3½ Inch Waves

Twenty miles on a wavelength of 9cm., or about 3½ inches, is predicted by Dr. Mouromtseff and repeated tests have been made where phone and other signals have been clearly received over distances more than a mile apart. Phone conversation on 3½ inch waves is being demonstrated at A "Century of Progress."

I. E. MOUROMTSEFF, Electronic Division Elec.

3½ inch (9 cm.) receiving apparatus, with reflector to concentrate the signals, set up for test. These 3½ inch wavelength signals are not disturbed by atmospheric noises, fogs, sleet, or rain.

● RADIO waves of various lengths are transmitted in quite different manners. Those ranging from extremely long ones of 20,000 meters, down to the ordinary broadcast range around 300 meters, fill out and travel through the space between this world and an upper layer of "ionized" air high above the earth. Radio "short waves," from 100 to 7 meters, such as used by police and radio amateurs, are reflected back and forth between the earth and the upper ionized strata like a beam of light between two long parallel mirrors. Ultra-short waves, or those under 7 meters, travel only in straight lines, their range being essentially limited by the curvature of the earth.

9 Centimeter Waves Demonstrated

In the Westinghouse exhibit at Chicago's "Century of Progress" is probably the first practical equipment ever built for ultra-short wave or "beam" transmission on such a short wavelength as 9 cm (9/100 of 1 meter). Never before, outside of small technical groups, has this scientific advance been demonstrated to the public at large.

Ultra-short radio waves unlike the ordinary variety, will not follow the curvature of the world; will not even, like ordinary "short-waves", be reflected back and forth between the surface of the earth and the mysterious "Heaviside layer" which hangs like a giant reflector, miles up in the sky. Instead, like a runaway locomotive, the ultra-short waves "jump the track," and leave the earth entirely at the first curve, and go shooting off, who knows where, into interplanetary space.

For the present, investigators are aiming at targets closer than radio power; use like a searchlight beam for communication in fog; to signal the approach of icebergs; to project radio paths for aviators to follow. And more interesting still; the use of high frequency to treat disease, for which Westinghouse has supplied a 35-centimeter apparatus. And perhaps, sometime, will come radio power.

Since ultra-short waves travel in straight lines, together with the possibility of focussing and projecting them at a distance in narrow beams by means of parabolic reflectors, similar to those used for searchlights, suggested for them the name "quasi-optical," which signifies "like-optical."

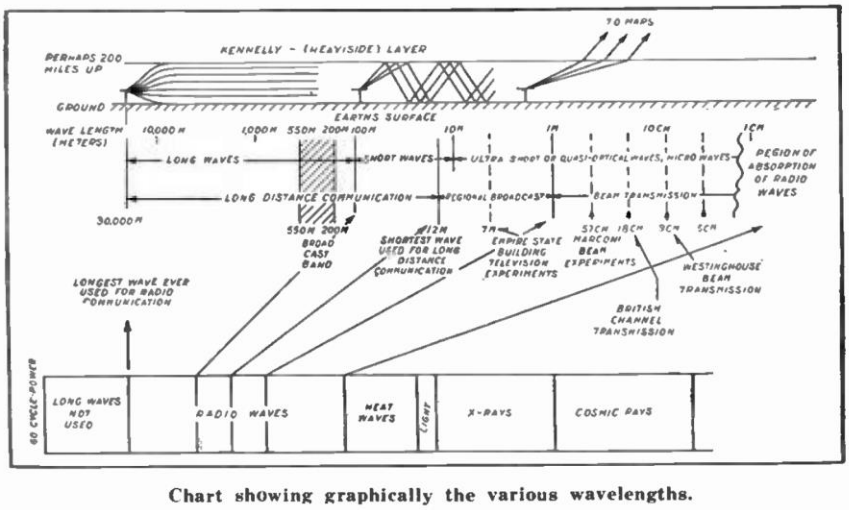


Chart showing graphically the various wavelengths.

Vital Uses for Ultra Short Waves

From the basic properties of quasi-optical waves, it is clear that they cannot be used for "long distance" communication. But whenever communication, or signalling must be established between the points "directly seen" to each other, quasi-optical waves possess considerable advantage, both over visual light signals and over regular radio waves. When used instead of, or parallel with, light beacons, they surpass them in the ability of penetrating through fog, mist, rain and similar atmospheric obstacles, because they are neither absorbed, nor scattered even by the heaviest cloudhurst. In addition, quasi-optical waves allow voice and sound communication. Also, unlike light signals, the same apparatus can be used day and night with equal convenience. In contrast to the longer radio waves, quasi-optical waves can be efficiently projected in narrow beams without building costly directive antenna arrays; require insignificant power; are not disturbed by atmospheric noises; and bring about a considerable degree of secrecy of communication. In addition, being sharply limited in range by the curvature of the earth, quasi-optical waves allow for sharply defined regional broadcasting. They are also very suitable for television carrier, because they can easily be modulated by frequencies of several hundred kilocycles; this also allows for simultaneous modulation by several broadcast frequencies, thus increasing the efficiency of communication on a quasi-optical beam. Generally quasi-optical beams are very suitable in numerous cases of sea and air navigation and for military purposes, even to their use on the battlefield, in trenches.

Increasing the Range of U. S. W's.

Due to the rectilinear propagation, quasi-optical waves, as has already been mentioned, have a very small range limited by the distance of "direct vision," or essentially by the geographical horizon. This usually does not exceed a few miles. However, one can increase the reach of a beam if the transmitter, or the receiver, or both, be raised above the ground, the higher the better. This simultaneously contributes to the elimination of absorption and field distortion due to the proximity of the ground. Therefore, the tops of high buildings, towers, the hilltops, or an elevated seashore will be the most suitable locations for quasi-optical beam stations. Houses, trees and other intervening objects between a transmitting and receiving station can absorb and dissipate en-

Now Practical

Wherever signalling must be established between two points "directly seen" to each other, these quasi-optical waves show considerable advantage over light signals and radio waves of ordinary length; the ultra short-waves surpass these older mediums in their ability to penetrate through fog, mist or rain.

Research Laboratories, Westinghouse Mfg. Co.

"Beamcasting" on 3½ inch waves. During trials of this apparatus at East Pittsburgh, speech and music were transmitted over one mile and reception is believed possible over 20 miles.

ergy of a beam, and therefore, must be avoided.

3½ Inch Waves Pierce Rain and Fog

A very important factor, emphasizing the usefulness of quasi-optical waves, is their ability to pierce such obstacles as fog, rain, and so on, which are sometimes completely opaque to the most powerful beams of light. In this respect, some calculations show that radio waves about 5 cm actually are not in the least affected by the atmospheric barriers; however, below this limit, absorption increases very rapidly, so that waves of two or three centimeters cannot be used at all for practical purposes. On the other hand, the shorter the waves, the easier and more efficient is the construction of the optical part of the beam transmission equipment, because the smaller are the reflectors and the sharper is the beam. The problem is: how to generate such extremely short waves. Fortunately, the absorption limit, 5 cm, almost coincides with the shortest waves which actually can be generated by means of vacuum tubes.

20 Mile Range

At the *Century of Progress*, the "beamcasting" demonstration is made from one end of the Westinghouse exhibit's long curved balcony to the other end, a distance of several hundred feet. However, the apparatus has been successfully tested many times at Pittsburgh between points more than a mile apart. There is every indication that it can be successfully used between points located *20 miles and more apart!*

That the radio waves have the straight line characteristics of light rays was shown in the demonstration in which the radio waves from the sender are reflected off a flat sheet of material to the beamcaster's receiver, just as light rays are reflected by a flat mirror or shiny surface.

The rays can be deflected by any flat material placed directly in the path of the beam. Metals reflect the radio beams almost completely, while non-metallic substances absorb part of the energy. Part of the demonstration was devoted to showing the degree of absorption of various materials such as asbestos board, wood and cardboard.

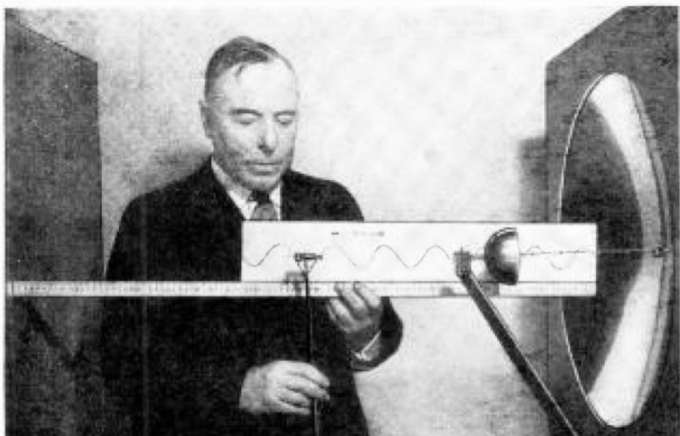
Our engineers have so developed their transmitter that the radio waves are polarized horizontally. A screen, consisting of wires, about three to the inch and running parallel to the direction of polarization, when placed in front of the beam, does not allow the waves to pass through it, but reflects them just as a solid sheet of metal does. However, when the wires are placed at right angles to the direction of polarization, the rays pass through unhindered.

Direct Measurement of the Wave

One of the most interesting points in the demonstration was a direct measurement of the wavelength. A metal sheet, placed in front of the transmitter, combined the direct and reflected waves into standing waves. At certain points along the beam, no oscillation can be detected while other points have a maximum oscillation, or the distance between two adjacent points of minimum oscillation or between two adjacent maximum points is exactly half the wave length—or four and one-half centimeters, slightly less than two inches. A metric rule is used to show this measurement.

Power generated in the "beamcaster" at the nine-centimeter wavelength approximates one watt and has never been approached by any other generator at such a low wavelength. It even exceeds the power used in short-wave transmission at 18 centimeter (7 inch) wavelength across the English channel.

(Continued on page 299)



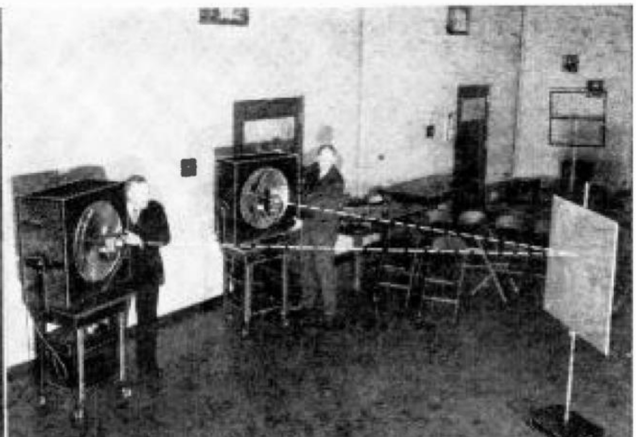


Illustration above at left shows S. M. Kintner, vice-president of the Westinghouse Company, in charge of engineering, actually measuring the length of a 9.1 cm. wave on a rule. Photo at right shows how these ultra short-waves can be deflected like light by flat material. Metal reflects the beam almost completely, while other material like asbestos board, wood, etc., absorb some of the energy.