advantages of this teamwork are strikingly demonstrated during emergency. That communications services damaged or destroyed during hurricanes, for instance, are so quickly restored to normal is, in large measure, the result of this teamwork responding to crisis.

Installation

Making substantial contributions to the Western Electric goal of superlative service are the people of the Service Division engaged in installation work. Here, too, the drive is for ever better ways of filling the needs of the Bell Telephone Companies — an objective pursued in terms of consistent high quality, reasonable cost and the quest for shorter installation intervals.

So basic is the installation of central office switching equipment to the expansion of the Bell Telephone network that it is a bit surprising to realize that before there were telephones there were WE installers at work. These men worked on the premises of customers, wiring and placing in service call bells, annunciators, fire and burglar alarms and the variety of other equipment that Western Electric made in its early days. The tradition of a quality job efficiently done was already firmly established when Western Electric joined the Bell System in 1882 and these installers became involved in a new and rapidly developing technology.

The dedication to quality is as strong today. What has changed, of course — and changed so greatly — is the complexity of installation work. The character of this work, the skills and perseverance it requires, create a group of employees unique in industry.

The primary responsibility of an installation crew is to set up switching equipment, connect it, test it and turn it over on schedule ready for use as a part of the nation-wide Bell Telephone network. This is the final link in WE's chain of service which joins the research of Bell Telephone Laboratories with the actual operation of compatible and reliable equipment by the Bell Telephone companies.

About 87 major operations are required for the installation and

test of a modern 10,000-line dial central office. Such an office would include about 500,000 feet of cable and wire and 225 tons of switching and power equipment. However, the Service Division installs a variety of other equipment as well, including multi-line switchboards for business and the Government, radio relay stations, and terminal equipment for underseas cable systems. Perhaps no other aspect of company operations affords so wide a survey of Western Electric's scope of effort to serve the Bell Telephone companies.

Annually, WE installers may work on some 77,000 jobs in as many as 7,500 different locations. As a result it is nearly impossible to select a typical installation location. Installers may and do work just about everywhere in the United States — in large cities, small towns, on isolated mountain peaks and southwestern deserts. While it is true that the size of certain Areas limits the amount of travel an installer may do in the course of his job, mobility is still a characteristic of the Service Division's installers.

All Bell System installation work at present takes place in the United States. There are 17 Installation Areas, varying widely in size. The New York Area, for example, includes the five counties of New York City and the suburban satellite counties. In contrast, the Denver Area comprises Colorado, Utah, Wyoming, Arizona, New Mexico, the southern two-thirds of Idaho and El Paso County, Texas.

Each Area is subdivided in districts which also vary greatly in size. In general, the smaller the Area, the greater the urban population.

The 17 Installation Areas — which correspond roughly to the Bell Telephone Companies they serve — and their geographical territories are listed below.

ALBANY:	New York State (except for counties comprising New York Installation Area) and Connecticut
ATLANTA — EAST:	Florida, Georgia, North Carolina, South Carolina
ATLANTA — WEST:	Alabama, Kentucky, Louisiana, Mississippi, Tennessee
CHICAGO:	Illinois, Wisconsin and the Indiana counties of the metropolitan Chicago area
CLEVELAND:	Ohio
DALLAS:	Arkansas and Texas (except El Paso County)
DENVER:	Arizona, Colorado, Idaho (except northern third), New Mexico, Utah, Wyoming and El Paso County, Texas

DETROIT:	Michigan, Indiana (except for counties in metropolitan Chicago Area)
LOS ANGELES:	Southern California
NEWARK:	New Jersey
NEW YORK:	Metropolitan New York including Long Island, Westchester and Rockland Counties and Stamford, Connecticut
OMAHA:	Iowa, Minnesota, Nebraska, North Dakota, South Dakota
PHILADELPHIA:	Pennsylvania, Delaware
ST. LOUIS:	Kansas, Missouri, Oklahoma
SAN FRANCISCO:	Northern California and Nevada
SEATTLE:	Northern Idaho, Oregon, Washington
WASHINGTON:	District of Columbia, Maryland, Virginia, West Virginia

Systems Equipment Engineering

It is largely through the efforts of WE Systems Equipment Engineers that the Bell System is assured of a communications system and not a collection of miscellaneous hardware. Before equipment for a central office or a microwave system is installed, Systems Equipment Engineering builds the project on paper (in the form of explanatory information, data sheets, and drawings) planning every detail to insure compatibility of circuits and equipment with all other parts of the network and, whenever possible, to develop means of reducing costs and improving service. In an age of many rapidly evolving communications advances, such engineering work is of prime importance to the Bell System.

In operation, Systems Equipment Engineering is divided into two primary functions: standards engineering and line engineering.

The standards engineer translates Bell Telephone Laboratories basic design work into information expressed in engineering and manufacturing terms. In so doing, he channels the flow of information needed to engineer, furnish and install communications equipment. He also determines availability and flow of tools, equipment and machinery used in manufacturing and installation to assure that common, up-to-date standards are used.

Working closely with the Bell Telephone companies, the line engineer in Systems Equipment Engineering plans for the manufacture and installation of equipment and circuits needed in a telephone central office. This ranges from planning brand-new installations to modifying existing equipment. For each order, the Bell Telephone com-

panies supply an outline of basic requirements. The WE line engineer researches a myriad of circuits and equipment for the right combination to fill the needs outlined by the customer. Frequently line engineers will coordinate projects with each other, as when a dial central office is added to a building containing toll facilities.

The analysis of needs is translated into detailed specifications and drawings. From these, other WE people manufacture or purchase needed components and install them. During the course of the whole project, the line engineer serves as liaison internally and with the telephone company until the order he has processed has been cut into service.

There are Systems Equipment Engineering offices for each of the seven Service Division regions.

* * * * *

In the present structure of the Service Division, WE's Distributing Houses and Installation Areas are organized geographically as follows:

SERVICE -- EAST

Distributing Houses

Atlanta
Boston
Carolinas
Cincinnati
Cleveland
Connecticut
Jacksonville
Long Island
Miami
Nashville
New Jersey
New Orleans
New York
Pennsylvania
Pittsburgh
Syracuse
Washington
Westchester

SERVICE -- WEST

Distributing Houses

Dallas
Denver
Houston
Illinois
Indiana
Kansas City
Los Angeles
Michigan
Milwaukee
Minneapolis
Omaha
Phoenix
Portland
St. Louis
Salt Lake City
San Francisco
Seattle

SERVICE — EAST

Installation Areas

Albany
Atlanta — East
Atlanta — West
Cleveland
Newark
New York
Philadelphia
Washington

SERVICE — WEST

Installation Areas

Chicago
Dallas
Denver
Detroit
Los Angeles
Omaha
St. Louis
San Francisco
Seattle

ADMINISTRATION

Like the Service Division, the Administration Division's present structure resulted from the reorganization of August 1, 1962. This Division carries on four major activities: directing WE purchasing and transportation activities; negotiating with non-Bell companies on licenses involving patents; supervising the design, construction, and remodeling of buildings owned or leased by Western Electric; and developing company production programs and supervising the marketing, pricing and commercial relations functions.

Purchasing and Transportation

The Vice President — Purchasing and Transportation is responsible for the purchase of all materials, equipment, and services, including transportation and public warehousing, required by the company to fill its function as the manufacturing and supply unit of the Bell System. His organization engages in a range of activities that include: establishing policies and procedures for the company's purchasing and transportation functions; determining the assignment of purchasing responsibility; surveying all purchasing and transportation activities and collaborating with other Divisions in developing new and improved methods or materials and in determining adequacy of suppliers' facilities; authorizing purchase of products for resale to Bell Telephone companies, inspecting such products and other products for manufacturing use and collaborating with Bell Laboratories on changes in design of purchased parts or products.

Another responsibility, specifically noted in the General Instruction defining the functions of Purchasing and Transportation is to keep in mind the opportunities for favorable public relations in dealing with

suppliers, sub-contractors and transportation companies.

The extensive scope of WE's purchases underscores the importance of this organization's work. In a typical year, for example, Western Electric does business with 40,000 suppliers who employ over 5,000,000 people in nearly 4,000 American towns and cities in all 50 states. Total payments for raw materials, telephone company supplies, Government sub-contracts, and transportation services exceed \$1.2 billion a year. More than 90 per cent of the suppliers are small firms with fewer than 500 employees.

Each year, WE purchases more than 150,000 different items: raw materials, parts, components, tools for our use and for telephone company people, and an array of finished products ranging from telephone directories to telephone poles. Some of these items and numerous special ones come from other suppliers who help with the defense projects entrusted to us by the Government. And still other items such as transportation are in the service category.

Western Electric's purchases for the Bell System eliminate the necessity for each telephone company to maintain separate purchasing and inspection organizations and permits a standardization of supplies. Savings contribute, too, to the economy of Bell Telephone service.

The Transportation organization's basic job is to make certain that the vast, varied amounts of raw materials, telephone equipment and supplies needed for the operation of the Bell System arrive at the right place at the right time. Typically, this involves the purchase of about \$70 million of transportation services from some 4,300 carriers for shipment of materials from WE suppliers to our manufacturing locations and distribution centers and thousands of Bell Telephone company locations. In addition, the Transportation organization arranges transportation for people traveling on company business and takes care of shipping household goods when an employee is relocated.

Since it is essentially a service organization for other divisions of the company, for the company's subsidiaries, and, on request, for the Bell Telephone companies, about half of Transportation's staff are at headquarters with the balance in field offices at our 13 major manufacturing locations and in San Francisco. Its basic objective is the same as that of the company — good service at low cost. On a day-to-day basis this means continuing determination of shipping routes involving just about all possible combination of land, sea, and air transport.

In addition, Transportation is concerned that Bell System carriers adhere to Federal, State and local regulations and that the carrier's financial responsibility, insurance coverage and terminal facilities are adequate to safeguard shipments.

Patent Licensing

In order to enable the Bell System to be free to use the best of known technologies in furnishing communication services, it is often desirable to employ inventions of others as well as those resulting from the System's own research and development activities. Usually, such inventions of others are patented and thus licenses for their use are required. The Patent Licensing Organization acts for the Bell System in obtaining licenses under these patents.

Patent Licensing is also responsible for granting licenses to others to use Bell System inventions. An outstanding example of a licensed Bell System invention, which has had a marked effect on the growth of the communications and electronics industries, is the transistor, which was created by Bell Telephone Laboratories.

As required by the Final Judgment entered into with the Government on January 24, 1956, the Bell System makes available to all who desire them, unrestricted non-exclusive licenses under any or all of its patents issued in the United States to make, have made, use, lease and sell any or all equipments as may be desired by the applicants. Such patents issued prior to January 24, 1956, are licensed royalty-free. Other United States patents are licensed at reasonable royalties. As a condition of licensing an applicant, the Bell System may require a non-exclusive license in return at reasonable royalties for any equipment useful in furnishing common carrier communication services and for machines, tools and materials useful in manufacturing or operating any such equipment. Similar licenses under foreign patents are available to all applicants at reasonable royalties.

Patent Licensing activities require a knowledge of fundamental engineering principles, a familiarity with the patent system and a thorough understanding of the commercial situation as it relates to the various technologies.

Plant Design and Construction

As implied in its name, this organization supervises the design, construction and remodeling of buildings that Western Electric owns or leases. The Manager — Plant Design and Construction and his staff are located at Headquarters, though the organization will have representatives on the spot where current construction or major renovation projects are being carried on.

The Manager — Plant Design and Construction has the direction of and responsibility for the fundamental policies of Plant Engineering and the action taken to implement them. To this end, the members of

his organization collaborate with appropriate company Divisions in the development of a long range program of plant expansion and construction to meet the changing needs of the company, and to establish standards of design and construction which best meet these needs.

It is this organization that is responsible for new and remodeled buildings from selection of the site and purchase of the land through the architect's sketch to occupancy. When occasion arises, they also see to demolition of obsolete facilities or their disposal. In performing these functions, Plant Design and Construction naturally confers with the Divisions calling on their services as to basic needs of space, location and type of facilities. These are the determination of the appropriate Division. Plant Design and Construction turns the needs outlined on paper into the reality of steel and stone.

Also, the Manager of Plant Design and Construction is responsible for all changes and additions to owned or leased land and facilities costing more than \$100,000 and for all changes or additions where basic designs are involved. (If less than \$100,000 is involved and standards established by Plant Design and Construction are followed so that there is no problem of basic design, changes and additions to existing facilities are the responsibility of the Division concerned.)

The Plant Design and Construction organization also issues necessary directions relating to the use and maintenance of facilities and services, safety regulations, and compliance with insurance requirements and periodically carries on inspections in these areas at all major leased or owned buildings.

General Program and Commercial

The three organizations that report to the General Program and Commercial Manager are headed by the Program Planning Manager, Commercial Manager, and Marketing Manager.

Program Planning

The Program Planning Manager's organization is responsible for developing immediate and long-range production and shipping programs by product that form the basis for planning WE activity, capacity, and financial affairs. These forecasts are important for the adequate provision of facilities and supplies in both mix and capacity, operating economy through the effect on shop loading, leveling peaks and valleys in manning and production, reduction of delivery intervals, and budgeting in the Manufacturing, Equipment Engineering, and Installation organizations.

The organization regularly collaborates with Bell Laboratories to

obtain pertinent information and analyzes this information in light of its own knowledge of the trends — summarizing its conclusions in Quarterly Production Estimates. The resultant estimate of dollar sales is compared with planned Bell System construction expenditures for further evaluation. The dollar forecast is also used by the Finance organization in planning the company's fiscal requirements.

Experience indicates that major production activities are profoundly affected by the development of new products involving concepts and components as yet unknown. The Program Planning organization keeps in very close touch with AT&T and Bell Laboratories in order to anticipate the impact of those new developments at the earliest possible moment and also to coordinate their scheduling in the engineering, manufacturing, and installation of the introductory process.

Commercial

The Commercial Manager's organization is responsible for the pricing of WE telephone products and services. It issues and distributes the various price lists and the terms and conditions related to the price lists. In addition, this group administers the Standard Supply Contracts, negotiates and administers other sales contracts and handles sales of telephone products to non-Bell System customers (other than the U.S. Government and its contractors), and carries on related activities involving the sales of products and services by Western Electric.

Marketing

Marketing was created in the summer of 1960 as a part of the Distribution organization. With the company reorganization of August 1, 1962, Marketing became a staff organization for the entire company. This organization seeks to make sure that Western Electric is offering the Bell Telephone companies the services and equipment they want and need. At the same time, the group keeps these companies up-to-date concerning products and services available from Western Electric.

Marketing seeks to inform WE people about Bell System needs, examines customer reaction to our equipment and services, reviews products and services in terms of the customer's needs, and carries on research to determine what others in the industry are doing.

ENGINEERING

The Vice President — Engineering is responsible for the broad aspects of relations with Bell Telephone Laboratories, for WE's basic technical and scientific research, and for the training and development of WE engineers. The Vice President — Engineering is also responsi-

ble jointly with the Vice President — Personnel and Public Relations for the training of technical personnel and for various information programs concerning Western Electric engineering.

Reporting directly to him is the Assistant Vice President — Engineering and the Director — Research and Development.

Organizations Reporting to Assistant Vice President—Engineering

Organizations reporting to the Assistant Vice President — Engineering include: Director — Systems Development; Director — Staff Engineering; Superintendent — Engineering Training.

Systems Development

The Systems Development organization advises and assists other Divisions in the coordination of engineering activities and applications carried on in the course of the company's business. This offers another means of assuring high quality equipment and service in meeting the immediate and future needs of the integrated, expanding Bell System network.

Staff Engineering

The Director — Staff Engineering directs a relatively small group within the Engineering Division. Here the concentration is on quality assurance of products and services offered by Western Electric. To this end, Staff Engineering collaborates with appropriate divisions within the Company and with Bell Telephone Laboratories to establish criteria for quality controls in the broader aspects of the work. (Inspection and quality controls deemed necessary by other divisions for their own purpose, however, are not a concern of Staff Engineering.)

Engineering Training

Further evidence of Western Electric's firm intention to retain leadership in its field can be found in the training activities carried on for the benefit of WE engineers. The Superintendent — Engineering Training, supervises those concerned with this work at the three Graduate Engineering Training Centers located in the New York Coliseum, a converted residence at Winston-Salem, North Carolina, and the Chicago Sun-Times building. The philosophy of this program and description of courses appear in the Graduate Engineering Training Program Catalog, copies of which are available to WE engineers on request.

Research and Development

The Director — Research and Development directs the efforts of the Western Electric Engineering Research Center at Hopewell Township, near Princeton, New Jersey. Here research is conducted in three areas relating to manufacturing operations: the development of new concepts and techniques to permit automatic manufacture of communications apparatus; the applications of mathematical techniques, automatic data processing, and computer technology to plan and control production; the application of the principles of chemistry, metallurgy, and physics to manufacturing problems.

The Center opened its permanent quarters — two ultra-modern buildings offering 138,000 feet of floor space — late in December, 1962. However, operations had been carried on in leased quarters at Princeton since 1958.

DEFENSE ACTIVITIES

The Bell System is dedicated to the principle that "in communications, defense of the Nation comes first." With this capsulated principle the importance of the Defense Activities Division as a company organization becomes evident, since the U.S. Government is far and away our biggest non-Bell customer.

The defense side of Western's business can be of great pride to all employees. The work being done on the Nike Zeus and Nike X anti-missile missile systems continues the important work that culminated in the air defense system that deployed Nike Ajax and Nike Hercules throughout the United States and free world bases.

A wide variety of projects of extreme importance to national defense are also carried on for the U. S. Navy. Typical projects are SONAR and missile communications work. The missile guidance system developed for the Air Force has been eminently successful for this use as well as for space exploration work.

In the area of Government work, Western Electric has always applied the company's standards of cost consciousness, quality and service to ensure to the Nation the finest communications and material possible.

With the changing and sometimes variable character of Government business, the Division is so constituted that it is able to respond to periods of high as well as low activity. The Vice President-Defense Activities Division is responsible for sales to the U. S. Government, and the resultant contractual relationships; for the company's relationships with Sandia Corporation and Bellcomm Inc.; as well as for the Laboratories' military budget and necessary facilities in connection with the Laboratories military work.

Reporting to the Vice President-Defense Activities are: Director, Government Sales and Administration; Director, Government Communications Projects; Director, Military Engineering Services and Technical Publications; Manager, Government Relations (Washington); and the Director, Military Systems Engineering.

Government Sales and Administration

As the title suggests, the Director is concerned with the negotiation, execution and administration of all contracts with the U. S. Government. Since this field varies so much from our Bell business, it is necessary that a whole system of directions and procedures be prepared. These directions and procedures aid all Divisions of the company engaged in government work to comply with such rules. The organization is also responsible for compliance with government security requirements by Western Electric and Nassau Smelting and Refining Co. In addition, the group represents the company in renegotiation proceedings. It establishes selling prices for non-telephone projects, provides facilities required for Bell Laboratories' military projects and generally establishes procedures for efficiency and control of expense. A recent addition to the area of government business is the Customer Relations organization which coordinates future government business and the potential company contributions to national defense with an engineering and field group.

Government Communications Projects

One of the changes in governmental procurement after World War II arose from the need for qualified managerial organizations to do large and complex projects. Out of this need with the DEW Line, the company established a special group dedicated to solving the difficult and challenging projects that this concept entailed. This organization is established with experts in communications, purchasing and transportation among other fields. As the situation warrants, qualified personnel may be drawn from Bell System operating companies to answer the needs of every project. Major projects, in addition to the DEW Line, have been SAGE, White Alice, BMEWS, Project Mercury communications network, and similar communications projects of major importance. Some smaller projects are also being handled in the field of telecommunications; the communications projects in Thailand and Nigeria are examples of this type.

Military Engineering Service and Technical Publications

During World War II the military soon found that technical changes in equipment and new equipment and techniques required trained personnel, not readily available within the military to assure complete use of the complex equipment being put into service. This was the genesis of the Field Engineer Force which has since been designated as the Military Engineering Service. These engineers travel the world over to assist the military to obtain maximum performance from equipment and systems supplied by Western. As can be expected with such complex equipment, clear and effective operating and maintenance manuals are required. This need is fulfilled by the Technical Publications Group which is responsible for writing, illustrating and printing the thousands of pages required to do this job. This organization is located at Reynolda Road in Winston-Salem, North Carolina, close to the production shops of the equipment involved.

Military Systems Engineering

In March, 1964, the operation of the U. S. Air Force guidance and control stations at Cape Kennedy, Florida and Vandenberg Air Force Base, California was transferred from Bell Telephone Laboratories to Western Electric's Defense Activities Division, which formed the Military Systems Engineering organization for this purpose. At the same time, Defense Activities became responsible for support functions for the Air Force and NASA space program previously provided by Bell Laboratories at North Carolina.

The Cape Kennedy facility was opened in 1956 to test the Bell Labs-WE guidance system developed for the Air Force Titan I ICBM. This system proved so successful it has been used in many space flights and the Cape Kennedy station has guided 74 launchings. It will also be involved in the Air Force Asset Program for re-entry glider studies.

The Vandenberg station, opened in 1959, has guided 85 missile launchings.

LEGAL AND PATENT DIVISION

The Vice President and General Counsel heads WE's Legal and Patent Division consisting of five organizations: the Assistant Vice President and General Attorney; the General Solicitor; the General Patent Attorney; the Labor Counsel; and the Tax Counsel.

All these organizations are located at company Headquarters, New York. However, patent attorneys serving Western Electric manufacturing locations and reporting to the General Patent Attorney are

stationed at various Works. In addition, two attorneys reporting to the General Attorney are located at Hawthorne.

General Patent Attorney

The General Patent Attorney has primary responsibility for all legal matters relating to patents, copyrights, trademarks and technical information. Patent lawyers under his supervision review the work of engineers and determine when an invention has been made for which a patent application should be filed in the United States Patent Office. They also handle applications for patents in foreign countries. They work with the Patent Licensing organization in granting licenses under Bell System patents to others and in obtaining the licenses we need from others.

Patent lawyers review all contracts with the Government, Bell System suppliers and others to be sure that they contain appropriate clauses regarding inventions made in the course of the work, use of technical information, and protection against claims of patent infringement.

Labor Counsel

The Labor Counsel deals primarily with legal aspects of relations between the company and labor organizations, representation proceedings, labor contracts, grievances and arbitrations. He is also concerned with problems arising under other Federal and state labor laws, for example, the Wage and Hour Law.

Tax Counsel

The Tax Counsel has primary responsibility for legal matters relating to taxes affecting the company and works closely with the Comptroller on these matters. His organization prepares, or advises with respect to the preparation of all company tax returns, approves all tax payments and represents the company in all tax audits, reviews and controversies with taxing authorities.

All other legal matters are the concern of either the General Attorney or the General Solicitor.

General Solicitor

The General Solicitor is responsible for legal matters in connection with the Final Judgment of January 24, 1956 and for most problems under Federal and state anti-trust laws. He also handles, from a legal standpoint, a wide variety of corporate and financial matters arising from the operations of the Finance Division (Secretary's, Treasurer's

and Comptroller's organizations) and advertising, publications, publicity and other matters stemming from the activities of the Public Relations organization. He is responsible for legal aspects of relations between Western Electric and the telephone companies, and between WE and its distributors. He is responsible for the coordination of data and for preparation of responses to governmental inquiries.

Assistant Vice President and General Attorney

The General Attorney is responsible for most of the legal advice given to the Defense Activities, Purchasing and Plant Design and Construction Divisions. He advises the Personnel Organization on Benefit Plan, group insurance, and EME problems, and handles workmen's compensation, unemployment compensation and disability compensation cases. He reviews pending legislation in fields of company interest, and in lawsuits where the company is plaintiff or defendant, acts as liaison with trial counsel.

All of these organizations, of course, have responsibilities other than those highlighted here.

FINANCE

The Vice President — Finance is chairman of the Executive Policy Committee (see Chapter 6, page 46). His responsibilities include: coordination of activities and studies required to carry out company-wide policies, practices, and programs; annual financial analyses of five-year forecasts of company expenditures and periodic review of programs as needed; development of financing and control procedures; issuance of General Instructions and operating results to company Divisions; coordination of WE activities incident to Bell Telephone company relations with regulatory bodies.

The Comptroller, Secretary, and Treasurer report to him.

Comptroller's Organization

The Comptroller is responsible for formulating the accounting and auditing policies of the company and for implementing these policies with procedures that will produce a sound accounting structure. To this end, the Comptroller's organization develops and prescribes accounting and auditing methods and approves operating methods in so far as they affect accounting or financial results. In addition it prescribes the regulations and conditions under which payments are authorized and made, establishes fundamental payroll procedures, and

designates the approval requirements relating to these and other accounting and financial transactions. It also makes accounting and financial audits, and arranges for retention of public accountants for annual audits.

The issuance and accuracy of the company's financial reports, statistics and forecasts are the Comptroller's responsibility. In this connection, his organization analyzes and interprets accounting results for action that may be required on the part of operating divisions and executives. It also assembles and prepares data necessary to management in the establishment of financial goals, including dividend policy, and determination of price policies, including the coordination and development of the company forecasts as needed for executive consideration, as well as recommending programs of financing and control consistent with the needs of the business.

The Comptroller's organization also has the responsibility for undertaking business research studies and providing management with such economic, actuarial, statistical and business information and techniques as may assist it in its planning and control functions. It recommends or establishes employees' security accrual rates and depreciation policy and rates. It collaborates with and advises other divisions on financial evaluation techniques and criteria for capital investment proposals. It maintains a business reference library.

It is also the responsibility of the Comptroller's organization to maintain the corporate accounts, to perform accounting and payroll functions for specified headquarters organizations, and to prepare or approve data for tax levies and other accounting and statistical information to be submitted to Government agencies and others. It places the company's insurance and handles claims for related losses, and establishes operating procedures for all voluntary payroll deduction plans. Further, the organization collaborates with and advises other divisions on accounting organization and personnel.

Incident to Bell Telephone company relations with regulatory bodies, this organization prepares and presents testimony in telephone rate cases as to the reasonableness of Western's earnings on its business with the Bell companies, as well as coordinating all company activities in the regulatory field.

It is responsible also for audits relating to safeguarding of the company's assets and for cooperation with other Divisions in the prevention of theft or fraud against the company. This includes establishment of security standards, internal or external investigation involving the company or its employees, liaison with other Bell System security organizations and dissemination of pertinent security information.

Secretary's Organization

A part of the Secretary's organization's work is the furnishing of staff services to Headquarters. The Secretary issues notices of meetings of stockholders, the Executive Committee, and the Board of Directors, organization notices announcing executive changes, and official bulletin board notices. He also issues an Emergency Directory, a Headquarters telephone directory and the booklet entitled "Directors, Officers and Principal Organization Heads of Western Electric Company, Incorporated and Subsidiary Companies." The Secretary also issues all General Instructions and G.I. Charts, affixes the corporate seal and attests all documents requiring the same and certifies certain delegations of authority made by executive officers. Records Management functions and the Corporate File are also included in the organization's role.

Various other functions more in the nature of general services are likewise a responsibility of the Secretary. These include such things as the company communications methods and facilities and the determination of office standards for the company.

Treasurer's Organization

The Treasurer is responsible for all matters involving company securities, including the issue and transfer of capital stock, the determination of funds available for investment, and the purchase and sale of U. S. Government securities. He also arranges for borrowings required by the company.

His organization is responsible for custody of company funds; recommending banks; maintaining adequate bank balances and cash on hand; maintaining the company's credit standing; and analyses of the investment operations of the Pension Fund Trustees. It serves as liaison between the company and the trustees, collecting monies due the company, and performing other similar and related activities.

It is the Treasurer who determines the company's credit policy. He appoints cashiers and assistant cashiers (subject to their approval by either the President or the Vice President - Finance), and approves the assignment of other financial personnel in all Divisions and at all locations.

PERSONNEL AND PUBLIC RELATIONS

The Vice President - Personnel and Public Relations is responsible for the administration and direction of three broad areas - Personnel, Labor Relations, and Public Relations.

Most of the organizations reporting to the Personnel Director are located at Company Headquarters in New York while all organizations

reporting to the Labor Relations Director and the Public Relations Director are located in New York.

Personnel

The Personnel Director implements such company-wide personnel activities as employee training, benefit programs, and health and safety programs. Primary functions are carried on by five organizations.

The Secretary, Employees' Benefit Committee and his staff administer local details and provide general guidance on a company-wide basis on all provisions of the company benefit program for both active and retired employees. This staff also maintains pertinent statistics and personnel service information relating to benefit program matters.

The General Medical Director and his staff develop policies and procedures for those concerned with the health and safety of employees and company medical services. The medical facilities at 222 Broadway are also a part of this organization.

The Director—Salary Administration Studies and his staff develop information designed to help maintain fair compensation practices throughout the company in terms of immediate and long term developments.

The Director—Management Development heads the organization that develops and operates various management development activities. These include such formal training programs as the five-month management training program in New York, and the integrated sequence of management seminars for each of the first four levels of supervision. This organization also provides consulting and development assistance on training programs of a more specialized nature. In addition, it originates and coordinates programs and methods for the identification, appraisal, development planning, and implementation of such plans for management personnel. College recruiting activities and development programs for college recruits are also conducted by this organization. Facilities are maintained by this organization in Chicago and Princeton, New Jersey, as well as in New York.

The Director, Personnel Administration and his staff develop and administer company personnel policies and procedures relating directly to all employees. Included are such areas as wage and salary administration, employment, personnel research and realty matters for transferred employees.

Labor Relations

The Director—Labor Relations heads the group that initiates, develops and recommends general labor relations policies applicable to all

divisions. (Each division has primary responsibility for its own labor relations within the framework of over-all company policies.) The Labor Relations group frequently consults and assists other divisions on specific matters dealing with the implementation of policy, and maintains liaison to assure that approved policies are being followed.

The group also conducts research and training on many aspects of labor relations, issues the Labor Relations Handbook for the guidance of divisional Labor Relations organizations, conducts research on wages and fringe benefits which is the basic element leading to company negotiation limits, conducts studies on long-range economic trends in labor relations and, holds an annual conference with Division bargaining agents for purposes of review, exchange of ideas, and training.

In addition, the Labor Relations group works with the Labor Counsel on contract language, analyzes contracts prior to bargaining, determines specific major bargaining issues and objectives, and closely follows unfair labor practices charges and active arbitration cases. It performs a general coordination function within the company, and acts as liaison between Western Electric and outside companies, and between WE and other Bell System companies.

Personnel Relations

The Personnel Relations group is basically responsible for the promotion of progressive personnel policies and practices, consistent with WE's position in the industrial community, for engineering and other salaried management employees. In this capacity it must be responsive to the needs of the individual employee, as well as groups of employees, and to developments in the field that occur outside the company. Surveys, conferences and personal contacts are extensively employed to achieve the necessary exchange of ideas and information. This group initiates studies and proposals with regard to personnel appraisal, salary administration, placement, employee information, fringe practices and other matters in the interest of improved employee relations. In conjunction with other advisory organizations, it evaluates, develops and coordinates the company-wide implementation of the resulting personnel programs. One of its major functions is to provide an alternate channel of communications for employees which parallels that available through existing line organizations.

Public Relations

The Public Relations Director is responsible for company publicity, advertising, public and community relations and employee information programs. Reporting to him are the Director—Advertising and Public

Information and the Director—Public Affairs and Employee Information.

The Advertising Manager and his staff develop and coordinate the company's various national institutional advertising campaigns (working with Cunningham and Walsh, WE's advertising agency), college recruiting advertisements, advertisements in local plant city publications, and administer requests from WE suppliers who wish to cite the company as a customer. The Advertising Manager also works with other interested organizations in the standardization of the company name and trademark, including identifications used on buildings, products, plants, packages and printed material. The design and production of WE printed material, photographic services and assistance to the Marketing organization are also under the direction of the Advertising Manager as are the company's historical archives.

The Information Manager's staff handles information for press, radio, TV, general magazine, scientific journals and technical publication, public talks, community relations, liaison with Bell Telephone companies, and the contractual fulfillment of information releases on military and government work.

The Publications Manager supervises the staffs preparing WE magazine, the *Western Electric Engineer*, monthly publications for Headquarters and the Service Division, and other company publications. Publication Services is also a function of the Publications Manager's group. In addition, this organization offers advice and assistance to employee newspapers published at WE plants and other locations.

There are two other Public Relations Managers. The first directs a group that develops and coordinates company-wide public affairs programs, the information programs for supervisors and employees and conducts employee information development and research. The other Public Relations Manager develops and coordinates college relations programs exclusive of college recruiting activities, takes care of the WE contributions and membership programs and of relations with various business associations and public service organizations.

ORGANIZATION PLANNING

Newest of the company's nine divisions, Organization Planning was established in mid-April, 1964 as a further step in assuring the effectiveness of WE's response to Bell System needs.

The accelerating pace of company operations, the increased complexity of communications technology, together with the broad dispersion of company units, calls for an examination of the company's structure in the light of the need for effective communication, clear assignment of responsibility and an alert response to customer needs.

To this end, Organization Planning undertakes studies of over-all company organization and functions in the light of current trends in our business and modern industrial practice and recommends the most effective organization of resources to carry out the company's responsibilities to the Bell System and to the U.S. Government.

Four directors of Organization Planning report to the Vice President of this division.

Principal Subsidiaries of Western Electric

VIII

Sandia Corporation

Sandia Corporation is one of the Atomic Energy Commission's three principal nuclear weapons development installations. Its responsibilities, in the field of nuclear ordnance, extend from inception of each nuclear weapon to the retirement of that weapon from stockpile.

Under a non-profit, no-fee contract, WE's Sandia Corporation operates two laboratories for the AEC—Sandia Laboratory, Albuquerque, New Mexico, and Sandia Livermore Laboratory, Livermore, California—a test range at Tonopah, Nevada, and smaller test facilities at Point Arguello, California; White Sands Missile Range, New Mexico; and Cape Kennedy, Florida. Sandia Corporation employs about 7,000 persons in Albuquerque and is New Mexico's largest civilian employer. Sandia Livermore Laboratory employees number approximately 1,000.

The Sandia laboratories design, develop, test, and monitor production of the arming, fuzing and firing systems and other non-nuclear components and systems necessary to make a finished weapon of the nuclear assemblies designed and developed by Los Alamos Scientific Laboratory (LASL) and Lawrence Radiation Laboratory (LRL) at Livermore, the AEC's other major weapon development installations.

Sandia's responsibilities involve basic and applied research; component, systems and manufacturing development; testing; reliability and quality control; technical support activities (personnel, computing, purchasing, etc.); and field engineering and training of military instructors in maintenance and operation of nuclear weapons. Testing includes participation in full scale tests; reliability and quality control include stockpile surveillance and sampling.

Sandia does not manufacture or assemble weapons for stockpile. The laboratories fabricate models or prototypes of components and

systems and then release manufacturing and design information on these prototypes to various sub-contractors throughout the country. Thus, drawings, specifications, and other manufacturing information are Sandia's chief products in the nuclear weapons program.

Sandia's activities are not limited to the weapons program. The techniques, facilities, and skills developed by Sandia over a period of years provide a capability that fits naturally into certain non-weapon projects of national interest. For instance, Sandia provided the logic systems for the Vela High Altitude satellites for detecting nuclear detonations in space, and is responsible for the safety aspects of nuclear systems to be used as auxiliary power sources in some satellites.

Sandia Laboratory had its beginning as a part of LASL during the planning phases of the first nuclear test shot in 1945. The activity was expanded in late 1946 to provide closer ties with the growing military and airfield facilities in Albuquerque. The Sandia facility continued to grow and in 1949 the University of California, which operates both LASL and LRL, asked to be relieved of the ordnance engineering job. President Truman, through the chairman of the AEC, asked the Bell System to assume the responsibility for management of Sandia Laboratory.

To do this, Western Electric created the Sandia Corporation as a subsidiary to operate Sandia for the AEC as a service of the Bell System to the Government. The AEC facilities which Sandia operates under a prime contract with the AEC, have a first-cost value exceeding \$150,000,000. The Sandia Laboratory includes the main lab, office and service buildings on Sandia Base on the outskirts of Albuquerque, and test areas located on a remote stretch of mesa a few miles away. Sandia Livermore Laboratory, opened in 1956 to provide a closer working relationship with LRL, is located in the San Francisco Bay area some two miles from the city of Livermore.

Sandia employees are paid from funds appropriated by the U. S. Government and, are not Bell System employees. However, some of Sandia's officials are on loan from Western Electric and Bell Laboratories.

Teletype Corporation

Teletype Corporation is Western Electric's largest subsidiary and is engaged in the research, development and manufacture of a complete line of data communications equipment.

Messages and data can be sent between locations, locally or long distance, and provide a record of any transaction either as a typewritten page copy (plain paper or business forms) or as a strip of coded punched tape.

AT&T introduced its teletypewriter exchange service (TWX) in

1931. During the first year, only 50 messages a day were routed over the system. Today, about 98,000 messages are normal traffic. In September, 1962, the TWX network was converted to dial operation in the largest cutover in telephone history. Some 60,000 stations were involved. As a result, all TWX stations went to All-Number Calling and a national TWX information center in St. Louis, Missouri became accessible by dialing a common code.

Two of the major companies that provide transoceanic radio channels for teletypewriter users, the Radio Corporation of America and Mackay, report that 700 calls a day go out by teletypewriter from New York and Washington to more than 25 countries overseas. Within the United States, teleprinter circuits are interconnected by AT&T's teletypewriter exchange service. TWX's 60,000 subscribers can communicate with one another through the switched dial network simply by dialing the number of the party wanted. In addition to TWX, there are thousands of private line networks, of which the biggest users are press associations, airlines and Government departments.

Teletype Corporation equipment is part of the DEW Line and SAGE Communications System and is used in the 18 Project Mercury tracking stations.

Teletype Corporation got its biggest boost during World War II. In a war that required outproducing the enemy, swift, written communiques were needed to avoid calamitous errors in coordinating war production. Also in long-distance conferences, teleprinter communiques could be "scrambled" more easily than telephone voices.

Teletype Corporation moved into new headquarters in Skokie, Illinois, a Chicago suburb, in 1960. The modern research laboratories, administration building and manufacturing facilities cover a total of one million square feet of floor space on an 105 acre site. The company also operates a small manufacturing plant in Little Rock, Arkansas.

Total work force is over 5,000 people. In addition, 33 Western Electric Supplies Service employees are resident at Teletype Corporation. They are the coordinating unit for procuring Teletype equipment for the various distributing houses, Long Lines and operating telephone company locations.

The company's new Model 30 series of equipment is as modern as the new Teletype plant. These newly designed sets fill the ever expanding needs of business and industry for a faster more flexible means of communication. Equipped with four row keyboards and automatic character generators the Model 33 and 35 lines offer a new dimension in operator ease and convenience.

The Model 28 unit which was first introduced to Bell System serv-

ice in 1954 is still the hard core of service use. The Model 28 series operates at up to 100 words a minute for page teletypewriters and up to 200 words a minute for some tape punching units. The previous model — No. 15 — operated up to 75 words per minute.

A recent addition to Teletype's equipment line has been the high speed tape-to-tape system. This system transmits and receives taped data on the rate of 1,050 words per minute. The Bell System markets this under the trademark DATASPEED.

Teletypewriter machines operate by the transmission of electrical pulses over communication channels from a sending unit to one or more receiving sets — as close by as across the room, or as far away as outer space. The sending unit creates pulses when the typewriter-like keys are pressed. The receiving unit converts pulses back into mechanical action, imprinting letters, figures and other characters on a roll of paper or business forms. In the code, each letter or number is represented by a distinct combination of electrical pulses.

Key to versatility of the Model 28 and 35 lines is a unique device about the size of a carton of king-size cigarettes that is known as a "stunt box." "Stunt" is an old printing telegraph term for non-typing functions such as spacing, carriage return, linefeed or switching. The stunt box makes it easy to add extra features to the teletypewriters — horizontal and vertical tabulators, for example. It also makes it possible to activate switches on or off from remote locations.

One of the principal applications of the stunt box has been to provide an economical selective calling system. Messages can be directed only to machines located at places that are actually concerned with the information being transmitted — a particular plant location, for instance. Printers in a system that are not called in for that particular message are always on the alert, their stunt boxes continually riding the line, waiting for specific information to be directed to them.

Teletype Corporation equipment offers not only a means of transmitting data whenever it is needed, but it provides a record of any transaction either in the form of the typewritten word or as a strip of coded tape which can be stored or used to activate business machines. With such versatility, Teletype equipment is ideally fitted for the job of feeding electronic data machines and then getting the information quickly distributed to the field. A great deal of Teletype research since the war has been devoted to faster transmission and printing of data.

While Teletype Corporation does not appear as a separate block on the WE organization chart, supervision of the company's interest in Teletype comes under the jurisdiction of WE Vice President—Manufacturing-Area B.

Nassau Smelting and Refining Co., Inc.

Early in its career as the manufacturing and supply unit of the Bell System, Western Electric began the reclamation of scrap metals as a means of reducing the cost of nonferrous metals used in manufacturing. These operations were initially carried on at Hawthorne Works. However, the rapid growth of the Bell System network during the '20s and concomitant improvement in service led to the replacement of older equipment in the field to the extent that telephone scrap began to accumulate faster than it could be processed by the facilities that were available.

To meet this need and to centralize scrap reclamation, Western Electric acquired the Nassau Smelting and Refining Company in 1931. Located at Tottenville, Staten Island, New York, it is under the supervision of the WE Vice President—Manufacturing-Area A.

As a result of this purchase, the Bell System was assured a dependable supply of secondary nonferrous metals—primarily copper and lead. From the first, Nassau's scrap reclamation operations proved most effective. However, there were considerable quantities of telephone scrap which could not be reclaimed for Bell System use but which could be used by other scrap dealers and consumers. In 1941, Nassau was given the additional responsibility of disposing of all Bell System scrap, selling to other processors the scrap and its by-products that could not be used by the Bell System.

Western Electric needs a great deal of copper to manufacture telephone cable and wire. Nassau has been a steady source of this material providing about one-quarter of our yearly requirements. This has proved to be of great assistance to the company in meeting its Bell System responsibilities, particularly during periods when copper is scarce.

The copper Nassau refines for WE must meet a purity standard of 99.93 and is comparable in quality to the high-grade copper produced by electrolytic refineries. Nassau's yearly production of copper wirebar from reclaimed material amounts to about 25 million pounds. To keep up with Western's demand for wirebar copper, Nassau also provides an additional 45 million pounds by contracting with other refineries to process scrap requiring electrolytic refining or which exceeds Nassau's refining capacity.

Nassau also produces copper shot which is used by WE for plating on steel wire, and tinsel bronze bars which WE uses to make telephone cords. Lead, in various alloy forms is also returned to Western Electric for Bell System use in sizable amounts.

The telephone companies are not obligated to sell their scrap

through Nassau Smelting and Refining but Nassau is obligated to handle and dispose of any such materials that the operating companies offer.

MANUFACTURERS JUNCTION RAILWAY COMPANY

The Manufacturers Junction Railway Company was incorporated in Illinois, January, 1903 to provide rail connections linking the Hawthorne Works with all major railroad systems entering Chicago. There are about 13 miles of track in and about Hawthorne and a small but adequate rolling stock. The railway delivers all of Hawthorne's inbound rail freight (mostly raw materials) to required locations within the Works area and all outbound finished communications equipment shipped as railroad freight. The railroad also serves some of Hawthorne's industrial neighbors.

The company's original tenure of 50 years was extended another 50 years late in 1952. As in the case of the Teletype Corporation, WE's interest in the Manufacturers Junction Railroad comes under the jurisdiction of the Vice President-Manufacturing-Area B.

* * * * *

While AT&T and Western Electric each own 50 per cent of the stock of Bell Telephone Laboratories and Bellcomm Inc., these companies are in legal effect subsidiaries of AT&T.

So fundamental to communications progress are the contributions made by Bell Telephone Laboratories, however, that a description of this unique organization more properly belongs (and appears) in the first part of this work, which deals with the functions and responsibilities of our Bell System "partners."

BELLCOMM INC.

A recent addition to the Bell System is Bellcomm Inc. Owned jointly in equal amounts by AT&T and WE, this company was incorporated on March 22, 1962. The Headquarters are in Washington, D.C.

The company was organized to provide systems planning support for the nation's manned flight program in response to a request from the National Aeronautics and Space Administration.

In a letter to F. R. Kappel, Chairman of the Board and Chief Executive Officer of AT&T, NASA Administrator James E. Webb wrote, "It would be a public service of the very first order of importance if the Bell System would undertake to assist NASA . . . by providing an organization of experienced men capable of giving the responsible NASA officials the benefit of the most advanced analytical procedures

to develop the factual basis they need to make the wide range of systems engineering decisions required for the successful execution of the manned space flight mission."

Bellcomm works with the Office of Systems in NASA's Office of Manned Space Flight. Projects for which it is providing systems planning support include the Gemini program to earth-orbit a two-man spacecraft and the Apollo program to land men on the moon and return them safely to earth.

Dr. John A. Hornbeck, Bellcomm's president, has described the company as an "organization of modest size and, we hope, high ability." Two-thirds of the employees are highly-trained technical specialists. The remainder are administrative personnel.

Part Three:

Specifics of Service

Communications Services and Products

IX

In the course of this survey of the integrated operations of Western Electric and its Bell System partners, the concept of service has proved the leitmotiv. Basic to this concept are the factors of reliability, flexibility and innovation. The concept is realized through the shared responsibility and common purpose in applying these three factors in the research and development, the manufacture and supply, and the coordination and operation of equipment providing communications. For this reason, Western Electric's role in the Bell System is best appraised in terms of the orderly development of the Bell System's nation-wide network and the System's ability to supply the array of communications required by the needs of its subscribers.

To judge the scope of this endeavor, it may be appropriate to review some of the kinds of communications other than regular telephone service which the Bell Telephone companies offer and the products supplied to them by Western Electric to this end. It may be noted that the descriptions which follow are selective rather than inclusive.

BELL SYSTEM COMMUNICATIONS SERVICES

Centrex This mechanized communications system offers the large business or Government agency direct inward and outward dialing and intercom dialing without the help of an attendant. With the assistance of the Centrex attendant, incoming calls may be transferred.

Data Communications Bell System *DATA-PHONE* service enables business machines to "talk" with each other in various codes and at various speeds over regular telephones throughout the United States. The Western Electric *DATA-PHONE* data sets and related equipment work in harness with a variety of business machines.

DATASPEED tape-to-tape system carries data originating from teletypewriters and certain other business machines producing punched data.

Educational Television Closed circuit Educational Television, carried over Bell System transmission facilities, offers school systems an economical means of expanding educational facilities. Drawing on its wide experience on commercial TV, the Bell System has developed a comprehensive information program concerning ETV.

Emergency Reporting Telephone Service With this system, fires and other emergencies are reported directly to fire and police dispatching switchboards through a network of strategically placed street phones.

Farm Interphone Combining the household telephone with speaker microphones in houses, barns, and outbuildings and with outdoor loudspeakers, this system enables the farmer or rancher to handle outside calls, reach people around the farm, indoors and out, and call them to the telephone by loudspeaker.

Group Alerting and Dispatching System Designed especially for the needs of small communities, this system provides for time and money-saving dispatch of volunteer fire companies through their own home or business phones.

LETS Law Enforcement Teletypewriter Service is a service which swiftly carries criminal alarms and administrative messages throughout a state or regional area as an aid to public safety.

Mobile Telephone Service This provides immediate contact between automobiles and any other telephone in the network. An advanced type of dial mobile service, offering fast and more convenient service, is under development.

School-Home System With this service, children who are confined to bed at home or in a hospital are able to hear and participate in their regular classes.

Teletypewriter Service The Bell System offers two kinds of teletypewriter service: Teletypewriter Exchange Service (twx) and Private Line Teletypewriter Service (twpl). twx service provides for connecting teletypewriter stations located in a subscriber's office on a switched basis similar to telephone message service. Any twx station may call any other. A twx directory, similar to the telephone directory, lists the names and numbers of each subscriber. twpl is a unit service which provides local and inter-exchange channels and station equipment throughout a customer's locations under many varied arrangements and conditions.

WATS Wide Area Telephone Service provides economical communications to all phones in designated geographical areas at full time or measured time monthly rate, combining the rate features of Private Line Service with the flexibility of regular Long Distance Service.

COMMUNICATIONS EQUIPMENT

To the Bell Telephone companies who rely on WE for equipment in the provision of these communications services, the items that Western Electric supplies divide into two main categories: subscriber products, like telephones and switchboards, which are physically located on the subscribers' premises; and non-subscriber products, the switching systems and transmission equipment which comprise the nation-wide Bell System network.

In some cases — certain test sets, for example, and telephone booths — the identifying number of the particular product is prefaced with the letters "KS" indicating manufacture by a firm other than Western Electric, that our company supplies. No attempt has been made to list the vast catalogue of items that Western Electric purchases in volume as a part of its supply function for the Bell System, though it may be noted in passing that these purchases represent a significant and basic part of the company's responsibility to its Bell System "partners."

Western Electric's Marketing organization publishes handbooks and brochures describing in detail but in non-technical language a good number of these subscriber and non-subscriber products and the supporting services that Western Electric also furnishes. In many cases, the brief notations of specific items which follow have been abstracted from this material.

SUBSCRIBER PRODUCTS

Telephone Sets A wide array of telephones serves the needs of home and business. Western Electric even makes an explosion-proof telephone set for such locations as mines or flour factories. The most familiar of these is, no doubt, the 500 desk set, but even this set is available in models with buttons for interconnection, holding calls, and signalling.

Another popular telephone for the home is the PRINCESS® set, first introduced in the fall of 1959. The Panel telephone, designed for recess in walls or surface mounting, was introduced in 1963 in three models: a basic panel with handset and dial; a Home Interphone panel; a unit offering both the basic and Home Interphone features (utilizing six-button flexibility) and a Speakerphone.

For business or professional use where more than six push buttons

are required, Western Electric manufactures several types of CALL DIRECTOR® telephones. These sets have certain plug-in modules mounted on the sloping front surface to provide centralized answering service for a number of people and intercom, conference, holding, multi-line pickup, signalling and transfer service.

Automatic Dialer telephones are also available. The RAPIDIAL®, an automatic dialer made by McGraw-Edison, uses a magnetic tape and can store as many as 290 numbers for repertory dialing. Another magnetic tape repertory dialer, the MAGICALL® El rapid dialer, manufactured by the Perini Electronic Corporation, can store as many as 950 numbers. The CARD DIALER® telephone, made at Indianapolis Works, has unlimited capacity and is especially useful in calling groups of numbers regularly. The customer codes often-used numbers on plastic cards which are inserted into a slot in the telephone unit to make a call.

Among the newest of Bell System telephones is the set for TOUCH-TONE® service, which went into production at Indianapolis during the fourth-quarter of 1963. Instead of the rotary dial, this set has a 10-button rectangular unit on which the subscriber taps out the number he is calling. The multi-frequency signals which result are converted to dial pulses for use by electro-mechanical central office equipment. In the era of electronic switching this conversion will no longer be necessary, of course.

PBX Equipment A PBX (Private Branch Exchange) consists of switching equipment located on a customer's premises to which are connected trunk lines to the central office and lines to the telephones on the premises. PBX's may be either manual or dial. In manual systems, the switching on all calls is handled by an attendant. In dial systems, all intercommunicating calls and outgoing calls may be dialed direct, and incoming calls are handled by an attendant. The switching equipment may be either step-by-step or crossbar. The company manufactures more than a score of PBX arrangements of widely varying size for the requirements that the convenience or desire of the customer demands.

One of the newest of these designs is the 101 Electronic Switching System, consisting of a unit in the central office that controls the switching units on the customers' premises, each of which is associated with an attendant console. Miniaturization of nearly 300,000 parts permits compact installation. A fuller description of the general principles of ESS appears later in this chapter, in the section dealing with Non-

®Trademark of the McGraw-Edison Company.

®®Trademark of the Perini Electronic Corporation.

Subscriber Products. Since, in effect, the 101 ESS, acts as an electronic PBX, and certain of its equipment is located on subscriber premises, it has been included in this section. The features of the 101 ESS include abbreviated dialing (in which frequently called numbers, local or long distance, may be reached by dialing three digits), TOUCH-TONE® calling, call transfer for outside calls without operator assistance, conference calls to dial two additional parties into an existing conversation by the party originating the conversation, and Centrex service. The first commercial systems, ready late in 1963, were scheduled for PBX and Centrex service.

Key Equipment Western Electric manufactures three basic types of key systems.

The 1A system provides such major services as multi-line pickup and hold of PBX or central office lines, manual or dial selected intercommunicating and signalling, tie line connections and manual or automatic cutoff or exclusion services.

The 1A1 system provides the same major services as the 1A system and differs only in the line circuit design used, the mode of mounting the equipment units, and a requirement for local power for line holding and other supervisory functions. Like the 1A system, all loose key telephone units are arranged on a "building block" principle, thereby offering flexibility in the provision of varying combinations of service features.

The 6A key telephone system is a dial selective intercommunications system with a capacity of 36 stations, also designed for installation on the subscriber premises. The system works in association with 1A1 circuits where access to central office or PBX lines is required and is available in three basic arrangements, described below.

The "Selector Only" arrangement provides for dial selection of from nine to 36 stations, means for conference calls, arrangements for off-premise connections and provision for common audible signalling.

In addition to the services described above, "Single Line" provides for flashing lamp signalling and automatic exclusion of all other stations from the connection. The "Two Line Arrangement" is set up for two talking links and thus is capable of handling more intercom traffic than the Single Line arrangement.

Products for Special Services Equipment supplied by Western Electric enables the Bell Telephone companies to offer subscribers a wide variety of special services tailored to the general needs of particular businesses. Representative of such equipment are the following items:

1-S Automatic Call Distributing System A small order-taking system which distributes incoming calls to attendant answering positions as they arrive, intended for department stores, mail order houses, airlines, railroads and similar applications.

Concentrator-Identifier This equipment concentrates 100 subscriber lines down to from two to four trunks between central office and answering. It is used with a PBX switchboard on the premises of telephone answering services.

Message Waiting Service System Message waiting service provides a flashing red lamp on a telephone set to indicate that a message has been received at a central control location during absence of the station set user. This equipment is intended primarily for hotels and motels.

3A Speakerphone System This transistorized voice switched microphone-speaker system permits hands-free conversation. (Certain WE CALL DIRECTOR® telephones incorporate the transmitter and controls as a part of the set.)

100A Telephone Answering System A small, general purpose announcement system with a two-minute message capacity, this set is intended for mounting in a remote location and is under control of the appropriate buttons on the key set.

Switching System No. 400 (20-40 Dial PAK) Designed for customers with fewer than 40 lines, this is a single cabinet dial system with limited access to outside traffic which utilizes add-on features to central office or other PBX lines. It provides traffic handling capabilities significantly greater than that of either the 6A Key Telephone System or the 755 PBX.

Lamp Signal Detector Seeing Aid Designed to assist a blind switchboard attendant, the equipment is available for use with No. 555 and 556 PBX switchboards.

107A Loudspeaker Set A transistorized amplifier, this device permits a small group of people to hear both sides of a telephone conversation. The set contains a combined on-off switch and volume control. It is intended for both business and home markets.

BELLBOY® 150MC A personal signalling device which is essentially an extension of the bell on the customers' telephone. A *small*, frequency modulated radio receiver carried in the customer's pocket,

the BELLBOY® can be signalled selectively to emit a soft tone to let the customer know he should call a predetermined number to obtain a message.

G6AR (Hard of Hearing) and G7AR (Weak Speech) Handsets Both of these handsets are intended for connection in place of the usual handset on 500, 600 and 700-type telephones. G6AR provides amplification for those with impaired hearing; G7AR provides amplification for those with a weak speech condition. Both make use of a transistorized amplifier and associated elements and are manufactured as a stock item at Indianapolis in all standard colors.

NON-SUBSCRIBER PRODUCTS

The quality and reliability of any Bell System communications service depends ultimately upon the vast array of equipment rarely if ever seen by the public. The bulk of Western Electric's manufacture consists of such equipment — switching systems, cable and wire, microwave and all the associated apparatus. Representative of this array are the switching and transmission systems described below.

Switching Systems As the number of Bell telephones has increased over the years, the nation-wide network has increased in complexity at an even greater rate. Today, three automatic switching systems, each the product of a different era of development in the art of telephony, all work together, even though the dates of their original installation may span a generation. While crossbar is the principal automatic switching system in the Bell Telephone network today, step-by-step installations are widely used while there are some panel systems in large metropolitan areas which continue to provide high quality service.

Panel switching equipment, originally developed well over 40 years ago, was installed until the late '30s in large metropolitan multi-office areas, where step-by-step equipment could not be used advantageously. In the panel system, an apparatus called a sender receives the dialing information from the subscriber, holds and transmits it to the various selectors so as to control their movements and directs them to the proper setting. This arrangement was designed to permit dialing over more complex and extensive trunking than was possible with direct control. The digits that the subscriber dials have no direct relation to the groups of trunks to which the various selectors move in completing the call and the selectors do not move in unison with the dialing.

Step-by-step systems offer another means of selecting a series of paths through which the circuit from the calling party to the called party can be progressively established. General use of step-by-step in the Bell System began about 1919. Step-by-step switches are electro-mechanical devices usually activated by dial pulses. As the name indicates, the connection is traced step-by-step through the line finder, which locates the calling line and connects the first selector to give the dial tone; to the selectors which progressively select the digits representing the office, the thousand, and then the hundred groups; to the connector switch which selects the called line and rings the subscriber, or, if the line is engaged, sends back a busy signal and places a busy condition on the called line. The speed with which a call is completed in step-by-step systems is tied directly to the mechanical switching time of the apparatus.

Crossbar systems developed during the '30's — represented a significant innovation in that they routed a call in less time than was required by the mechanical motion of panel and step-by-step in hunting various switching functions.

The crossbar switch, the principal switching element used, is a device employing horizontal and vertical members, each magnetically operated. The operation of a vertical member in conjunction with a horizontal member causes a particular set of contact springs associated with the vertical member to close and to remain closed as long as the magnet of the vertical member remains in operation. In crossbar systems, calls are set up on marker equipment, the unit of the system which selects and establishes the points in the network through which calls must go before any of the intervening paths are actually used. When the connection is completed, the common equipment — senders, markers, connectors — drops out and proceeds with another call. This process reduces the amount of equipment tied up during the length of a call and hastens its processing. Crossbar also provides alternate routing for calls — a major advantage over the other two systems.

No. 1 crossbar was the first such switching system to be introduced by the Bell System. No. 5 crossbar, also designed for local dial central offices, represented a modification of the original design. Although fundamentally a local system, No. 5 is capable of operating with all types of tandem and toll switching systems and may itself serve as a tandem or toll office. It can also be readily arranged for toll dialing, for Automatic Message Accounting (AMA) and for Centralized Automatic Message Accounting (CAMA) both of which are described below.

Four-Wire No. 5 Crossbar Affording high-quality simul-

taneous two-way transmission, this concept of No. 5 crossbar switching is suited for handling high-speed data. It may be used as a separate four-wire facility, or added to existing two-wire No. 5 crossbar systems. Originally intended for military and Government applications, four-wire switching by No. 5 crossbar has commercial application in such fields as teletypewritten material, data, message encryption and facsimile. Columbus initiated manufacture in 1961.

Packaged No. 5 Crossbar System Essentially a repackaging of an existing system, the general description of this system is similar to that of No. 5 equipment. The packaged No. 5 affords economies in engineering, installation and space utilization, particularly for smaller offices. Four standard packages are currently offered: 26-28 frames for 580 lines; 31-33 frames for 960 lines; 44-46 frames for 1960 lines; 54-56 frames for 2940 lines. For additional economy the 580, 960 and 1960-line offices use an office test frame rather than a master test frame. The Packaged No. 5 was first introduced in 1960 and is available from Columbus, Oklahoma City and Omaha.

Toll In toll applications of crossbar, toll trunks are connected to other toll trunks with the scanning of alternate routes typical of crossbar. The rapidity with which these routes can be selected by crossbar equipment has been the chief reason for the reduction of time required to complete long distance calling and the introduction of Direct Distance Dialing across the nation. The original crossbar design for toll traffic was identified as No. 4 crossbar. It required certain adaptations for Direct Distance Dialing and while the redesign was in process, some new offices were provided with the most essential improvements and designated A4A. When the redesign work was completed the new crossbar was designated as No. 4A.

4A is a crossbar control switching point system which provides four-wire paths for establishing connections mechanically on a nationwide basis, between intertoll trunks, tandem and intertoll trunks and toll switching and miscellaneous terminating trunks.

Operating on a destination route basis, No. 4 toll crossbar is capable of routing a call over a preferred route or any one of as many as six predetermined alternate routes automatically without operator assistance. The No. 4A system includes all of the features of the No. 4 and No. A4A systems which preceded it, and both the No. 4 and No. A4A can be modified to No. 4A capabilities. The use of multi-frequency pulsing considerably shortens the time required for transmitting the pulses which control the switching equipment. The equipment was introduced in 1952 and is manufactured at Kearny, Columbus, and Oklahoma City.

Crossbar Tandem is a two-wire switching system originally developed as an intermediate mechanical switching office for interconnecting panel and No. 1 crossbar local offices in a large metropolitan area. Subsequently, crossbar tandem was used for two-way through toll switching in place of No. 4 where a smaller capacity system is suitable. Currently, most crossbar tandem equipment being installed is for toll switching and CAMA purposes.

Electronic Switching System is the Bell System's newest switching development. ESS represents a completely new approach to switching. By utilizing the programming technique for problem solving used by large computers in various control units of the system, variations in features of different central offices will be provided with one basic design.

The high speed of electronic devices will perform the basic functions of logic, memory, input-output supervisory control and outpulsing to other offices. The high operating speed permits a very small number of these control circuits to serve a large number of lines and trunks. TOUCH-TONE® dialing, as well as the conventional rotary dialing will be compatible with the new system. As central office equipment, ESS offers the following new services to non-business subscribers: abbreviated dialing of frequently called numbers; code-dialing for providing intercom service over household extension telephones; automatic routing of incoming calls to other telephones if the called line is busy; transfer of incoming calls to another phone if the customer is absent from home; a camp-on feature which brings an immediate connection to a busy line as soon as the user hangs up; code dialing for adding others to telephone conversations.

So significant an advance has naturally required a great deal of work, and characteristically this effort took the form of close teamwork between Bell Telephone Laboratories and Western Electric engineers. During 1963, the Bell System introduced two electronic switching systems, one for central offices and one for business customer locations. (The latter, the 101 ESS, has been described earlier in the text under "Subscriber Products.")

Automatic Message Accounting Electro-mechanical counting devices, called message registers, have been used for years to record local message units used by each subscriber. In preparing monthly bills, the information on the register, was supplemented by handwritten tickets prepared by operators for calls beyond the local dialing area. The extension of dialing to wider areas, including Direct Distance Dialing where calls to distant points are completed without operator assistance,

made it necessary to develop some automatic means of recording the information. Automatic Message Accounting (AMA) provides the means. With this equipment, information regarding the number calling, the number called and the duration of the call is recorded automatically on paper tape in the central office.

In some central locations, where volume is insufficient to justify the investment of AMA equipment, the combined needs of several local central offices may make it economically feasible to use such equipment in Centralized Automatic Message Accounting (CAMA).

Subsequently, Automatic Number Identification (ANI) equipment provided the means whereby CAMA offices were able to identify the calling number and transmit the information without operator assistance.

Transmission Systems Long distance telephone lines between cities are usually in cables or on radio relay systems. Many of the circuits in the cables and all of those on radio relay take one of the forms of carrier.

Carrier is a transmission medium using waves that can be modulated by changing their amplitude, frequency, or phase so that they can carry channels of communications (voice, data and telegraph, for instance). Carrier systems were first introduced by the Bell System in 1918, with broadband carrier appearing in 1940.

Since World War II, technological innovations have steadily improved the capacities of carrier and today such systems are the backbone of the Bell System's nation-wide network, providing about 90 per cent of the intercity circuit mileage, approximately 85 per cent of telegraph mileage and practically all intercity television program mileage. Development work continues in carrier. For example, the Merrimack Valley Works initiated manufacture in 1962 on three systems for short-haul transmission.

T-1 Carrier is intended for use in short-haul heavy-route metropolitan areas. It is the least expensive way yet developed to use existing cable facilities for carrier transmission, developing 24 message channels over two exchange type wires up to 50 miles.

N-2 Carrier is designed for 25-200 mile transmission and is specially suited for new services such as Direct Distance Dialing and data transmission. An N-2 terminal provides 12 channels for telephone transmission over two cable pairs within the 36-268 KC band, or transmission of 48 channels over microwave.

L Multiplex offers short-haul transmission with narrow cross sections as well as long distance, heavy cross section facilities and so can

transmit program, data, message or video via coaxial cable or microwave. Designed for compatibility, L. Multiplex can join with or replace L carrier, an earlier system.

Microwave is a generic term applied to radio frequencies whose wavelengths are sufficiently short to have some of the characteristics of light. Microwave transmission is generally line-of-sight; microwave energy can be easily focussed into a light-like beam. Among the newest microwave equipments WE manufactures for the Bell System are the following examples.

TD-2 Microwave was the first transcontinental microwave system offered by Western Electric. Manufacture was initiated at Merrimack Valley in 1950 and the product is now produced at Kansas City Works. TD-2 is especially suited for heavy-route, multi-channel communications and can carry at least 600 voice circuits or two video circuits for each pair of six two-way RF channels.

TH Microwave, Western Electric's second heavy-route system with transcontinental range, is designed to carry up to 1860 circuits on each two-way broadband RF channel. Using the 6 KMC common carrier frequency band, this system provides eight such channels — six working and two "spares." With its 10 megacycle baseband, TH can also transmit high-definition "theatre" (closed circuit) video. Merrimack Valley initiated manufacture in 1959.

TL-1 Microwave A short-haul system, TL-1 microwave operates in the 11 KMC common carrier frequency band to provide low-cost "packaged" transmission facilities for distances up to 300 miles. Merrimack Valley initiated manufacture in 1961 and a video version of TL microwave was introduced in 1963. At least 240 circuits per channel can be derived at 10 hops and up to 600 at five hops (from one repeater station to another).

TJ Microwave Like TL-1, TJ Microwave operates in the 11 KMC common carrier band and provides point-to-point transmission facilities for distances up to 300 miles. Three two-way broadband RF channels are offered for diversity applications and six for non-diversity. Using L Multiplex, at least 240 circuits per RF channel are available at 10 hops and up to 600 at shorter hops. TJ is also suitable for video transmissions. Manufacture began at Merrimack Valley in 1958.

TL-2 Microwave Like TL-1, the TL-2 microwave system operates in the 11 GC common carrier frequency band. Significant features introduced in this system make it especially suitable for multi-channel Educational Television (ETV) transmission. It is one of the newest of

WE microwave systems to be developed for the Bell System network. Manufacture of TL-2 microwave was initiated at Merrimack Valley in 1963.

THE SERVICE DIVISION'S SUPPORT

However high the quality, however fine the design, the equipment and apparatus Western Electric provides for Bell System communications services is of no use until put into actual operation as a part of the nation-wide telephone network. Moreover, when the need for a new central office or microwave route is established by one of the operating companies, or the company decides that additional equipment must be added to existing facilities to meet demand, it commits itself to spending a substantial sum. Obviously, this investment cannot start earning a return until the equipment purchased is in actual operation. The Bell Telephone companies are naturally interested in getting new or additional facilities on a paying basis as soon as possible.

Western Electric has devoted considerable attention to this endeavor. Major innovations in recent years have been undertaken in the inventory and repair functions carried on at WE Distributing Houses to just this end.

Various mechanizations and new procedures have enabled Distributing Houses to ship most orders within 24 hours, thereby eliminating to a large extent the necessity for telephone company storerooms. The introduction of *DATA-PHONE* service by the Distribution organization brought increased speed in handling orders and virtual elimination of errors in their processing in those Houses where it was tried, and the use of *DATA-PHONE* service on an organization-wide basis seems probable.

Repair functions have also been reviewed in the drive toward improved performance. The application of mass production techniques in the reconditioning of repaired station equipment, for example, saves the telephone companies both time and money. New methods have also been devised in the repair of test sets. An expedited program known as the "Red Ball Test Set Repair" makes it possible to repair, recalibrate and return to the telephone companies up to 200 test sets within two days after their receipt by the Distributing House.

In an effort of similar intent, the WE Service Division's installation people have also sought ways of reducing intervals allotted for the installation and turnover of equipment. A revision of testing procedures, for instance, utilizing selective testing techniques and a different progression of tests brought about a reduction in interval from the start of a job to its turnover. Further testing improvements by Western

Electric have encouraged the telephone companies to put central office equipment into service immediately upon turnover without the costly delay formerly required for their own testing procedures. This concept includes the "packaged" No. 5 crossbar office.

Turnkey Operations A further illustration of this effort to improve service is the development of the "Turnkey" idea used principally on microwave installations.

Once an operating company elects to use this approach, Western Electric assumes the job until that figurative point when the Bell Telephone company representative turns the key and takes possession. In addition to normal Service Division functions, Western Electric is also accountable for procuring such items as construction of roads and fences, erection of microwave towers, portable buildings and for undertaking final system line-up, testing and inspection, although an operating company may elect to perform any of these functions itself.

Afterword: The Future

Planning in terms of long-term development has been a constant endeavor since the Bell System was first conceived. It remains so today. Quite simply, innovation is an aspect of the industry.

During the '20s dial switching was introduced. In the '30s carrier telephony helped transform long distance service from a luxury into an everyday convenience. Direct Distance Dialing was launched in the '40s. In the '50s the transistor opened vast new fields of communications concepts. During the '60s electronics provides the means for further innovations in switching and transmission equipment.

As the Bell System has grown in service, so, too, has the number of subscribers grown. Today, about three-quarters of all American families have a telephone in their homes. By 1975 it is estimated that as many as 95 out of every 100 households in the United States will have telephone service.

It seems most likely, too, that intercontinental television and communications via satellite will become everyday realities before too long a time has passed. While voice communications will undoubtedly increase greatly in the coming years, it is also anticipated that machine "talk" — transmission of data between processing centers — will come to exceed voice communications in volume.

New types of telephones will also appear in the years ahead. Several are under trial now; others exist as rough prototype designs at Bell Laboratories; still others exist only as speculation of eventualities.

Some of the new telephones under design will be tested and, because of the results of their trial, discarded; others will be tested and found worth while, joining the array of Bell System instruments. Here arises a point of major importance to all who try to evaluate the promise of the future.

The progress of the Bell System -- and the continuing well being of all its component members, including Western Electric -- ultimately depends not just on technical prowess alone but on our ability to apply this prowess to means of satisfying the Bell System subscribers.

"Today, we can meet any number of customer needs that we could not satisfy a few years ago," AT&T Chairman F. R. Kappel said in an address before the 1962 General Assembly of the Telephone Pioneers of America. "And in the fast moving future," he continued, "we shall certainly be able to satisfy hundreds more.

"But this situation calls for sober reflection. When your capacities increase, one thing is certain; more is expected of you. We are constantly enlarging our public commitments to perform -- giving new hostages to performance, if you please -- and we can depend on it that the public will require us to redeem every one.

"Furthermore, the public's expectations will not be satisfied by technical marvels alone. Nor do the marvels stay marvelous for long. They are soon taken for granted. It is only our human abilities that cannot be taken for granted now or at any time. I mean the ability to use the tools at our disposal with good judgment and with thorough understanding of each customer's needs and wishes . . .

"We must know our way around among our new tools. We must create within ourselves new dimensions of knowledge about what we have to offer. We must be more and more imaginative as to how different services and combinations of services can provide the best results for each customer in every respect."

Thus for the people of the Bell System, the promise of the future calls for a closer concentration of teamwork, a greater cooperative effort. And in this effort to increase the value of service, Western Electric will by necessity of function assume a major responsibility.

Appendix

IN THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF NEW JERSEY.

UNITED STATES OF AMERICA,
Plaintiff,

v.

WESTERN ELECTRIC COMPANY, INCOR-
PORATED, AND AMERICAN TELEPHONE
AND TELEGRAPH COMPANY,
Defendants.

Civil Action No. 17-49.

FINAL JUDGMENT

Plaintiff, United States of America, having filed its complaint herein on January 14, 1949; the defendants having appeared and filed their answer to such complaint denying the substantive allegations thereof; and the parties, by their attorneys, having severally consented to the entry of this Final Judgment without trial or adjudication of any issues of fact or law herein and without this Final Judgment constituting any evidence or admission by any party in respect of any such issues;

Now, THEREFORE, before any testimony has been taken herein, and without trial or adjudication of any issue of fact or law herein, and upon the consent of all parties hereto, it is hereby

ORDERED, ADJUDGED AND DECREED AS FOLLOWS:

I.

This Court has jurisdiction of the subject matter herein and of all the parties hereto. The complaint states a claim upon which relief may be granted against each of the defendants under Sections 1, 2 and 3 of the Act of Congress of July 2, 1890, entitled "An act to protect trade and commerce against unlawful restraints and monopolies," commonly known as the Sherman Act, as amended.

II.

For the purposes of this Final Judgment:

(a) "Western" shall mean the defendant Western Electric Company, Incorporated.

(b) "A T & T" shall mean the defendant American Telephone and Telegraph Company.

(c) "Bell Operating Companies" shall mean the 22 corporations listed in Appendix A attached to this Final Judgment, any other subsidiaries of the defendants engaged in furnishing common carrier communications services and the respective subsidiaries of and successors to each of the foregoing.

(d) "Companies of the Bell System" shall mean A T & T, Western, their subsidiaries and the Bell Operating Companies.

(e) "Westrex" shall mean Westrex Corporation, a Delaware corporation.

(f) "Patents" shall mean United States letters patent except for the reference to foreign patents in Section X (E)(3).

(g) "Bell System patents" shall mean patents owned or controlled by either of the defendants or any of their subsidiaries, and patents on inventions made in the course of their employment by employees of defendants and their subsidiaries (other than employees of subsidiaries exclusively engaged in the performance of contracts with the plaintiff) employed to do research, development or other inventive work, subject to any releases of rights to such employees prior to the date of this Final Judgment, and shall include patents of others under which and to the extent to which

either of the defendants or any of their subsidiaries may have the right to grant licenses.

(h) "Equipment" shall mean apparatus, systems, materials, supplies, machines, tools and any other product.

(i) "Common carrier communications services" shall mean communications services and facilities, other than message telegram service, the charges for which are subject to public regulation under the Communications Act of 1934, or any amendment thereof, or would be subject to such regulation thereunder if such a service or facility were furnished in interstate commerce; and shall also include any communications service or facility, other than message telegram service, the charges for which are or become subject to regulation under existing or future laws of any state, territory, or the District of Columbia, but only in the jurisdiction or jurisdictions in which the charges for such service or facility are subject to regulation.

(j) "Associated companies" shall mean, as to defendants, the Companies of the Bell System, and as to any applicant, its subsidiaries.

(k) "Person" means any individual, partnership, corporation, association, firm, trustee or other legal entity.

(l) "Message telegram service" shall mean the electrical transmission by a common carrier of a message presented to it at one of its public offices in written form or, if presented orally, reduced to written form by the carrier and delivered by the carrier to the addressee in written form or, if orally, by a reading of the written message by the carrier.

(m) "B-2 agreements" shall mean the license agreements dated July 1, 1932, made by either or both of the defendants with General Electric Company, Radio Corporation of America, and Westinghouse Electric Corporation, or any of them, and all agreements supplementary thereto, and "other parties to the B-2 agreements" shall mean said companies, their subsidiaries, successors and assigns.

III.

The provisions of this Final Judgment, applicable to a defendant, shall be binding upon said defendant, its officers, agents, servants, employees, and attorneys, and upon those persons in active concert or participation with said defendant who receive actual notice of this Final Judgment by personal service or otherwise.

IV.

(A) The defendants are each enjoined and restrained from commencing, and after three (3) years from the date of this Final Judgment from continuing, directly or indirectly, to manufacture for sale or lease any equipment which is of a type not sold or leased or intended to be sold or leased to Companies of the Bell System, for use in furnishing common carrier communications services, except equipment used in the manufacture or installation of equipment which is of a type so sold or leased or intended to be sold or leased; provided, however, that this Section shall not apply to the artificial larynx, by-products of reclamation of scrap, or equipment manufactured for the plaintiff, or for plaintiff's prime or sub-contractors for the performance of contracts with plaintiff or sub-contracts thereunder.

(B) After three (3) years from the date of this Final Judgment, the defendant Western is enjoined and restrained from engaging, either directly or indirectly, in any business not of a character or type engaged in by Western or its subsidiaries for Companies of the Bell System, other than (1) businesses in which defendant A T & T may engage under Section V hereof, (2) businesses in which Western is required to engage under this Final Judgment, and (3) any business engaged in for the plaintiff or any agency thereof.

(C) No sale of any subsidiary or assets made necessary by this Section IV need be made otherwise than at a fair price and on reasonable terms nor shall it be made except to a person approved by this Court. Defendants may apply to this Court for an extension of the time established by this Section IV, upon notice to the plaintiff, and such extension may be granted upon a showing of good cause therefor.

V.

The defendant A T & T is enjoined and restrained from engaging, either directly, or indirectly through its subsidiaries other than Western and Western's subsidiaries, in any business other than the furnishing of common carrier communications services; provided, however, that this Section V shall not apply to (a) furnishing services or facilities for the plaintiff or any agency thereof, (b) experiments for the purpose of testing or developing new common carrier communications services, (c) furnishing circuits to other communications common carriers, (d) for a period of five (5) years from the date of this Final Judgment, leasing and maintaining facilities for private communications systems, the charges for which are not subject to public regulation, to persons who are lessees from defendants or their subsidiaries of such systems forty-five (45) days after the date of this Final Judgment, (e) directory advertising, (f) advice or assistance to other communications common carriers, or (g) businesses or services incidental to the furnishing by A T & T or such subsidiaries of common carrier communications services.

VI.

The defendants are each enjoined and restrained from making or performing, directly or indirectly, any contract or agreement with any person whereby either defendant or its subsidiaries will have any right in any territory to act as distributor of any equipment manufactured or sold by such person, or whereby such person will have any exclusive right in any territory to act as distributor of any equipment manufactured or sold by either defendant or its subsidiaries; provided, however, that this Section shall not prevent the defendants or their subsidiaries from buying any equipment for sale or lease to, or supplying any equipment to, the defendants' associated companies or the plaintiff, or prevent Westrex and its subsidiaries from acting as distributor to sound recording studios or outside the United States, nor shall this Section be deemed to prevent the disposition in any channels of trade of any equipment originally acquired for sale to defendants' associated companies or to the plaintiff.

VII.

The defendants are each enjoined and restrained from making, performing or enforcing, directly or indirectly, any contract or agreement with any independent telephone operating company under which such company is required to buy any equipment from them (but this shall not apply to any specific purchase order or to any specific contract for the purchase of operating plant), or with any purchaser to limit, fix or control the prices to be charged by such purchaser on the resale of any equipment.

VIII.

The defendants are each enjoined and restrained from acquiring, directly or indirectly, any person engaged in the manufacture, distribution or sale of equipment useful in furnishing common carrier communications services, either by acquisition of securities thereof or by acquisition of its assets.

Nothing in this Section VIII shall be construed to prohibit:

(a) acquisition by either defendant of all or part of the securities or assets of its subsidiaries;

(b) formation of subsidiaries by either defendant and the transfer thereto of assets of either or of other subsidiaries of either;

(c) application to this Court, upon notice to the plaintiff, for permission to acquire the securities or assets of a person engaged in such manufacture, distribution or sale, which may be granted upon a showing that the effect of such acquisition will not be substantially to lessen competition or to tend to create a monopoly.

IX.

Western is ordered and directed to maintain cost accounting methods that conform with such accounting principles as may be generally accepted and that afford a valid basis, taking into account the magnitude and complexity of the

manufacturing operations involved, for determining the cost to Western of equipment sold to A T & T and Bell Operating Companies for use by them in furnishing common carrier communications services.

X.

(A) The defendants are each ordered and directed to grant or cause to be granted, to any applicant who shall make written application therefor at any time or from time to time, non-exclusive licenses under all claims of any, some or all existing and future Bell System patents to make, have made, use, lease and sell any or all equipment as desired by the applicant, such licenses (1) to be royalty-free, to persons other than the other parties to the B-2 agreements, under all Bell System patents (other than patents of Teletypesetter Corporation) issued prior to the date of this Final Judgment, under which licenses or sublicensing rights were exchanged between the defendants and such other parties to the B-2 agreements, (2) to be at reasonable royalties to the other parties to the B-2 agreements under the aforesaid patents, except that such licenses shall be royalty-free to any such other party during any period for which licenses granted by it to the defendants or either of them, of the scope and character which the defendants may require it to grant to them pursuant to this Section X (A), shall be royalty-free under all patents issued prior to the date of this Final Judgment under which, and to the extent to which, such other party or its associated companies may have the right to grant licenses, and (3) to be at reasonable royalties to all persons under all other existing and future Bell System patents; but upon condition that the applicant shall grant to defendants at reasonable royalties licenses to make, have made, use, lease and sell such equipment useful in furnishing common carrier communications services and such machines, tools and materials useful in manufacturing or operating any such equipment, as defendants may then designate in writing, under all claims of any or all existing and future patents under which, and to the extent to which, the applicant or its associated companies may have the right to grant licenses. Except with the consent of the grantor of any license hereunder, no such license shall be under patents on inventions made more than five (5) years after the effective date of the license, but the applicant may make successive applications for licenses. Each grant of a license hereunder shall be for the unexpired terms of the patents under which such license is granted, or for such lesser period as the grantee shall elect, and shall include the right to sublicense the grantee's associated companies for so long as they remain associated companies.

The provisions of this subsection (A) requiring the defendants to grant royalty-free licenses under certain patents shall not be deemed to constitute a finding, determination or admission that such patents are without value or that the defendants are not entitled to full damages and an injunction in the case of infringement of any such patent by any unlicensed person.

(B) Upon receipt of a written request for a license under the provisions of this Section, the defendant to whom such request is addressed shall advise the applicant in writing of the royalty, if applicable, which it deems reasonable therefor, and also of such licenses as defendants may specify under subsection (A) above. If the parties are unable to agree within ninety (90) days upon reasonable royalties or any other terms, the applicant or such defendant may apply to this Court for the determination of reasonable royalties and other terms, and the defendants shall, upon filing or receipt of notice of the filing of such application to this Court, promptly give notice thereof to the plaintiff. In any such proceeding the burden of proof shall be on the defendant to establish the reasonableness of royalties or other terms requested by it, and on the applicant to establish the reasonableness of royalties or other terms requested by the applicant. Pending final determination of the foregoing, the applicant or said defendant may apply to this Court to fix interim royalty rates and other interim terms and conditions. If this Court fixes such interim rates, terms and conditions, such defendant shall then tender and the

applicant may then accept an agreement under which licenses shall be granted, in accordance with such interim determination, providing for the periodic payment of royalties, if applicable, at such interim rates for any manufacture, use, or sale under the patents involved. If the applicant fails to accept such license agreement or fails to pay interim royalties in accordance therewith such action shall be grounds for the dismissal of his application.

(C) The defendants are each enjoined and restrained from including in any license granted by them any restriction or condition whatsoever limiting the exercise of the rights granted thereby except that the license may be personal and non-transferable and may be conditioned on (1) payment of a reasonable royalty, if applicable, which shall be non-discriminatory as between licensees whose licenses are granted subsequent to the date of this Final Judgment, other than defendants' associated companies, but the royalty provisions of agreements under which licenses are exchanged and royalties are adjusted or eliminated to reflect a bona fide estimate of the values of such licenses shall not be deemed to discriminate between licensees, nor shall the bona fide compromise of claims for accrued royalty be deemed to be discriminatory, (2) subjection, to any grant of licenses and rights by applicant to the defendants, of patents of any company of which applicant is a subsidiary and subsidiaries of any such company and of patents on inventions made in the course of their employment, after the effective date of the license agreement, by employees of any such company, applicant or any of its subsidiaries employed to do research, development or other inventive work, and (3) such other terms as this Court shall approve upon application by the defendants and notice to the plaintiff. If the applicant shall so request, any agreement in which licenses are exchanged between applicant and defendants shall fix a reasonable royalty for each license, where applicable, rather than providing for the adjustment or elimination of royalties.

(D) Each license agreement executed pursuant to this Section X shall contain, if the licensor so requests, reasonable provisions requiring the licensee to keep records, submit royalty statements and give appropriate license notices, and for periodic inspection of the books and records of the licensee by an independent auditor or any person acceptable to the licensee.

(E) Each license agreement executed pursuant to this Section X shall provide;

(1) That the licensee upon giving written notice to the licensor may cancel any such license for any specified equipment, but subject to paying accrued royalties.

(2) If any licensee requests, that such licensee may at any time surrender its license under any specified patent or patents identified by number by written notice to the licensor, but subject to paying accrued royalties. If any licensee requests, the license agreement shall also provide that upon such surrender the royalty rates shall be renegotiated if requested by the licensee in writing, and if there is a material difference between the reasonable value of the licenses granted to such licensee, including the patents affected by such surrender, and the reasonable value of such licenses without such patents, then such rates shall be reduced by an amount representing such difference. In event of disagreement whether a reduction shall be allowed or the amount thereof, the matter may be determined in the manner set forth in subsection (B) of this Section X.

(3) If any licensee requests, a royalty-free grant of immunity under all foreign patents owned or controlled by the licensor or its subsidiaries relating to the sale or use abroad of equipment manufactured under the license granted pursuant to this Section X.

(F) Each licensee of either defendant under a license agreement in effect at the date of this Final Judgment may cancel any licenses granted to it and its associated companies under such agreement by written notice to the licensor which shall terminate the obligation to pay royalty under the license agreement with respect to any equipment not manufactured, sold, leased or put into use under such licenses prior to such notice. Within sixty (60) days from the date of this Final Judgment,

defendants shall mail a copy of the provisions of this Section X to all such existing licensees.

(G) The defendants are each enjoined and restrained, except where this Court upon application by a defendant and notice to the plaintiff shall find good cause therefor, from directly or indirectly:

(1) acquiring any license, grant of immunity or similar right under patents unless such license, grant of immunity or similar right shall be non-exclusive;

(2) disposing of any patents, or rights thereunder, so as to deprive defendants of the power to grant or cause to be granted licenses as required under this Section X unless it be a condition of such disposition that the transferee shall observe the provisions of this Section X with respect to the patents and rights so acquired and shall file with this Court, prior to such disposition, an undertaking to this effect, provided, however, that this subsection (G) (2) shall not be deemed to apply to (a) any transfer of patents or rights thereunder to the plaintiff or any agency thereof, or (b) a disclaimer, or a concession or other grant in interference proceedings; or

(3) granting or receiving any right to grant sub-licenses under patents except to the grantee's associated companies for so long as they remain associated companies.

XI.

Western is ordered and directed, upon written request of any person, to furnish to such person a list, prepared as of January 1 of the year in which the request is made, of unexpired patents owned by either defendant or its subsidiaries, identified with the classification of the United States Patent Office on the date of issue of such patents.

XII.

The defendants are each enjoined and restrained from acquiring, directly or indirectly, title to any patent owned or controlled by any person other than Companies of the Bell System and employees thereof, except where this Court, upon application by either defendant and notice to the plaintiff, shall find that otherwise the defendant could not obtain rights under the patent or that the only terms upon which the defendant could obtain non-exclusive licenses under said patent are unreasonable, provided that nothing in this Section XII shall be construed to prohibit the acquisition of patents on inventions made by other persons pursuant to any research or development contract with any Company of the Bell System.

XIII.

The defendant A T & T is enjoined and restrained from receiving from the defendant Western any payment of patent royalty in respect of the manufacture, lease or sale of equipment by Western to the Bell Operating Companies.

XIV.

(A) The defendants are each ordered and directed, upon written application at any time and from time to time, to furnish to any person domiciled in the United States and not controlled by foreign interests, licensed pursuant to Section X of this Final Judgment under any patents of either of the defendants, technical information relating to equipment specified in such application, to the extent and upon the terms hereinafter set forth.

(B) The technical information so to be furnished shall be information relating to equipment manufactured by Western for sale or lease to Bell Operating Companies or A T & T for which the applicant is licensed pursuant to Section X of this Final Judgment, and shall consist, to the extent that the defendants shall have, and have the legal right to furnish, the same, of manufacturing drawings and specifications of the materials and parts comprising such equipment, and manufacturing drawings and specifications covering the assembly, wiring and acceptance test requirements of such equipment.

(C) The defendants are each enjoined and restrained from including in any agreement, under which technical information is furnished pursuant to this Final

Judgment, any restriction or condition whatsoever limiting the exercise of the rights thereby granted to use such information, except that the right to use such information may be personal and non-transferable and may be conditioned on (1) payment of a reasonable charge or charges which shall be non-discriminatory as between recipients of such information pursuant to application made hereunder, other than defendants' associated companies, (2) the furnishing by an applicant to Western, upon payment of a reasonable charge or charges therefor, of its own technical information of the character and scope of that furnished by Western, but only respecting equipments for which the applicant has licensed defendants pursuant to Section X of this Final Judgment, and (3) such other restrictions and conditions as this Court shall approve upon application by either defendant and notice to the plaintiff.

Defendants' obligation to furnish technical information in any case shall be subject to such restrictions as may be imposed at any time by any department or agency of the plaintiff for reasons of national security.

(D) The reasonable charge or charges permitted by subsection (C) of this Section XIV shall be designed to reimburse the defendants or the applicant for the cost of gathering and reproducing the information furnished and for that proportion, if any, of the development expense that is reasonable and is properly allocable to the class of equipment with respect to which the information is being furnished. The amount by which such charge or charges collected by defendants shall exceed the cost of gathering and reproducing such information shall be credited to the development and related engineering expense accounts of Western.

(E) Each agreement under which technical information is furnished pursuant to this Final Judgment shall contain, if the party furnishing such information shall so request, reasonable provisions requiring the recipient of such information to keep records, submit statements respecting charges, keep such technical information confidential, and use such technical information only for manufacture pursuant to the license granted to the recipient of such information under Section X of this Final Judgment, and providing for periodic inspection of the books and records of such recipient by an independent auditor or any person acceptable to such recipient.

(F) A party shall not be deemed, in connection with the furnishing of technical information pursuant to this Final Judgment, to have given any warranty against infringement of patents of others, or any warranty of success in connection with the use of such information.

(G) In the event of disagreement as to the amount of the charge or charges payable under this Section XIV, the matter may be determined in the manner set forth in subsection (B) of Section X of this Final Judgment.

XV.

(A) The defendants are each enjoined and restrained from making, performing, enforcing or adhering to any contracts or agreements under which fields of manufacture, sale or distribution of any equipment are divided with others, provided that, subject to other provisions of this Final Judgment, an exchange of non-exclusive licenses and rights under patents, without more, between the defendants and others shall not be deemed to divide fields of manufacture, sale or distribution of equipment.

(B) The defendants are each enjoined and restrained from performing or enforcing any term or provision of any contract or agreement that (1) makes exclusive any licenses or other rights under patents, or (2) grants to one party the right to sue for infringement of the patents of another party.

(C) The defendants are each enjoined and restrained from enforcing any restriction or condition on any licenses or other rights under patents granted by either of them, that (1) imposes maximum quantity or dollar limitations, or (2) restricts sales to designated customers (except where sales are limited to subsidiaries, under existing licenses, or to the plaintiff), or (3) restricts the price at which licensed

equipment may be sold.

XVI.

For the purpose of securing compliance with this Final Judgment, duly authorized representatives of the Department of Justice shall, upon written request of the Attorney General, or the Assistant Attorney General in charge of the Antitrust Division, and on reasonable notice to the principal office of either defendant, be permitted (1) reasonable access during the office hours of said defendant to all books, ledgers, accounts, correspondence, memoranda and other records and documents in the possession or under the control of said defendant relating to any matters contained in this Final Judgment and (2) subject to the reasonable convenience of said defendant and without restraint or interference from it, to interview officers or employees of said defendant, who may have counsel present, regarding such matters, and upon request said defendants shall submit such written reports as might from time to time be reasonably necessary to the enforcement of this Final Judgment. No information obtained by the means provided in this Section XVI shall be divulged by any representative of the Department of Justice to any person other than a duly authorized representative of such Department, except in the course of legal proceedings in which the United States is a party for the purpose of securing compliance with this Final Judgment, or as otherwise required by law.

XVII.

Jurisdiction is retained for the purpose of enabling any of the parties to this Final Judgment to apply to this Court at any time for such further orders and directions as may be necessary or appropriate for the construction or carrying out of this Final Judgment, or the modification or termination of any of the provisions thereof or for the enforcement of compliance therewith or for the punishment of violations thereof. Upon any such application by the plaintiff, the plaintiff shall be deemed to have made a sufficient showing of a change in circumstances warranting appropriate modification of this Final Judgment if it shall show elimination hereafter, in a substantial number of states, of public regulation of charges for common carrier communications services.

Jurisdiction is further retained for the purpose of enabling the plaintiff to apply to this Court at any time, without the necessity of showing any change in circumstances, for orders under this Final Judgment:

(a) requiring sales, at non-discriminatory prices, of any telephone equipment manufactured by Western or its subsidiaries to independent telephone operating companies, or prohibiting or limiting sales of such equipment to such companies; and

(b) requiring that any equipment manufactured by Western or its subsidiaries that is used by A T & T or any Bell Operating Company in furnishing a common carrier communications service, other than telephone equipment, shall be sold at non-discriminatory prices to any person lawfully engaged in furnishing such a service in competition with them or in furnishing message telegram service, for use by such person in furnishing any such service; and

(c) requiring that A T & T shall, and shall cause its subsidiaries to, continue to lease, to common carriers engaged in the message telegram business, on reasonable terms, circuits required by such carriers for use in their business, to the extent that such circuits shall be reasonably available without further construction.

Dated: January 24, 1956

THOMAS F. MEANEY

United States District Judge

We hereby consent to the making and entry of the foregoing Final Judgment:

For the Plaintiff:

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EDWARD A. FOOTE

W. D. KILGORE, JR.

RAYMOND DEL TUFO, JR.

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HORACE P. MOULTON

Its Vice President and General Counsel

For the defendant WESTERN ELECTRIC COMPANY, INCORPORATED

WALTER L. BROWN

Its Vice President and General Counsel

APPENDIX A.

Bell Telephone Company of Nevada
Illinois Bell Telephone Company
Indiana Bell Telephone Company
Michigan Bell Telephone Company
New England Telephone and Telegraph Company
New Jersey Bell Telephone Company
New York Telephone Company
Northwestern Bell Telephone Company
Southern Bell Telephone and Telegraph Company
Southwestern Bell Telephone Company
The Bell Telephone Company of Pennsylvania
The Chesapeake and Potomac Telephone Company
The Chesapeake and Potomac Telephone Company of Maryland
The Chesapeake and Potomac Telephone Company of Virginia
The Chesapeake and Potomac Telephone Company of West Virginia
The Cincinnati & Suburban Bell Telephone Company
The Diamond State Telephone Company
The Mountain States Telephone and Telegraph Company
The Ohio Bell Telephone Company
The Pacific Telephone and Telegraph Company
The Southern New England Telephone Company
Wisconsin Telephone Company