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This is a reprint, from the spring 1958 issue of the BELL TELEPHONE MAGAZINE, of an article entitled "Communications and Defense," by Mr. Charles C. Duncan, Assistant Director of Operations, Long Lines Department of the American Telephone and Telegraph Company. The article is a transcript of the major portion of a lecture given at the Industrial College of the Armed Forces by Mr. Duncan on 3 March 1958 (L58-116).

The first issue of the reprint was distributed at the Annual Convention of the Armed Forces Communications Electronics Association held in Washington 4-6 June 1958.

The American Telephone and Telegraph Comapny has kindly made the lecture available in this form for distribution to readers of Industrial College publications.

Bell Telephone MAGAZINE

COMMUNICATIONS AND DEFENSE

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Assistant Director of Operations
LONG LINES DEPARTMENT, A. T. & T. CO.

A Bell System executive discusses the responsibilities of the communications industry in national defense before the Industrial College of the Armed Forces

COMMUNICATIONS AND DEFENSE

C. C. DUNCAN

Assistant Director of Operations, LONG LINES DEPARTMENT, A. T. & T. CO.

(Note:—Mr. Duncan addressed the Industrial College of the Armed Forces in Washington, D. C., on March 3, 1958. His subject was "The role of the commercial telecommunication systems in preparedness for national emergency." *He spoke, by invitation, as a representative of the entire industry, which includes the international cable and radiotelegraph companies, the Western Union Telegraph Company, more than 4,000 independent telephone companies, and the Bell System. These organizations have assets of approximately 21 billion dollars, some two million owners of securities, and employ about 900,000 men and women—figures which emphasized to Mr. Duncan's military audience the industry's capacities both human and mechanical. The address is quoted in part below.* Editor)

THE NERVES of modern weapon systems are the electronic communications for collecting and disseminating information and for weapon guidance—integrated for effective military use by means of engineering, planning, and management. These arts are basic also to the communication business and it is, therefore, understandable why these companies are so heavily involved in defense.

All branches of the industry are or have been so engaged. Since I am more familiar with those being handled by the Bell System, I would like to discuss several of the defense projects in which it is involved.

Even before the start of World War II, the Bell System was called upon to take responsibility for many important undertakings of this nature because of its integration of basic research, design, development, manufacture, and operations. The System did not seek these assignments; in fact, its policy is to accept only those which it is particularly well qualified to handle. Nevertheless, the volume and variety of these assignments have steadily increased.

During World War II, approximately 85 per cent of the coördinated research, development, and production facilities of the Bell Telephone Laboratories and the Western Electric Company—the Bell System's manufacturing unit—were devoted to work for the Armed Forces. Again, starting in 1949 and greatly accelerating with the advent of the Korean outbreak in 1950, many of our facilities and personnel

The Industrial College of the Armed Forces was opened in 1924 as the Army Industrial College, and a class of nine officers was graduated in June of that year. The College was reconstituted in 1948 as a joint educational institution operating under the direction of the Joint Chiefs of Staff—its present status. Its objective may be said to be to enlarge the appreciation of its student body as to the importance of large segments of the nation's economy in promoting national defense. Its classes now total about 140, including not only officers from the Services but civilian members of major government departments.

The Industrial College of the Armed Forces moved in 1946 from the Pentagon to its own building at Fort Leslie J. McNair, a historic military site at the confluence of the Anacostia and Potomac Rivers, at Washington. The Post is also the home of the National War College, and the two institutions share some of the same facilities and coöperate to a considerable extent in lecture programs.

were taken from their normal duties and assigned to special defense projects . . .

EDITOR'S NOTE: *Mr. Duncan then proceeded to enumerate a number of important defense projects which have involved the Bell System —activities which in several instances have been described in this and other Bell System publications. These included the Sandia Laboratories, the DEW-Line, and the White Alice communication system. He then discussed a number of programs in the field of guided missiles:*

1. *Nike—Anti-Aircraft Missile System—Ajax and Hercules*

In 1945 the Bell Laboratories were asked to determine the feasibility of guided missiles for anti-air defense. By 1950 the design of such a system was almost completed when the Korean outbreak resulted in a military order to the Bell Laboratories and Western Electric to institute production on a "crash" basis, with research and development overlapping. Western Electric accepted over-all responsibility, utilizing subcontractor assistance to produce control systems for the missiles.

2. *Missile Test Range Submarine Cable*

The guided missile center at Cape Canaveral, Florida, and its firing range, extending over the Bahamas into the South Atlantic, has been prominently in the news lately. The Bell System built for the Air Force a submarine cable system over 1,000 miles long that connects the string of control stations extending from Cape Canaveral to Puerto Rico.

3. *Titan*

This most important project involves research and development by Bell Laboratories for a radio-inertial guidance system for the Air Force Intercontinental Ballistic Missile unit. Work has been under way for more than a year and the project is on schedule.

4. *Nike Zeus (AICBM)—Defense Against Intercontinental Ballistic Missile*

Faced with the threat of attack by ICBMs, the Army and the Air Force requested a Bell Laboratories-Western Electric study of the feasibility of defense measures, based on the evolving Nike family of guided missiles. Intensive study has shown defense to be feasible but very difficult and complex. Drawing on its Nike experience, both in development and production, a Bell System team is now heavily engaged in the AICBM program.

5. *A Warning System for Ballistic Missiles*

A system that will warn of a ballistic missile attack is vital to allow our defense commands to take off within their brief allotted alerts. Such a warning system is possible. It involves unusual radar installations in the very far north, their interconnection by communication links, and, most importantly, a sure and secure communication system to bring the warning instantly and reliably from these extreme

locations to Strategic Air Command Headquarters and its air bases. The Bell System team—composed of members of the operating telephone companies, Western Electric, and the Bell Telephone Laboratories—has been asked to plan for this communication system. It will connect with radar equipment to be installed under the direction of the Radio Corporation of America.

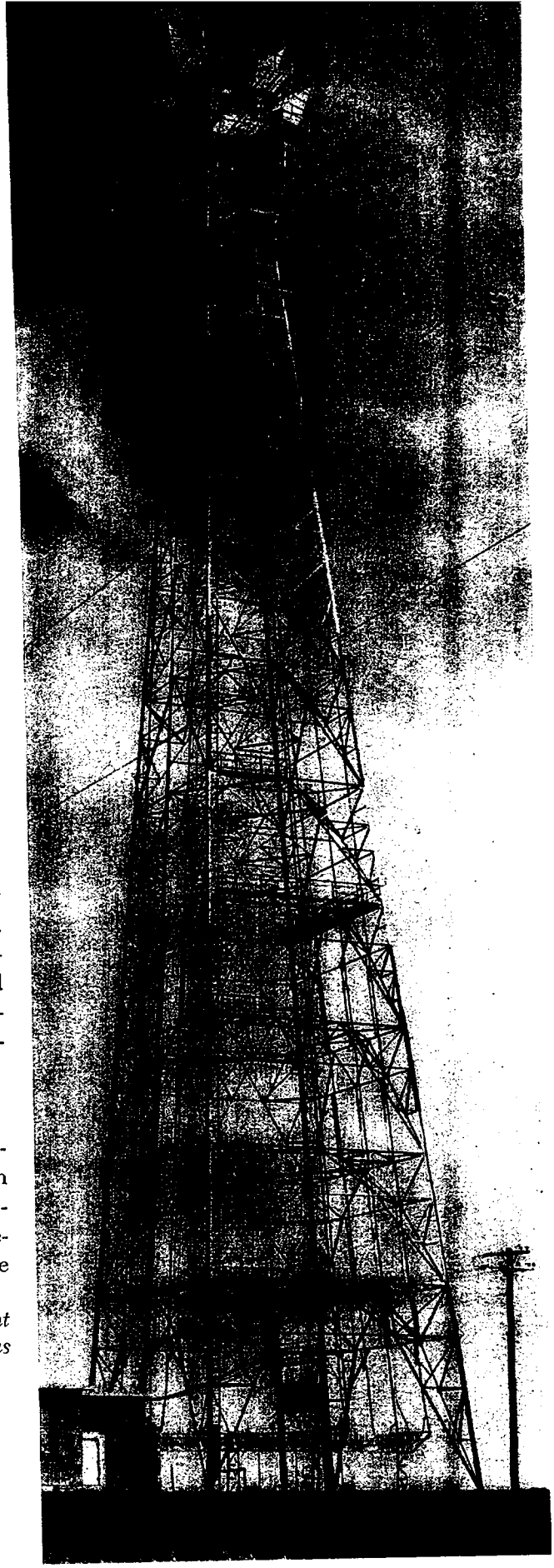
The American Method

IN ALL THESE PROJECTS, it has been the practice of the government to call upon the resources and know-how of the large communication companies to act as prime contractors in planning and supervising them. In turn, these organizations have asked the aid of thousands of sub-contractors to do much of the detailed engineering and practically all of the field construction work. Also, a large number of manufacturing companies have supplied the equipment needed. Here we have a partnership between big and little business.

Let me point out, incidentally, another significant fact about our communication industry. In its development and service, I believe I can say in all modesty, it is preeminent in the world. With us, the industry is almost all privately owned and operated. Abroad, for the most part, the communications organizations are government owned and operated. To me, the scope and excellence of our facilities are an eloquent testimony to the American method.

World-Wide Communications

IN THE YEARS since World War I, the communications industry, in coöperation with many overseas administrations, has provided a system of world-wide radiotelegraph and radiotelephone circuits. These



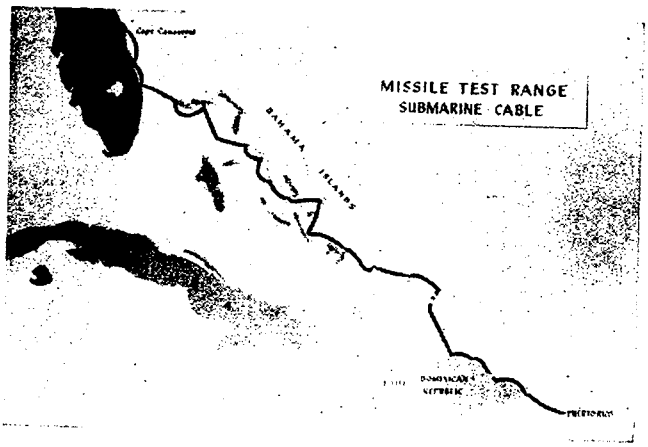
A busy radio relay tower on an important mid-West by-pass route, with ten antennas for transmitting and receiving

The Bell System made great contributions to the planning and construction of the White Alice communications system in Alaska, where it provides communications for military and civilian use

overseas circuits extend to almost every country, and were used extensively by the military forces during the last war.

While overseas radiotelephone circuits furnish good service most of the time, they have limitations. In your use of them, when telephoning abroad, you may have noticed fading and noise conditions that are sometimes experienced during magnetic storms. The effect of these storms varies considerably, with the worst conditions occurring

The Bell System built for the U. S. Air Force a 1000-mile submarine cable from the guided missile station at Cape Canaveral to Puerto Rico



across the North Atlantic and in the Alaska area. Another limitation in the use of radio is the crowding of the radio frequency spectrum. This has reached a point where it is difficult to add many more circuits to meet rapidly increasing civilian and defense needs. A third limitation, particularly important from the standpoint of defense, is the possibility of enemy jamming of this type of radio circuit.

Although these circuits have contributed greatly to world-wide communications and will continue to do so, it became evident a number of years ago that they would have to be supplemented by long submarine telephone cable systems. However, the problems inherent in transmitting the voice are quite different from those solved long years ago when underseas telegraph communication first became feasible. We in the Bell System have been working since 1919 on this problem of underseas voice transmission. As a result, a good submarine cable system was developed that uses underwater amplifiers, spaced about 40 miles apart, which can provide 36 telephone circuits over distances of about 2,000 miles. This development was completed shortly after World War II, and in 1950 a prototype of the system was installed between Key West and Havana.

In 1956, if you will recall, we constructed submarine telephone cable systems to Great Britain and Alaska, and last year one to Hawaii . . . Because of the success of the first transatlantic cable, we are now in the process of building a second system across the Atlantic. This one will extend to France and will serve the same European countries connected by the first cable as well as such additional countries as Spain and Italy. The second transatlantic telephone cable will be completed in 1959. By the use of these two cable systems and the existing radio channels, we feel that re-

liable telephone service can be furnished between North America and Europe at all times . . . Plans have also been announced for the construction of a submarine telephone cable system between continental United States and Puerto Rico, to be completed early in 1960.

Military Communications Circuits

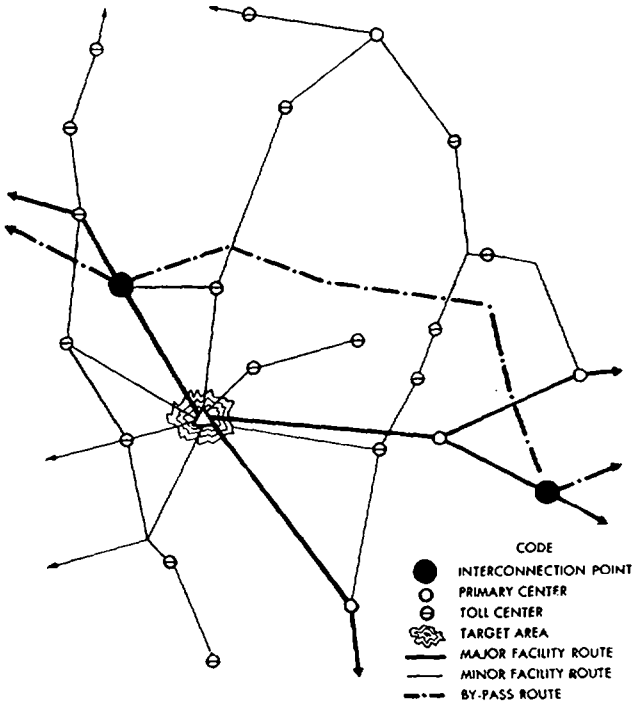
A NUMBER OF full-time networks involving millions of circuit miles connect military bases, government agencies, and civilian defense centers throughout the country. These circuits are in current use and are vital for directing the defense activities of the country in case of attack. The Air Force uses many of these circuits for the interconnection of radar stations, SAGE computer centers, fighter bases and command headquarters. Nation-wide air warning circuits and many others are being used, too. These facilities include those suitable for the transmission of data signals plotting the course of a plane, picture transmission, teletypewriter, television, and ordinary speech. In addition to these private line communication networks, all branches of the Defense Department use standard commercial service for individual calls.

Express and By-Pass Routes

EVER SINCE modern communications came into being in this country, the whole industry has been faced with the problems of providing uninterrupted service, despite storms and floods and even if a farmer should accidentally cut one of our cables in digging a ditch through his field. To be sure, much has been done to reduce the frequency of such troubles by improved engineering design and maintenance methods—but from time to time failures still occur. Long ago, we found the best way to provide reliable service was to diversify our circuits so well that all of our eggs were not in one basket.

With rapidly expanding volume and demand that require the construction of new telephone facilities, we have been able to provide this diversification by building new

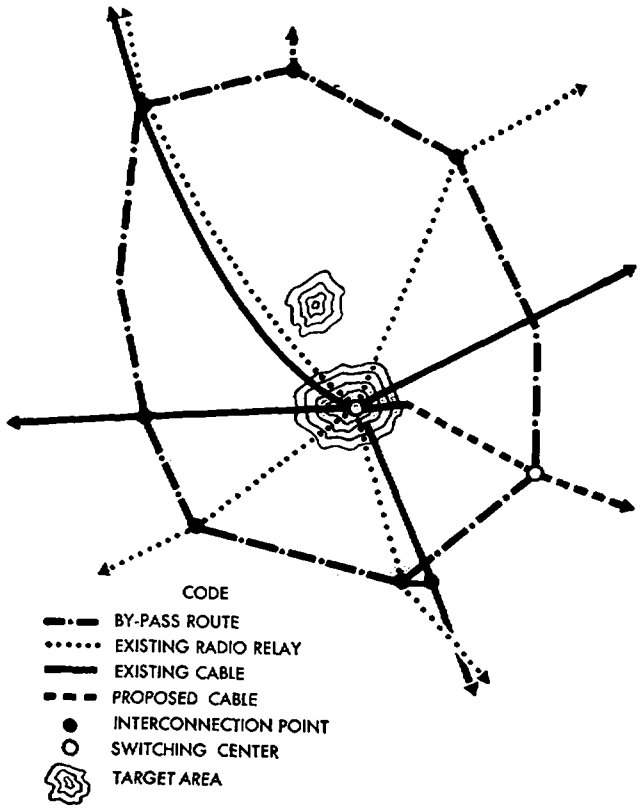
This is the headquarters of Sandia Corporation in New Mexico—the first Bell System major post-war project for defense. Since 1949, under Western Electric's management, various nuclear weapons have been produced for the Atomic Energy Commission



For the past three years the Bell System has been constructing routes which by-pass large cities and would thus avoid disruption of service in case of nuclear bombings

routes. As the network of telephone facilities spread, connecting every town and village in the country, it was relatively simple to route part of the circuits between any two points over separate lines. This worked all right—as long as we were dealing with individual emergencies. However, with the advent of nuclear bombing and the possibility of simultaneous bombing of many large communities throughout the country that might destroy a large number of cities, we realized that our long distance telephone facilities might be seriously crippled. This was because, until recently, our circuits had been routed for the most part through the centers of large cities along the way. Consequently, a by-product of widespread bombing of these cities would have been the disruption of the long distance telephone service.

About three years ago, we came to the conclusion that we should provide by-pass routes outside large cities, so that a portion of our circuits which formerly had all gone through these centers could be routed over such by-pass routes. Thus, in case the city itself was destroyed the flow of calls would not be unduly affected. In some cases it was necessary to construct new routes – called express routes – that



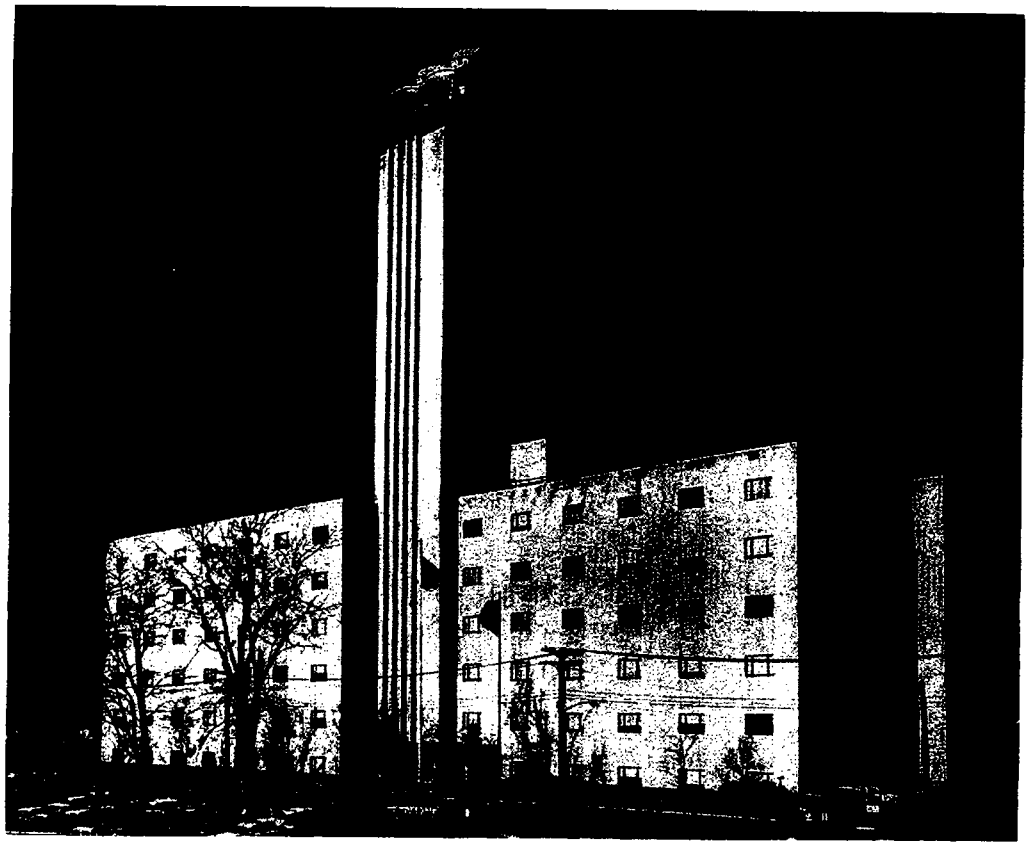
On these two pages are shown diagrammatically how telephone calls would be handled to avoid a large city (opposite) and to avoid its central area (above)

would avoid target areas. These communication avenues have branches leading into the cities along the way. As additional circuits have been required for growth, we have kept these considerations paramount in our plans.

The construction of by-pass and express routes is being undertaken by the Bell System to protect all of its services, both civilian and government. Part of this is required by construction needed for actual growth and the remainder to benefit the whole service. This project is well along and practically all of the by-pass and express routes will be completed this year.

When they are completed, we shall be able to route telephone circuits between any two points in the country without going through critical target areas. We will handle a portion of the normal commercial traffic between any two towns over these express and by-pass routes. Diversification will also be provided for essential military and other government circuits. Sufficient capacity is being built into these routes so that, in an emergency, all of the essential services can be placed on by-pass routes.

This is not a static program. Our plans are constantly being brought up to date as new goals are defined and enemy capabil-



A blast-resistant switching center on one of the nation's express long distance routes

ities increase. In some cases, where potential targets are created, we find out about them soon enough so that the location of our plant—a group of radio relay stations, for example—can be changed before it is built. In other cases, to avoid a newly constructed air base or other critical installation, we have to provide by-passes for the by-passes!

Emergency Protection

IN ADDITION to locating our express and by-pass offices away from other targets, we have provided storage batteries and stand-by power generating sets at each point. These make the offices independent in case of failures in commercial electric power.

Great advances have also been made in providing automatic equipment to restore circuits that have been interrupted, to start emergency power generating equipment, and to handle the nation-wide switching of telephone calls automatically without the use of any operators or maintenance men. These measures are particularly important in view of problems that might arise in connection with radio-active fallout caused by nuclear bombing.

Of course, if an enemy wants to expend the necessary weapons, we are still vulnerable to direct bombing attack on our buildings. The destruction of certain of them would be serious. However, we have a vast amount of emergency equipment that could be available for quick restoration. This is normally dispersed throughout the

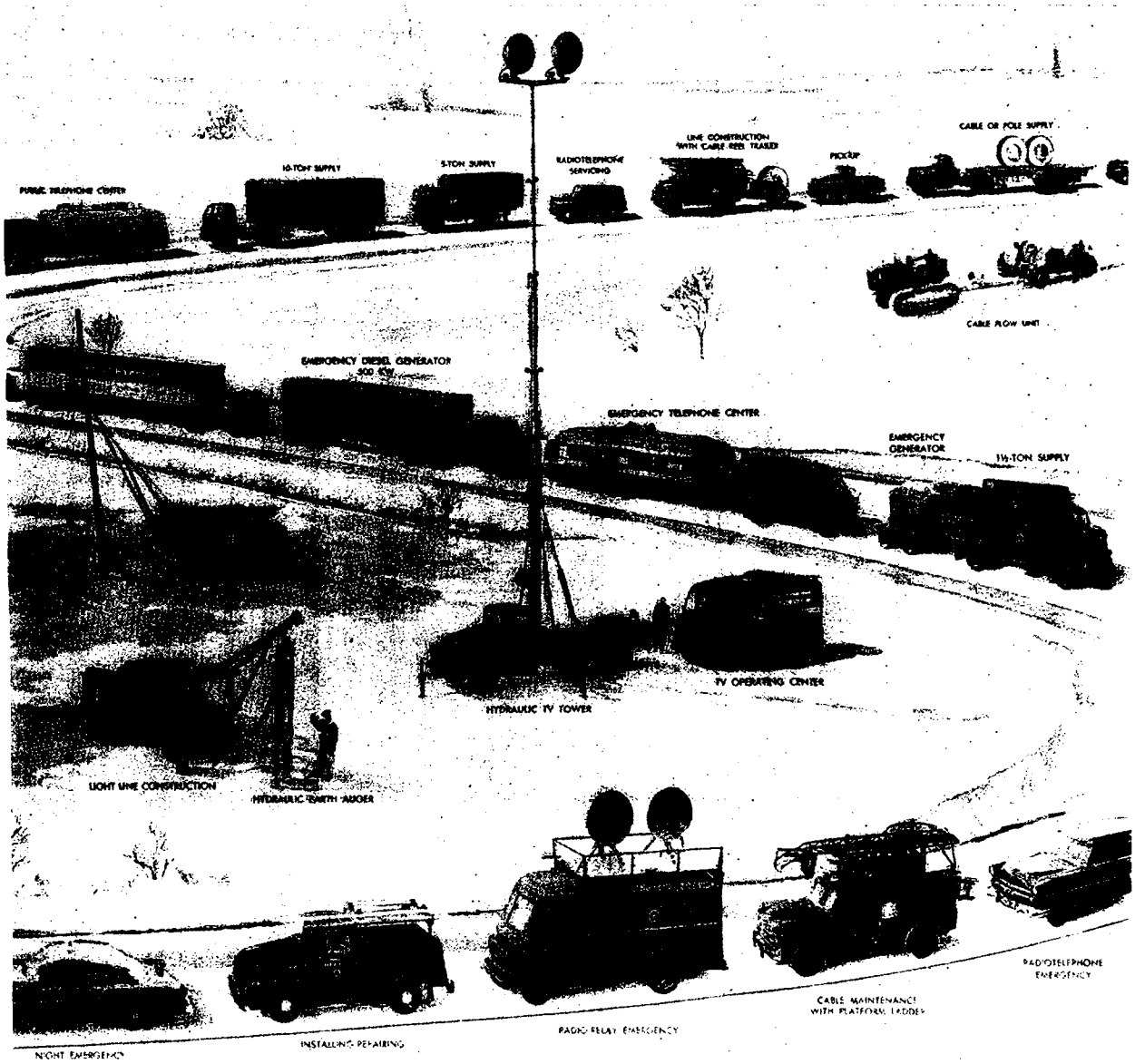
country. For example, truck-mounted radio units are located at strategic points, readily available to replace microwave stations that might be destroyed.

These emergency offices are self-contained and include radio towers and power-generating equipment. Each of them can provide a microwave sending and receiving channel that can carry 600 telephone circuits.

Manpower

WHILE MACHINES AND EQUIPMENT are important, the tremendous resources represented by the 900,000 trained men and women of the communications companies should not be overlooked or minimized. These people—who are designing, manufacturing, building, operating and maintaining communication facilities—represent an indispensable pool of widely dispersed

Vast amounts of Bell System emergency equipment, dispersed throughout the country, are made available for quick restoration measures by vehicles of many types. Below are typical examples of such motorized equipment



and immediately available trained personnel ready to meet any emergency in communications.

At their command are vast amounts in equipment, material, and supplies spread throughout the nation. At any moment, there are literally hundreds of millions of dollars' worth of new equipment and supplies in factories, in thousands of supply depots, and in transit available for regular and emergency calls.

Disaster Plans

THE PEOPLE of the communications companies are familiar with the means to restore their facilities damaged by such disasters as storms, floods, fires, etc. They frequently handle this type of emergency, and practical arrangements for meeting them have been well established.

Fortunately, we have not been faced with the actuality of nuclear bombing. But we have been studying and rehearsing the measures that would have to be taken if this happens. For several years we have participated in all of the studies on this subject and in such exercises as "Operation Alert—1957," which simulated widespread nuclear bombing. During this exercise Bell System, Western Union, and other disaster centers were activated throughout the country. These centers evaluated the effect on communications of simulated bombing, as it occurred. They also set up re-routed facilities, as required, to restore communications necessary for military, government, and other essential needs. Such centers maintained immediate contact with the government organization participating in this exercise.

The 1957 exercise and others showed that the communication facilities now in existence would cover essential needs for the defense of the country. They also indicated that we have an adequate reserve to restore and rebuild any facilities which, if destroyed, would be needed after an attack.

From all the facts presented, I think you will agree that the commercial communications companies represent an essential part of the defense organization of this country. But we in the industry are not content nor complacent about the communications available today. I want you to know that we recognize our responsibilities for foreseeing and planning to meet fully all of our country's communications needs —now and in the future.

C. C. Duncan, left, aboard H.M.T.S. Monarch, *at the time of the laying of the transatlantic cable. Besides him stands Frederick R. Kappel, then president of Western Electric; Messrs. W. A. Wolverson and R. J. Halsey of the British Post Office; and, at the far right, Cleo F. Craig, then president of A. T. & T.*

SAVE FOR an interval of eight months in 1951 when he was supply practices engineer in A. T. & T.'s Department of Operation and Engineering, C. C. DUNCAN has spent his 31 Bell System years in the Long Lines Department. He joined it in St. Louis as a student in 1927, and in 1937 was appointed district Plant engineer. He went to Dallas as district Plant superintendent in 1939 and stayed there seven years, returning to St. Louis as division Plant superintendent. In 1950 he was transferred to Long Lines Headquarters in New York as general Plant supervisor. Later that same year he was appointed Assistant to the General Manager, where one of his principal responsibilities was the direction and coördination of Long Lines Plant protection and defense activities. After his return from A. T. & T., he was made Operating Staff Manager in charge of the Plant, Traffic, and Commercial Headquarters staff. In 1953 he became General Manager-Special Projects—an appointment which made him responsible for the building of the Atlantic, Alaskan, and Hawaiian submarine telephone cable systems. Since 1956 Mr. Duncan has been Assistant Director of Operations in charge of the Long Lines Headquarters engineering staff. He is a member of the A. I. E. E. and of the Armed Forces Communications Association. He has recently returned from a trip to Anchorage, Juneau, and Ketchikan, Alaska, in connection with the official opening of the White Alice communication system, with which he had been concerned. This is an integrated system for military and civilian use, which employs both microwave radio and the recently developed over-the-horizon method in providing a high-quality, reliable service under extremely rugged weather conditions. Mr. Duncan contributed "Conservation of Materials" to this MAGAZINE for Autumn 1951, and "Transatlantic Cable Puts Out to Sea" to the issue of Summer 1955.