Policing *the* Ether Lanes

Uncle Sam spent a quarter of a million dollars for his radio receiver, but it is no ordinary receiver. It reaches out to the ends of the world to check up on the transmitters deviating from assigned frequencies

By Martin Codel

OUT on the Nebraska prairie, not very far from the geographical center of these United States, stands radio's super-policeman—a sort of robot traffic cop of the ethereal wavelengths.

If you should detrain at Grand Island, Nebraska, and travel about seven miles westward along the Lincoln Highway, traversing a level sandy plain unusual for its lack of vegetation, you would come to a turn-off leading for a quarter mile or so to where this robot cop stands his lonely vigil.

Your eyes would behold a few innocent-looking, squat new buildings; all around them, covering 50 acres of the flat lands, they would also see a veritable forest of tall cedar poles looking for all the world like telephone poles but supporting a maze of wires strung in intricate patterns and stretching in all directions. (See Figure 1.)

You are at the standard frequency monitoring station of the Radio Division of the U. S. Department of Commerce. Those buildings and that jungle of wires figuratively constitute America's "policeman of the air." Radio's traffic cop is nothing more than a radio receiving system; but——

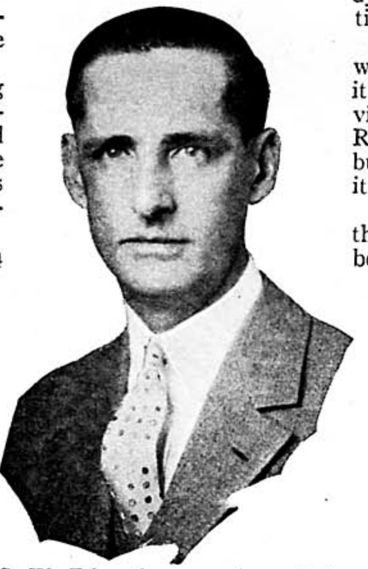
He has probably the most sensitive ears in the world, for there is hardly a radio station anywhere in the world, broadcasting or telegraph, that he cannot hear!

Enter the brick structure labeled "Main Building," Figure 3, and you will see panels and loops and loud speakers and gadgets galore, all shining new, all neatly and precisely arranged, all looking as though they mean business. They do mean business. They are there for a real purpose; otherwise the federal government would hardly have agreed to expend a quarter million dollars or more to have them there.

Over that maze of antenna wires come radio-frequency impulses from every nook on this earth of ours. By means of those instruments, trained men can tune in those impulses and hear what they are saying, whether they sputter forth dots and dashes or speak a native tongue. With those instruments, it is possible to measure to within one part in one million whether the radio frequencies are precise, *i.e.*, whether they are deviating or "wobbling" from their assigned positions in the wavelength spectrum.

Radio's traffic cop bellows forth no orders or abuse. He has a meek little voice, only 750 watts of power behind it, over which he telegraphs his findings by radio to Washington. More frequently he uses the wire telegraphs to inform Washington or to inform the station which he has been measuring. He is exacting as a scientist in his determinations; he is mild as that same scientist in his "human" relations with offenders. They are given every chance to come within standard, to stop wobbling off frequency, to make the ether channels safe for their own travels as well as for others to travel.

The measurement of frequencies according to precision standards fixed by the U. S. Bureau of Standards is, then, the purpose of our "policeman of the air." If you are a DX fan, the monitoring man might let you have a few moments' thrill tuning in—well, Russia's Radio Moscow on the long waves with its constant flow of news and propaganda; that broadcaster in Malabar, Java; a broadcaster out in New Zealand; France's Tour Eiffel; Germany's Koenigwüsterhauser, and code stations all over the world. Or it might be Mukden, up in Manchuria, talking about an earthquake, as it actually happened to be a few months ago. That's easy, the monitoring man will tell you, very easy, if the station is using substantial power on a clear channel. Easier still to hear North American stations—though there has to be a lot of manipulating of antennas to catch the call letters of the stations on channels that are badly heterodyned because they are so crowded with a multiplicity of stations.



S. W. Edwards, supervisor of development and production of the radio division, Department of Commerce

"We haven't gone after any station yet that we haven't been able to receive, at least to catch its call letters," says S. W. Edwards, supervisor of development and production of the Radio Division, the man who conceived and built the government's standard frequency monitoring station at Grand Island.

Glance over the list of stations heard up to the time of this writing, early in February, or before the station had gone into everyday operation, and it looks like a voluminous compilation taken whole from a gazetteer of the world. There are tricks to every trade, and there are certain little tricks whereby this remarkable station can be made to tune in even the stations wanted on the badly heterodyned channels. For measurement purposes, of course; it would hardly do to promise real entertainment on those channels.

The Grand Island development is Edwards' brainchild. He conceived it about five years ago while he was federal radio supervisor at Detroit. With his chief, William D. Terrell, director of the Radio Division, he went to the then Secretary of

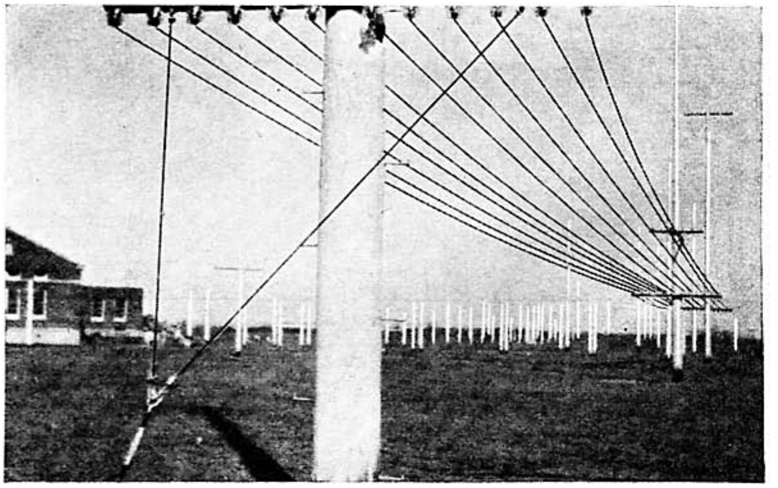


Figure 1. This photograph conveys some idea of the complexity of the antenna systems. The multitude of poles are only a part of those used

Commerce, Mr. Hoover, with the idea. The next step was to enlist the support of the country's leading radio engineers. They were wholeheartedly in favor of the project.

It was decided that the best place for the measuring station would be somewhere out in the Middle West. Extensive field strength tests were made throughout the Corn Belt. Reception conditions were found to be exceptionally good almost everywhere in the prairie regions. It then became a problem of elimination to choose one site over another.

The Grand Island site was chosen because of its central location, the nature of the terrain and the fact that neither radio, telegraph, telephone nor man-made interference were there to cause trouble. Grand Island is just about equidistant by air line between Boston and Los Angeles.

Congress appropriated first $50,000 and then $30,000 for the land, buildings, road and communications lines. Under earlier departmental appropriations, about $200,000 was made available for the equipment for this and a group of secondary standards planned by the division. Fortunately for the government, the Grand Island Chamber of Commerce donated the 50-acre tract. By October, 1930, the plant was ready for operation, except for a delay in the arrival of the two Diesel engines needed for its independent power plant and for the delay in obtaining sufficient personnel to man the station.

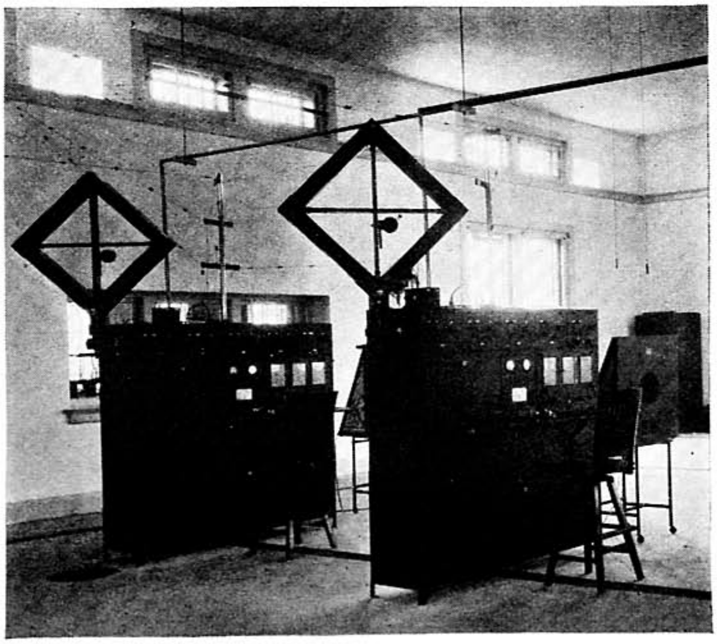


Figure 5. The two 200-3,000 meter receivers with their loops for use in emergencies

The land was surveyed for the antenna layout before the buildings were planned. Eleven different antennas were led out on Great Circle bearings. Four were multiple doublets, each 312 feet long with the doublets in parallel every eight feet to build up bigger voltages. These antennas are not unlike those used by the Radio Corporation of America's long-distance receiving stations at Riverhead, L. I. They are exclusively used for high-frequency (short-wave) receptions and are so placed that their reception effect is directional.

One set of these doubtlet antennas, tuned to the range of from 25 to 75 meters, is pointed toward London and tunes in stations in eastern United States and Europe. The other set, tuned from 65 to 175 meters, is pointed to Porto Alegro, just north of Rio de Janeiro, to take in the continent of South America, all Central America, the West Indies and the southern part of the United States. To hear western United States and Asia on these frequencies, the station depends upon round-the-world impulses.

Two 200-foot single doublets covering the band from 100 to 225 meters and two 150-foot single doublets covering the band from 40-100 meters, non-directive and not as reliable as the multiple, complete the doublet set-up.

Next there is a so-called "general purpose antenna," which simulates as closely as possible conditions under which the average broadcast listener receives. It is tuned to the broadcast band from 200 to 550 meters, although it has considerable overlap.

Then there is a vertical antenna for tuning just below the broadcast band in the upper range of the high frequencies. It consists of a brass tube 65 feet long mounted on 8-inch standoff insulators along the side of one of the 60-foot cedar poles which support all but the long-wave Beverage antenna. The vertical antenna is for general all-around high-frequency reception and ties in with one of the multiple doublets to lessen fading.

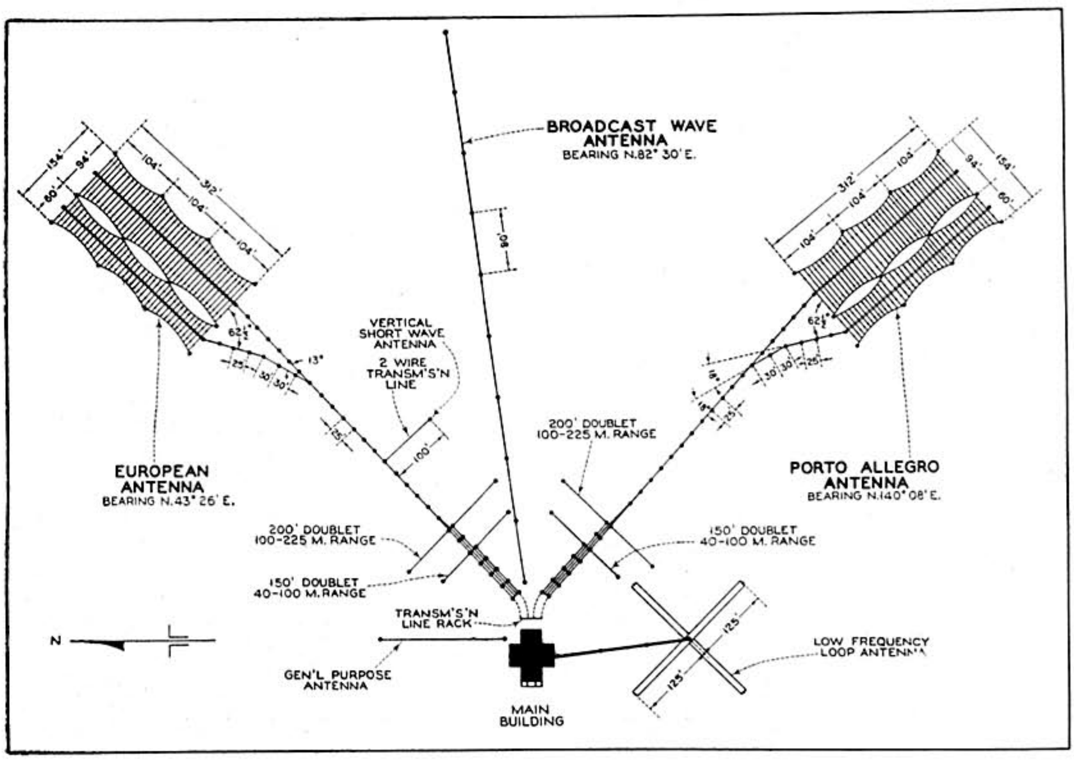


Figure 2. The layout of the antenna systems, which include eleven antennas, four of which are short-wave directional systems, indicated by the grid-like forms at the upper right and left

The eleventh antenna is of the Beverage type, consisting of one single strand of No. 12 hard-drawn copper wire 1440 feet long and running due east from the main building. While constructed for the broadcast band, it also is adapted to receive radio beacon signals on 1000 meters, and the monitor can consistently tune in aviation beacon stations as far away as Bellefonte, Pa., and Oakland, Calif.

Finally, there is the loop antenna, probably the largest of its kind in the world. It consists of two loops at right angles, each 500 feet long and 40 feet high on the sides. They, too, are mounted on 60-foot poles. They can tune the long waves between 3000 and 30,000 meters.

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By an arrangement of the apparatus, the various antennas enable the receivers to tune anywhere in the spectrum between 10 and 30,000 meters, and it is a simple matter of coil arrangement to make them go below 10 meters for the ultra-high frequency development that is now taking place.

These antennas lead into the main building to a transmission line rack in the rear of the building. Thence they go to a lightning arrester rack, each antenna having its own arresters. All of the arresters are connected to ground through a heavy copper strip.

After passing through the lightning arrester, the transmission lines from the antennas lead into the main instrument room as shown in Figures 4 and 5. All lines are transposed to prevent antenna effect, or the picking up of extraneous signals.

There are receivers for each frequency band, and indoor loops to be used in case heavy snows, winds or sleet storms break down the outside antennas. The receivers are built for three frequency bands and the antennas connected accordingly. There are two type C receivers to handle the frequencies from 10 to 200 meters: two B receivers for 200 to 3,000 meters, and one A receiver for 3,000 to 30,000 meters.

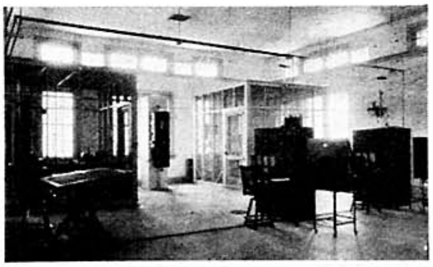
These receivers, built by Westinghouse under specification drawn up by the Department of Commerce, are among the most sensitive in the world, if they are not the most sensitive. They are so constructed that by changing coils they cover wide ranges of frequencies with maximum effect. The A receiver has three stages of tuned r.f., two or untuned r.f., a regenerative detector and a power amplifier; the B receivers have four stages of tuned r.f., a regenerative detector and a power amplifier; and the C receivers have three stages of tuned r.f., using screen-grid tubes, a regenerative detector, a power amplifier and a balanced radio frequency amplifier of two stages put on ahead of the first r.f. stage to heighten the sensitivity and match the impedance of the transmission lines to the impedance of the first r.f. stage.

So much for the technical equipment. A monitoring man sits at each receiver. He tunes throughout the bands, and asks the two men stationed in the measuring booth to measure the frequency of the stations he receives. Their primary standard is obtained from a clock with a seconds pendulum of invar metal, electrically driven and with temperature and vacuum control. This clock, which is checked twice daily against Arlington time signals, is used to ascertain whether a 5,000 cycle tuning fork, the basis of all the measurements, is fast or slow. The tuning fork is then checked against standard frequency transmissions from the U. S. Bureau of Standards.

The booths also contain secondary standards as auxiliary equipment in case 36 radio engineers are required. The accuracy is one part in 100,000.

To maintain 24-hour watches, at least there is trouble with the primary. Their Radio Division was literally begging Congress for the necessary personnel when this was being written; with only six men available early in February, monitoring work at the Grand Island station was almost at a standstill.

Why monitor radio stations? Let Edwards answer: "We have international agreements and national assignments covering wave band allocations and wave length assignments. These agreements are based on scientific needs. Frequencies are reserved and assigned with the object in view of obtaining the best results with the least amount of interference. We all know how badly congested the wave lengths have already become, nationally and internationally. We all know how tremendously important to the commerce of nations radio communications are.



View of monitoring equipment, showing highly sensitive and selective receiving apparatus

"Off frequency operation would be bad for all concerned—the party using a particular frequency no less than the parties on frequencies adjoining. No one gains from interference; everyone stands to lose.

"Nowhere else in the world can accurate checks of frequencies be made in accordance with accepted standards."

For strategic purposes, the Grand Island station has a tremendous military value. For radio intercept work in time of an emergency, it could be called into play to act as the ears of the military. If our diplomats want to know the nature of the propaganda a foreign government may be transmitting via radio, it would be a simple matter to put a shorthand reporter at the receiver. Even in peace time it has a social value other than technical. When the Columbia Broadcasting System wanted to rebroadcast the ceremonies attending the exchange of signatures of the naval disarmament conference last autumn, it was a simple matter for Grand Island to tune in J1AA, Tokyo, and have the Japanese end of the service relayed to the network via the usual telephone lines.

Withal the splendid jobs that are being accomplished at the incomparable Grand Island station, there are greater plans for the future. More and improved antennas will be needed from time to time; right now they could well use some new directional layouts. Several hundred acres more of antenna space will be needed. America's "ear" may be the most sensitive in the world today; but, even that isn't sensitive enough.