# Developments in High-Power Radio

## And Its Practical Application in the Services of the United States Navy

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## PART II

THE passage by Congress of the Naval Appropriation Act of August 22, 1912, contributed greatly to the advancement of the radio art as regards the development of high-power radio, not only in the United States but throughout the world. It gave to the Naval radio service a great opportunity, but it also placed a heavy responsibility on those entrusted with the direction and administration of the service.

This Act appropriated $1,500,000 for the establishment of six of the Navy's projected high-power stations, those to be located in the Isthmian Canal Zone, on the California Coast, in the Hawiian Islands, in American Samoa, at Guam and in the Philippines. This constituted a programme of great magnitude in high-power radio construction and one which obviously was difficult of accomplishment at that period. The trail had not yet been blazed in this direction and little information of a practical nature was available. The Arlington station was under construction but had not yet been finished; so that definite information was not available as to what could be expected from a station of this type.

The plans for the six new stations therefore must necessarily be held in abeyance pending the completion and testing of the pioneer high-power Arlington station. Being a pioneer in substantial high-power radio construction, this station must be regarded in the light of an experiment. Because of insufficient scientific knowledge at that time, mistakes were made in the establishment of the Arlington station, principal among which were locating the station on high ground and placing the steel towers too close together, but nevertheless this station has rendered most valuable service to the Government ever since it was placed in commission, and moreover it served as a guide by which similar mistakes on a larger scale were avoided. It also made available a high-power station for testing different types and makes of apparatus in actual service, thereby enabling the selection of the most efficient type of equipment available for service at that time. It was, in short, the agency by which delay was avoided in establishing the extensive radio system required to meet the needs of our Atlantic, Pacific, and Asiatic Fleets and other government agencies.

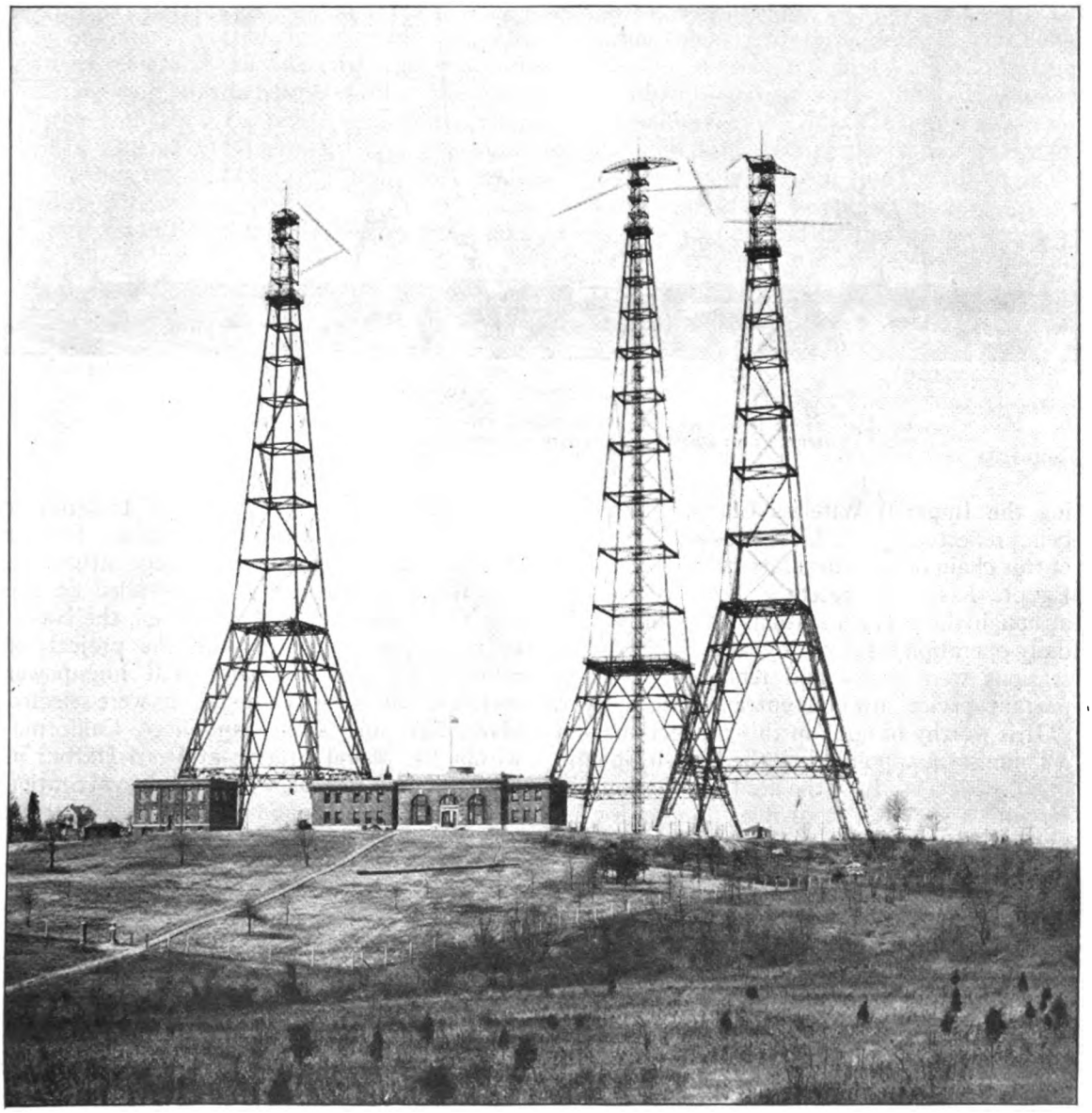
The Arlington station may justly be regarded as the pioneer development in high-power radio in the world, as well as the fountain head of the Navy's existing radio service, a service of which the stations on shore extend more than one quarter the distance around the world and whose signals are constantly encompassing the globe. The true significance of the Arlington station will not be fully appreciated until the history of radio is finally written.

### THE POULSEN ARC TRANSMITTER

UNDOUBTEDLY the second feature of importance in connection with the development of radio in the United States, especially as regards high power, is the Poulsen-Federal arc converter. This type of transmitter, successfully developed by the ingenuity of American radio engineers from powers of 30 KW to 1,000 KW within a brief interval of ten years, and manufactured in the United States, is the outstanding unit of apparatus in the Naval radio service. Arc transmitters have given satisfaction in the services where they have been employed for powers from 2 KW to 1,000 KW. The Navy has used this type of apparatus in its high-power stations continuously since the first 30-KW arc transmitter was tested out in the Arlington station ten years ago. Arc transmitters produce harmonics as do other types of transmitters. They also produce a form of interference called "mush," the cause of which is not yet thoroughly understood. Two waves were also radiated, instead of one, in the system of signaling

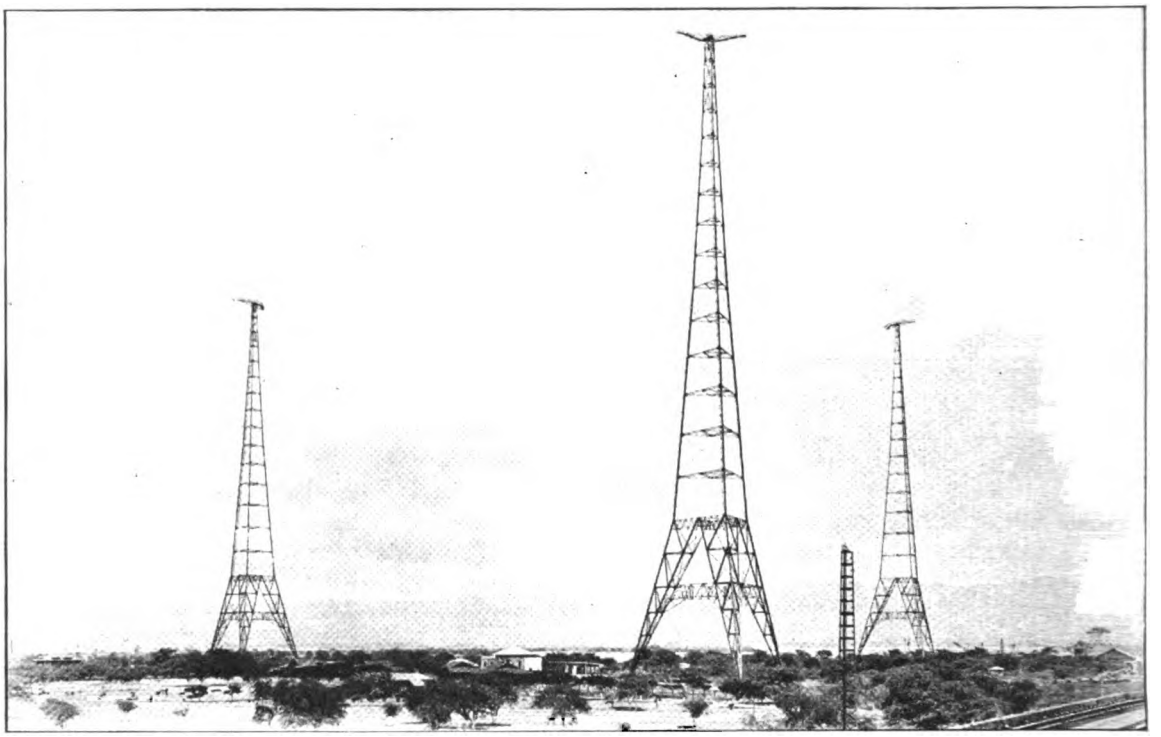
originally employed. All three undesirable features are gradually being eliminated, however, and it is expected that the arc will then radiate as pure a wave as any of the other existing transmitters.

By originally adopting the arc transmitter for its high-power stations, the Navy has obtained satisfactory service from the beginning and it has not yet become necessary to replace the original installation in order to keep abreast of the progress in radio. It thereby avoided the expense which the Marconi Wireless Telegraph Company of America (now the Radio Corporation of America) found it necessary to assume when that company was obliged to scrap practically new spark transmitters and install alternators in all its high-power stations in order to carry on transoceanic traffic satisfactorily. It also avoided long delay in establishing its transcontinental, transpacific chain of high-power stations such as has been experienced by the British in establish-



ARLINGTON

Probably the best known radio station in the world. All manner of new developments are tried out by the Navy at this station. Mariners listen for its time signals and weather reports the world over



PEARL HARBOR, HAWAII

The U. S. Navy high-power station in mid-Pacific. It is not uncommon for experienced amateurs as far away as our eastern seaboard to copy messages from this giant

ing the Imperial Wireless Chain, this delay being reflected by the fact that one of the first of this chain of outlying stations, that at Cairo, Egypt, has only recently been completed, although the Navy's stations have all been in daily operation for several years. The Navy's stations were ready and rendered most important services after our entrance into the war.

It is worthy of note, in this connection, that a commission appointed by the British Government made a study of the arc type of transmitter with a view to its possible adoption for use in the stations of the Imperial Wireless Chain, about the same time the Navy was investigating it for use in its high-power stations. The British Commission's report, which was promulgated after the Navy had definitely decided to adopt the arc, was to the effect that this type of apparatus was unsatisfactory for the purpose intended and it was therefore not recommended for use. Notwithstanding this fact, the arc transmitter is now being installed in stations in the Imperial Wireless Chain.

Vested with the authority granted by Congress in 1912 and being satisfied with the performance of the arc type of transmitter as a result of the Arlington tests and further extensive tests carried on subsequently with the 100-KW arc converter installed in the new Canal Zone station at Darien, the Navy, in 1914-15 went ahead with the project of establishing the five additional high-power stations. Sites for these stations were selected about five miles from San Diego, California, within the Naval Station at Pearl Harbor in the Hawaiian Islands, within the Naval Station at Tutuila, American Samoa, at a point about five miles from Agana on the Island of Guam, and within the Naval station at Cavite about twelve miles from Manila.

Three-legged, self-supporting steel towers, similar to those designed for the Arlington station, were erected at all of the stations with the exception of Tutuila where 300-foot wood, guyed, lattice masts were used, owing to insufficient funds for steel ones. Three 600-foot towers were erected at the San Diego, Pearl Harbor, and Cavite stations. Two 450-foot towers were erected at Guam. Two 300-foot wood masts were erected at Tutuila.

A 200-KW arc converter was installed at Challas Heights, 350-KW at Pearl Harbor, 500-KW at Cavite and 30-KW at Tutuila and Guam.

All five stations were completed and in commission within two years thereby linking our most distant possessions, the Philippines and other islands in the Pacific with Washington by radio. As a result of the establishment of this chain of high-power stations and with the stations at Cordova, Alaska and Cayey, Porto Rico, subsquently established, and the replacement of the Arlington station by the more powerful Annapolis plant, the Navy Department is enabled to keep in constant touch with our three fleets, with their auxiliaries and with their bases. The Government now has a system of communication radiating from Washington and covering our entire coasts and our outlying possessions, a system entirely independent of the land lines and the meagre cable facilities in the Pacific.

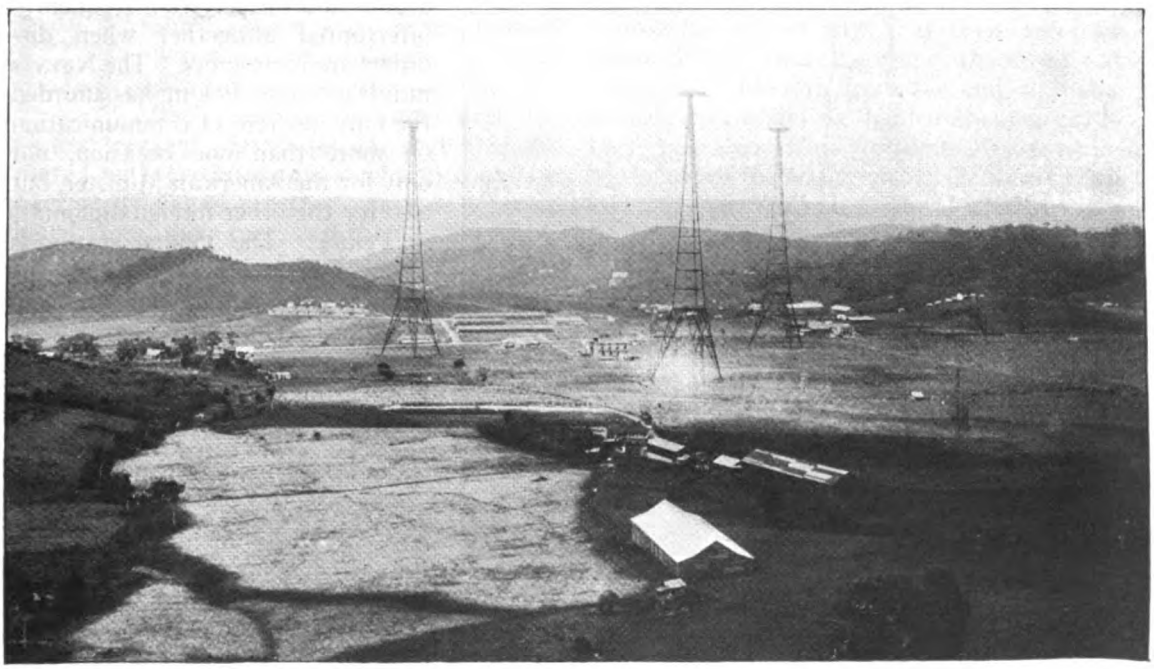
The Naval radio service is used by all the government departments and agencies. It serves the Army for communicating with its forces in the Philippines and our other possessions in the Pacific, with the Canal Zone and the West Indies. It serves the Weather Bureau, the Bureau of Lighthouses, the Bureau of Fisheries, the Coast Guard and similar government agencies. It provides channels of communication with our outlying possessions which make them entirely free of foreign-owned or controlled cables and therefore it is a potential asset for the development and fostering of our trade.

The Naval radio service normally handles approximately 20,000 words per day across the Pacific, this volume of traffic being greatly increased during cable breaks. About 5,000 words are normally handled between Puget Sound, Washington, and Cordova, Alaska, and when breaks occur in the Army's cable between Seattle, Washington, and Valdez, Alaska, the number of words averages between 30,000 and 35,000 per day. About 8,000 words are exchanged daily through the Darien station in the Canal Zone and about 5,000 words through the Cayey station in the West Indies.

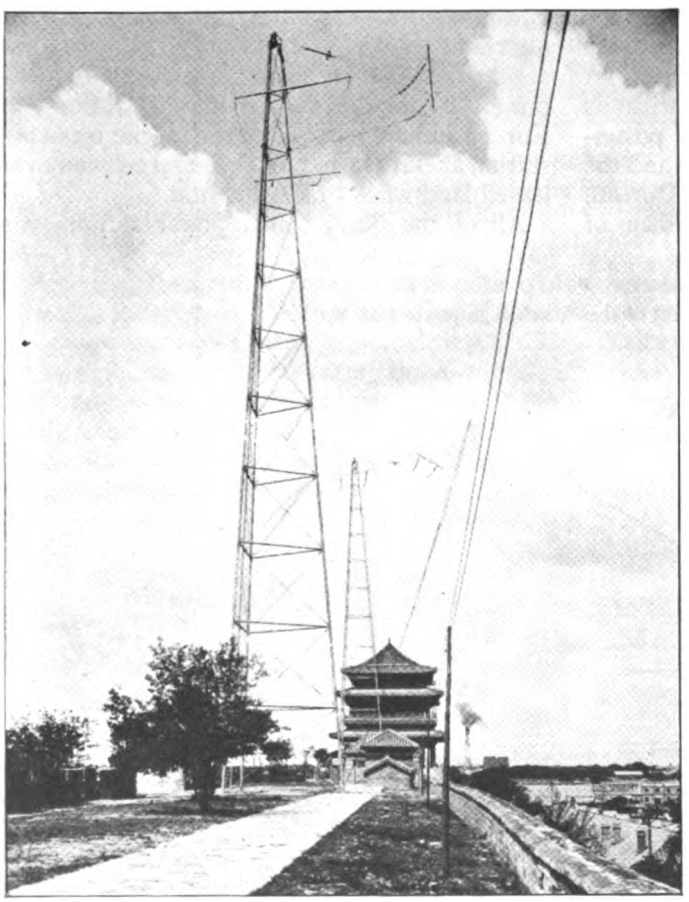
Messages are constantly passing between the various coastal stations on shore and naval and merchant vessels at sea. Government messages are sent daily from the Annapolis high-power station to corresponding stations in Europe and are received at the special receiving station at Bar Harbor, Maine, and relayed over leased land wires to Washington.

All of the Navy's high-power stations are

CAYEY, PORTO RICO
The Insular outpost of the Navy's high-power system



operated duplex to enable messages to be received at the same time other messages are being sent from the same station or unit. This is accomplished by establishing a control and receiving station at a distance of about ten or twelve miles from the transmitting stations and connecting the two stations by land wire telegraph. Radio men are posted at the transmitting stations to start and stop the machinery and to regulate the apparatus, the functioning of which for transmitting messages, however, is controlled by the operator at the central and receiving station. In practically all the Navy's high-power stations there are installed a medium-power and a low-power transmitter in addition to the high-power set. Operators at the central and receiving station may be sending out messages with the three transmitters simultaneously and other operators may receive from distant stations at the same time.



THE U. S. NAVY STATION AT PEKING, CHINA

Operated by the U. S. Marines located at the American Legation Compound which is within the famous 40-foot Tartar Wall. Two of the towers are atop the wall

The naval stations in the Pacific and in Alaska would be almost completely isolated from the United States were it not for the Army's cable and the Navy's radio service. The Army's cable has deteriorated considerably with age and consequently is frequently broken. At such times the radio service takes over all cable traffic in addition to its normal traffic and passes it on to stations situated along our Pacific Coast. In the Pacific, reliance is also placed on a single cable and when this fails, the only remaining medium of communication is radio. There is no connection with American Samoa except by radio but entirely satisfactory service is maintained between Tutuila and Pearl Harbor over the Navy's radio circuit, about 2,000 words being exchanged daily.

The Navy's transpacific high-power radio circuit may be said to extend into China and temporarily at least, into Siberia. A station of 30-KW power has been established within the Peking Legation Compound, surrounded by the 40-foot-high Tartar Wall, which encloses the American Legation, to prevent the American Minister from becoming isolated from the outside world when internal disorders are in progress in China. The ordinary communication facilities in China are unreliable under normal conditions and the service is frequently interrupted altogether when disorders are in progress. The Navy's radio station at Peking has afforded the only medium of communication on more than one occasion, not only for the American Minister, but also for the other foreign diplomats in Peking. The Peking station is operated by members of the Marine detachment guarding the American Legation. This station exchanges communications with the high-power station at Cavite, with the flagship of the Asiatic Fleet, with vessels of the Yang Tse Patrol and with the station at Vladivostok.

The Navy took over from the Russian Government the then incompleted radio station at Vladivostok as a result of the dispatch of American troops to Siberia during the war. This station has since been

operated by Naval radio operators under the direction of the Commander-in-Chief of the Asiatic Fleet, and communicates with Cavite, Peking, and Naval and merchant vessels in Asiatic waters. The existing naval radio circuit extends eastward from Vladivostok and Peking through the Philippines, Guam, the Hawaiian Islands, American Samoa, to San Francisco, thence northward along the Pacific Coast to Puget Sound, Washington, and to Alaska; from San Francisco, southward to the Isthmian Canal Zone; from San Francisco through San Diego and across the continent to Washington; from Washington along the Atlantic Coast, the Gulf of Mexico and along the Great Lakes; from Washington southward to the Isthmian Canal Zone and the West Indies; and again from Washington across the Atlantic where contact is made with stations in European countries including the 1,000-KW station established by the Navy at Croix d' Hens, near Bordeaux, France to insure contact with our Expeditionary Forces in the event of the cutting of the transatlantic cables by submarines during the war.

The fact that the aggregate cost of the six successful naval high-power stations was within $1,500,000 is worthy of considerable reflection on the part of commercial companies engaged in building radio stations during the period 1914 to 1917.

The development of the Navy's high-power radio system cannot fairly be reviewed without paying tribute to Rear-Admiral R. S. Griffin, U. S. Navy, now retired, who, as engineer-in-chief of the Navy, was responsible for the building up of the naval radio service during his term as chief of the Bureau of Engineering from 1913 to 1921.

# One Vessel that Radio Might Have Saved

By ORTHERUS GORDON

HOW long will it be before small ship owners will realize that a wireless outfit placed on their sloops and schooners may pay for itself hundreds of times over, on the first voyage? Day after day they are confronted with evidence that ought to convince them of its value, yet they continue to send their barges, their tugs, and their sailing craft down coast without proper means of calling for help should they suddenly need it.

A striking example of what radio might have done toward the saving of property for at least one merchant came to my attention with the sinking of the three-masted schooner *Tarok*, a year and a half ago. At that time, I was on board a large oil tanker going south in ballast. We had experienced rough weather from Cape Hatteras down and learned from passing ships that conditions farther south had been rough and unsettled for some days. The second morning below Hatteras we sighted a small black object one point off the port bow and soon made it out to be a small boat. As we approached it, we saw that there were five people aboard, and that one of them was waving a red tablecloth from the end of a spar. Coming alongside, we hauled them aboard—they were too weak to climb—hoisted their boat clear of the water, and made it fast alongside our port lifeboat. Then, while we continued our journey, we heard the story of the *Tarok*.

Her captain was as bitter as he was weary. He had recommended a thorough overhauling and a spell in dry-dock for his vessel. He had also wanted radio, if nothing more than a small spark transmitter to be run from a storage battery, and a crystal receiving set with which to set his chronometers occasionally, from the Arlington or Key West time signals. He had tried for these, but without success. The owners said the ship didn't need the first thing, and that he didn't need the second. They had told him it was absurd to equip with wireless a vessel that didn't go more than one hundred