



In this, ALL's third advertisement in the new IRE series, we are continuing our policy of presenting engineers not with sales material but with information. This month's article gives a new slant to an old adage, with data which proves that hearing is believing.

An Observation on the Detection by the Ear of Microwave Signals

Back around 1947 several of us at ALL were working on the antenna of a large ground radar, when we noticed an interesting phenomenon that does not seem to be generally known. We found that it was possible to hear the repetition rate of the radar when we were standing close to the antenna horn. It became obvious from simple tests that the sound was produced in the head without any direct acoustic input.

The radar was operating at about 1300 mc with a peak power of about one half megawatt. The pulse length was 2 microseconds and the prf was 600 cycles. An audible response was obtained up to about five or six feet away from, and directly in front of, the horn. When we told this story to others in the Lab, it was received with much skepticism and rather pointed questions about our mental health. The radar antenna was located on top of a 75 foot tower, so that some of the critics were easily silenced with an invitation to see (or hear) for themselves. We did persuade a dozen or more people, including two of the Laboratory medical doctors, to make the sacrifice, and everyone else heard the phenomenon except for one man who is deaf. This fellow wore a bone conduction hearing aid and we did not find out what form of deafness he suffered.

An attempt was made to determine roughly the place on the head which was most sensitive. With a cylindrical shield can with a round

hole in the side, about $\frac{1}{4}$ wavelength in diameter, we could crudely localize the field in the head. The areas of maximum sensitivity were found to be the sides of the head at a point about midway between the ears and eyes, and somewhat above them.

At the time, we were rather excited about this discovery since we wondered whether we had found a new way of stimulating the sense of hearing without an acoustic input. Of course, we were well familiar with the old stories about the fillings in the teeth of the fellows who claimed they could hear broadcast stations, but we never believed these tales. We contacted an officer of the Acoustical Society, thinking that an important paper could be prepared, but we were told that though possibly novel in detail this effect probably was not significantly new. We therefore got busy on other things and forgot about the whole matter.

ALL now has a Department of Medical and Biological Physics and they heard about this story recently. We therefore had to prove our assertions, and so we tried the experiment again with essentially the same results. We were more cautious this time, however, since we are familiar with the work that has been done on the formation of cataracts in the eye due to microwave radiation. We found that we could obtain audible response at power levels below the levels which are supposedly dangerous, for short exposures. However, since we should

assume that not too much is known about the dangers, we feel we must be extremely cautious.

It is interesting to note that the sounds heard appear to have mostly high frequency components and not very much fundamental. In testing several different people, it was found that two persons whose ear responses cut off at about 5 kc had much less response to the signal than those observers whose ears responded to at least 15 kc. Since the spectrum of the pulse consists of harmonics spaced 600 cycles apart, with essentially equal amplitude through the audio range, it may be expected that the person who can hear up to 15 kc will receive more power than the person who cuts off at 5 kc.

Undoubtedly there must be some persons among our readers who have experienced this phenomenon, and we invite correspondence from anyone who can shed some light on this effect. However, we strongly urge against any further experimentation on this phenomenon except by persons who are thoroughly familiar with the risks involved. According to Williams,* exposure of the head to power levels as low as 0.5 watts/cm² for ten minutes can produce cataracts of the eyes. Before anyone rushes off to put his head in front of an antenna, he should read this paper, measure the power density in the field, and use a large safety factor.

We invite correspondence from anyone who has noticed this effect or has a reasonable explanation to offer. Letters should be addressed to Walter Tolles or William Horvath, Department of Medical and Biological Physics.

*D. B. Williams, et al.: Production of Lens Opacities by Microwaves. IRE Transactions on Medical Electronics, PGME-4, p17, February 1956.

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