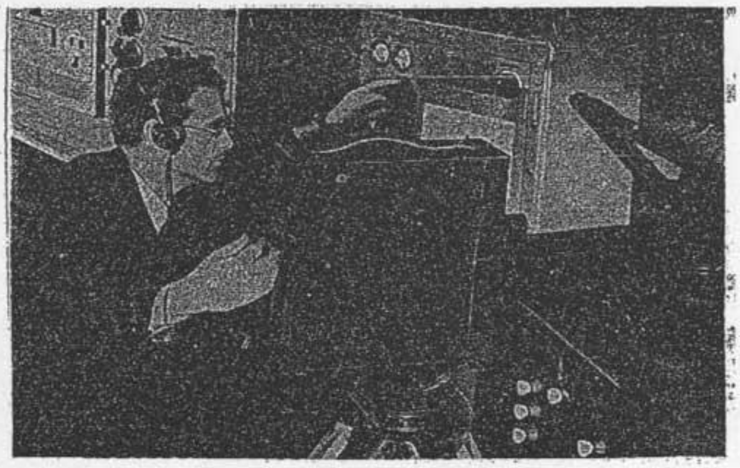
In the Realm of Science: Phenomena of Radio Bring Television Pictures Across the Atlantic

Experts Study Rare Instances Of Reflection

By John J. O'Neill

A feat of radio television increased the 25 mile range of a transmitter a hundred fold a few days ago, and delivered in New York a television picture broadcast in London. A wave which was intended to carry the picture only as far as the eye can reach when standing on a tower in the center of London actually bridged the Atlantic.

It was done "with the aid of mirrors," but in this case the mirrors are electrical reflectors that exist in space far above the earth in the region known as the ionosphere, which is much higher than the stratosphere. The ionosephere is composed of clouds of electrons arranged in layers of variable thicknesses and existing at various heights above the surface of the earth. They surround the earth like the layers of an onion. Most of these layers are a constant factor within certain limits and radio engineers use them to advantage in achieving long distance transmission on short waves.



Dewitt R. Goddard, R. C. A. engineer, filming at Riverhead, Long Island, television broadcast from London.

Comparable to X-Rays

When ultra-short waves are used a new problem comes into the picture because the very short waves go through the electrical ionosphere mirrors instead of being reflected back In this aspect there is about the same difference between the long and the very short radio waves as there is between ordinary light and X-rays. Ordinary light waves are stopped and reflected back by solid objects, making possible our ordinary power of vision, but X-rays go right through dense objects.

For very definite and important technical reasons it is necessary to use ultra-short radio waves for transmitting television by radio. All radio waves travel in straight lines when uniform electrical conditions exist in the space through which they travel. The fact that radio waves travel around the earth is not made possible by the radio waves following a curved path but by the waves being reflected back toward the earth when their straight line path would, if continued, carry them out into space.

Ultra-short waves go right through the reflecting surfaces in the ionosphere that send back the longer waves. The first straight line journey that the ultra-short waves take from the transmitting station is their last one. They usually travel in straight lines to all points as far as the horizon, and may be picked up by receiving sets within that area, or just slightly beyond it, but the first line that passes above the horizon takes the wave into space, and it cannot be received on the surface of the earth.

This is the reason television stations are operated on such a very short wave length compared with ordinary broadcasting stations and why the television programs sent from the antenna on top of the Empire State Building are not received satisfactorily beyond Freeport, L. I., to the east and Morristown, N. J., to the west, both of which are within eyeshot of the tower. All television stations have been planned on this basis of coverage.

Freak Reception Beyond Range

Despite these quasi-optical properties of the ultra-short radio waves, amateur radio experimenters have repeatedly experienced freak reception of messages on these wave lengths far beyond the 25-mile range, with very long distance reception more probable than other shorter distances.

Dr. DeWitt R. Goddard, of the Radio Corporation of America laboratories at Riverhead, L. I., has been studying the propagation of radio waves. He made continuous observations on the wave used by the television station of the British Broadcasting Commission in London, and found that by using particularly sensitive receivers available in his laboratory it was possible to pick up this station. He has done this on many occasions since last fall and this week was able to make public the pictures obtained of the television program he received. He thus received pictures 150 times farther than the range of the station sending them out, the great circle distance from London to New York being 3,400 miles.

The fact that the ultra-short television waves could be received over this distance indicates that there is some mechanism in the ionosphere, or beyond its accepted boundaries, for capturing these waves and sending them back. The pictures received were indistinct and far below any standard that would be considered satisfactory for commercial television, but the mere fact that any television picture could be received over this distance is remarkable.

Goddard's Sunspot Theory

Dr. Goddard worked out a theory that during the years of maximum sunspot activity there would be a greater degree of ionization in the gases of the outer atmosphere of the earth and that the additional clouds of electrons might furnish sufficient reflecting power to capture the ultra-short waves and send them back to the earth. His first tests were made in January, 1937, when the sunspot cycle was at its maximum, and on January 21 of that year succeeded in picking up a faint signal. The pictures were being broadcast on a frequency of 45,000,000 cycles, and the voice on 41,500,000, both of which correspond to seven meters.

Until March of that year the voice wave was picked up with a great deal of clarity on several occasions but no recognizable pictures could be obtained. During the summer all reception on this channel was blotted out. In the fall signals were picked up again. A tuned, diamond-shaped antenna, with directional properties, was installed. This made it possible to get occasional glimpses of the pictures.

"Ghosts" interfered seriously with the success of the experiments. "Ghosts" are extra images of the transmitted subject produced by signals being received over several paths of different lengths. Those that come over longer paths arrive later than those that come over the short paths. The later arrivals are reproduced beside the original in a position that corresponds to the time of their arrival. Since a single horizontal line in a picture is scanned in about one ten-thousandth part of a second, a delay of one fifty-thousandth of a second would cause a displacement of one inch, and even so slight a delay as the millionth part of a second would cause a noticeable "ghost" displaced one-twentieth of an inch from the principal image.

"Ghost From the Palisades"

It is also possible to have "ghosts" produced by reflection of the wave by objects within the broadcasting area. In observations of the signals sent out from the Empire State Building a "ghost from the Palisades" has been repeatedly observed. The vertical wall of rock on the New Jersey side of the Hudson acted as a reflecting surface. The receiving set received its principal image on the direct wave from the Empire State tower and the delayed extra image via the Palisades route. "Ghosts" produced by reflections from airplanes also have been observed. Another annoying source of "ghosts" is the gas tank, its large metal surface providing an excellent reflecting medium.

The reflecting area in the skies reappeared in the fall of 1938 and Dr. Goddard again was able to pick up the London television transmitter. In October he was picking up both voice and picture signals. He then set up a motion picture camera which he synchronized with his television receiver and was able to make a motion picture film of the program. In doing so he made in the New York area a duplicate of the film record which was broadcast in London.

Now that spring is approaching Dr. Goddard expects that the reception will grow weaker steadily and finally disappear. Whether he will be able to pick up the programs again next fall is uncertain. He expects that there will be a few years during the period of sunspot minimum when reception will be impossible due to the lack of the necessary electronic clouds in the upper atmosphere.

Not an Unmixed Blessing

While the reception of television images across the Atlantic is a remarkable achievement, the fact that the short waves may be reflected from the upper ionosphere and can be diverted into a variety of horizontal paths, makes the newly observed properties of these ultra-short waves far from an unmixed blessing. It means interference between stations separated by long distances when television is accorded a practical test this year.

Lieut. Comdr. Lawrence Cockaday, U. S. N. reserve and director of radio research at New York University, who has been investigating raidio wave propagation for years, warned the Federal Radio Commission two years ago that the seven-meter band was not a satisfactory one for television transmission principally because of the reflections from the upper ionosphere which made it possible for him to receive the London broadcasts during the spring and fall.

"Television stations broadcasting on the seven-meter band have an effective service range of about 25 miles and an interference range of between 3,000 and 4,000 miles," Mr. Cockaday said.

Amateurs and experimenters know that the best band for getting long distance reception and transmission on is the seven-meter band, during the fall. At this time of the year the signals can be heard clear round the earth. Yet this is the band which is planned for television reception with a calculated range of 25 miles.

Urged One and a Half Meters

"The best band for television is one and a half meters. Amateurs are now using waves of this length without difficulty. With commercial devices now available they can build transmitters and receivers that work on wave lengths of one-half meter.

"There is not adequate space on the seven-meter band to allow for any extensive development of television, particularly in view of the demonstrated power of long distance waves to interfere with local stations, and I consider it very unwise for the television industry to go before the public on a band which will have to be changed in a short time. It should be started," concluded Mr. Cockaday, "on the one and a half meter band where the space is ample for expansion and where the waves will have more purely optical properties and not be subject to long distance interference."

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Courtesy of John Pinckney