RADIO

Fighting Radio's Bugaboos

Through Use of Ultra-Short Waves, Static and Fading May Be Overcome and Messages Carried to Distant Planets

By J. W. YOUNG

A WORLD that sometimes receives news of technical developments with bored unconcern is on tiptoe to learn more about a new kind of radio now the subject of intensive research in laboratories of both America and Europe. Occasionally brief demonstrations of the new apparatus are given, and for days thereafter the papers tell how radio energy has been focused as if it were from a searchlight and sent with the consumption of an extremely small amount of power in a straight line to a receiver some miles distant.

It is not generally realized that these demonstrations may herald the day when radio will be free of its two greatest bugaboos, static and fading, when television will become as commonplace in the home as sound radio is now, when even our nearest planetary neighbors, Mars and Venus, will be reached from the earth by radio signals just as continents on our globe are joined together today.

Strange Capabilities

The basis for these views into the future tells the story of the rise of ultra-short wave radio and the strange things that scientists have found these previously neglected radio waves capable of doing.

In the beginning of radio broadcasting the wavelengths then considered most choice—from about 200 to 500 meters—were set aside for stations broadcasting entertainment, and they continue to be used for that purpose. The thousands of radio amateurs who had been free to use these wavelengths were pushed down the scale to the "worthless" bands below 200 meters.

As might have happened in a story book, appearances soon proved deceptive. The amateurs began to do wonders with their "worthless" strip of electromagnetic vibration. They learned how to talk to friends on the other side of the world with less power than a broadcasting station uses to send its program a score of miles. They even heard their signals echo back after circling the earth several times.

While amateurs worked largely by inductive experimentation, commercial interests were busy applying the deductive methods of research to the lower wavelengths and soon they began to link the continents for long distance radio telephone communication by using wavelengths well below the 200-meter mark.

Research is continuing to tear the veil from that part of the electro-magnetic spectrum between radio waves and heat waves, revealing more clearly than ever before the fact that all radiations are of the same kind—from those of powerful long wave wireless stations like the U. S. Navy transmitter at Arlington, Va., down through radio broadcast waves, heat waves of a hot iron, light rays from the sun, and X-rays of medical and industrial use, even unto the cosmic radiation from outer space. The difference is only a matter of the length of the vibration.

But what a great difference there can be in wavelength, even in that comparatively narrow band of the spectrum which includes the radio waves! The U. S. Navy is planning stations that will put on the air waves longer than 25 miles. A common length for a wave from a broadcasting station is six hundred feet. You can talk to Europe from your telephone on waves as short as 42 feet. At about this length, radio waves become more interesting. From a length of thirty feet, or about ten meters, down to .0008 of a millimeter, scientists call them ultra-short radio waves.

Use of the term, wavelength, to locate radiations or radio energy on the spectrum has been given up for many purposes in favor of the measurement of frequency by the unit, kilocycles, in which the dials of home radio sets are now calibrated. As wavelength increases, frequency decreases, for, since the speed at which the waves travel remains the same, it takes a long wave longer to pass a fixed point than a short one.

Ultra-short radio radiations do not act as good radio waves should nor are they well-behaved heat waves, the form of radiation of next shortest wavelength. They combine properties of both. These waves are the scientific curiosities that hold so much in store for tomorrow. Their relatives farther down the spectrum are also interesting.

Next to heat or infra-red waves, which blend into and overlap the shortest radio waves, are light waves, the longest being red and the shortest violet. Beyond the short violet rays are the invisible, but photographically active ultra-violet rays. X-rays, of medical fame, and then gamma rays follow. Last in the electro-magnetic spectrum, one school of thought has already placed the recently discovered cosmic rays whose source we do not know. The longest of these rays are said to have a wavelength of only one quadrillionth of a centimeter. A centimeter is less than half an inch.

Can be Focused

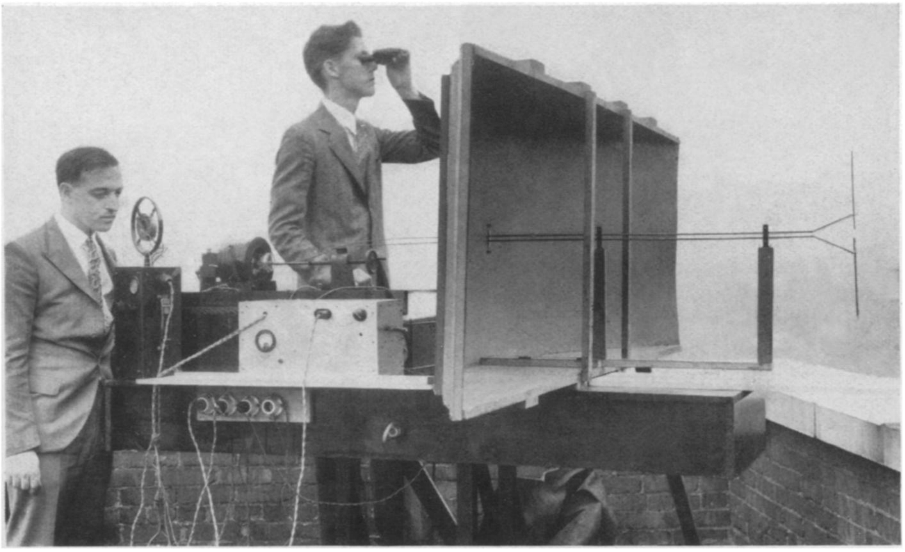
Among such a weird collection of relatives, it does not seem so surprising to find stunted radio waves with peculiar habits.

Since they are between radio waves and heat waves, they act very much as both these neighbors do, hence the name quasi-optical has been applied to them. The shorter ones can actually be focused by lens and reflected by mirrors. For best results in focusing, the mirror must have a diameter several times the length of the wave.

Such focusing makes possible the concentration of greater radio energy than has been possible previously, but, in spite of the great amount of power that is brought together in such a small space these waves cannot be sent long distances over the surface of the earth—not without repeater stations or reflectors placed about every 100 miles.

Since they can be reflected and focused they can be made to travel in a straight line. The resulting "searchlight" beam of radio energy, refuses to follow the curvature of the earth, as do longer waves sent out by present broadcasting methods, but goes shooting off into space as soon as it has passed the curve of the horizon.

Consequently the range is limited by the finding of two points between which a straight line can be drawn. If the apparatus is taken to the tops of tall buildings or put on mountain peaks this distance may be as much as 100 miles. Marconi, the radio pioneer, has already given demonstrations with waves of this kind over distances of 25 miles.



AIMING ETHEREAL MESSAGE

The curved metal sheet is a reflector that focuses short wave radio energy as if it were a beam of light. This apparatus is being used experimentally by the Westinghouse Company, one of the many organizations pioneering in the new field.

Conversation has been sent across the English channel on a wave only seven inches long. The aerial was three-quarters of an inch long and the power used only sufficient to light a small flashlight bulb. The aerial was placed at the focal point of specially shaped metal reflectors, 10 feet in diameter, which gathered the radio energy into a narrow beam as if it were the light from a brilliant bulb and aimed it at a similar receiving mirror on the other side of the channel.

If the beam is made very narrow it must be aimed carefully at the receiving mirror. Only a receiving station in the direct path of the beam is able to hear its message—an advantage of secrecy that will be valuable in war.

Because these ultra-short waves travel in a straight line between the sender and receiver and keep away from the variable electrified atmosphere far above the surface of the earth, the well-known Kennelly-Heaviside layer, they stay practically free of fading and static. The ionized gases about 50 or more miles above the earth reflect from a rough undersurface most of the waves that reach it and have come to be blamed largely for the two bugaboos of radio.

Radio engineers have noticed that only occasionally are waves below 30 feet in length reflected back to earth from the Kennelly-Heaviside layer. These waves must, it is thought, travel on into outer space.

Dr. I. E. Mouromtseff, research engineer who has been directing the experimental short-wave work for the Westinghouse Company, suggests that knowledge of these waves, which apparently pass on through the ionized gases, brings the earth a step nearer to communication with neighboring planets. The first radio transmitter to Mars would simply be a powerful short wave sender having its huge parabolic reflector directed heavenward.

"We are certain," Dr. Mouromtseff explains, "not only that heat and light waves can penetrate something like the Kennelly-Heaviside layer, but that all radio or 'dark light' waves less than seven meters long will penetrate that layer and leave the earth.

May Reach Mars

"It is conceivable," he continues, "that the power we have succeeded in getting into 42-centimeter beams we have worked with is sufficient to pierce the Kennelly-Heaviside layer and travel 35,000,000 miles to Mars. It is possible that such small power may carry to such great distances because of the fact that practically all intervening space is really a high vacuum and does not, therefore, absorb the waves, once they get through the earth's atmosphere."

Though they will not be absorbed in outer space, quasi-optical waves disappear and weaken strangely on the surface of the earth among familiar objects which have dimensions very nearly the same as the length of the waves.

When radio is installed on a train between engine and caboose care must be taken to see that the proper wave length is used, Eduard Karplus, engineer for the General Radio Company, points out. The wave used must be shorter than the diameter of tunnels, or the radio will not work while the train is underground. Yet if the wave chosen is so short that its radiations are very directive, train communication will be interrupted by curved tunnels.

Mr. Karplus also gives interesting facts about the ability of quasi-optical waves to pentrate rain and fog. Humidity, rain and fog have no effect on waves down to five centimeters in length, he says. But below five centimeters they are weakened by the humidity of the atmosphere and even by the amount of carbon dioxide in the air.

Surprisingly, there is a short portion of the quasi-optical spectrum whose waves radiate such a small amount of energy into the atmosphere that they have not been found useful for communication. They are absorbed and scattered in the immediate vicinity of the transmitter, Mr. Karplus says. Radiation useful for communication starts again at the shorter heat or infra-red waves and in the light range.

Interesting methods of sending sound by light are being devised. Music has been sent 3,000 feet across the Hudson river at New York on a narrow beam of neon light by engineers of the General Electric Company. Dr. E. W. F. Alexanderson of the same company modulates electrical impulses from sound into high frequencies on a light beam from a high intensity arc and picks up this talking light with a photoelectric cell. He suggests as a radio aerial of the future, a powerful arc light mounted upon the top of a tall building.

"Light broadcasting may have the same relation to radio broadcasting that the local newspaper has to the national newspaper," Dr. Alexanderson suggests. "These light waves can be received only at relatively short distances, perhaps ten miles. Each community could then have its own light broadcasting system."

In company with other scientists, Dr. Alexanderson sees in short waves that travel in a straight line a solution to one of television's most important problems. The greatest difficulty in television today, he believes, lies in the method of transmission. Radio waves usually follow several paths in traveling from the transmitter to the receiving station. Each ray following a different path produces a different image so that a composite image is apt to be blurred. For this reason television has been tending toward the shorter waves.

Science News Letter, April 16, 1932