the head, no matter how the subject twists or rotates in the rf field.

Our early experimentation, performed using transmitters with very short square pulses and high pulse-repetition rates, seemed to indicate that we were dealing with harmonics of the PRF. However, our later work has indicated that this is not the case; rather, the rf sound appears to be the incidental modulation envelope on each pulse, as shown in Fig. 1.

Some difficulty was experienced when the subjects tried to match the rf sound to ordinary audio. They reported that it was not possible to satisfactorily match the rf sound to a sine wave or to white noise. An audio amplifier was connected to a variable bandpass filter and pulsed by the transmitter pulsing mechanism. The subjects, when allowed to control the filter, reported a fairly satisfactory match. The subjects were fairly well satisfied when all frequencies below 5-kc audio were eliminated and the high-frequency audio was extended as much as possible. There was, however, always a demand for more high-frequency components. Since our tweeter has a rather good high-frequency response, it is possible that we have shown an analogue of the visual phenomenon in which people see farther into the ultraviolet range when the lens is eliminated from the eye. In other words, this may be a demonstration that the mechanical transmission system of the ossicles cannot respond to as high a frequency as the rest of the auditory system. Since the rf bypasses the ossicle system and the audio given the subject for matching does not, this may explain the dissatisfaction of our subjects in their matching.

At one time in our experimentation with deaf subjects, there seemed to be a clear relationship between the ability to hear audio above 5 kc and the ability to hear rf sounds. If a subject could hear above 5 kc, either by bone or air conduction, then he could hear the rf sounds. For example, the threshold of the subject whose audiogram appears in Fig. 2 was the same average power density as our normal subjects. Recently, however, we have found people with a notch around 5 kc who do not perceive the rf sound generated by at least one of our transmitters.

THRESHOLDS

As shown in Table 1, we have used a fairly wide range of transmitter parameters. We are currently experimenting with transmitters that radiate energy at frequencies below 425 mc, and are using different types of modulation, e.g., pulse-repetition rates as low as 3 and 4/sec.

In the experimentation reported in this section, the ordinary noise level was 70–90 db (measured with a General Radio Co. model 1551-B sound-level meter). In order to minimize the rf energy used in the experimentation, subjects wore Flent antinoise ear stopples whenever measurements were made. The ordinary noise attenuation of the Flents is indicated in Fig. 3. Although the rf sounds can be heard without the use of Flents, even

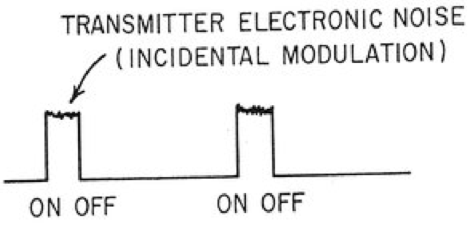

FIG. 1. Oscilloscope representation of transmitter output over time (pulse-modulated).

TABLE 1. *Transmitter parameters*

Transmitter	Frequency, mc	Wavelength, cm	Pulse Width, μsec	Pulses/Sec	Duty Cycle
A	1,310	22.9	6	244	.0015
B	2,982	10.4	1	400	.0004
C	425	70.6	125	27	.0038
D	425	70.6	250	27	.007
E	425	70.6	500	27	.014
F	425	70.6	1000	27	.028
G	425	70.6	2000	27	.056
H	8,900	3.4	2.5	400	.001

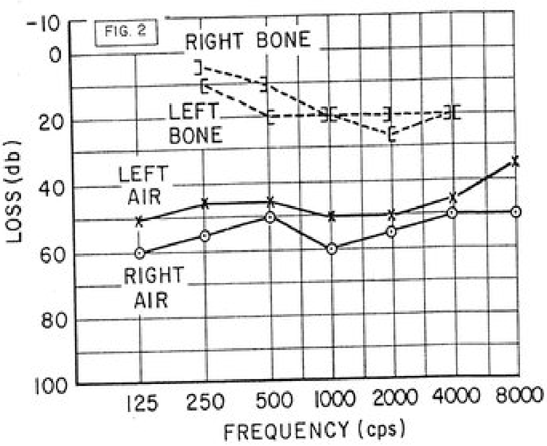

FIG. 2. Audiogram of deaf subject (otosclerosis) who had a "normal" rf sound threshold.

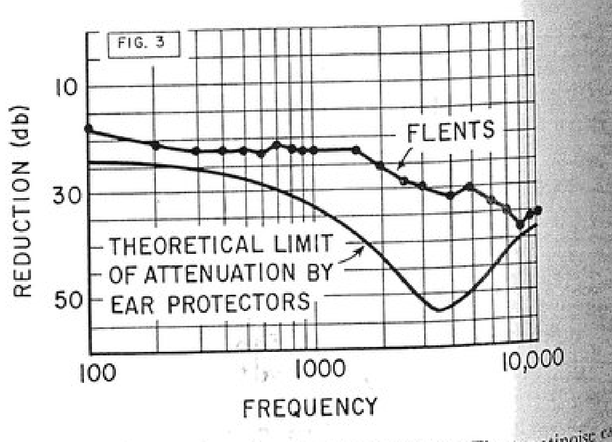

FIG. 3. Attenuation of ambient sound with Flent antinoise ear stopples (collated from Zwislocki (3) and Von Gierke (4).