the cochlea. There were also speculations that pulsed microwaves, unlike conventional acoustic inputs, might act directly on the central nervous system [2] since earlier investigations failed to observe any cochlear microphonic activities. More recently Chou, et al. [7] has recorded 50 KHz oscillations from the round window of guinea pigs during 918 MHz pulsed microwave irradiation. These oscillations promptly followed the stimulus, preceded the nerve responses, and disappeared with death. It may, therefore, be concluded that a microwave induced hearing phenomenon is the cochlear response to acoustic signals generated by microwave pulses.

The questions of where and how the electroacoustical transduction occurs, however, have not been satisfactorily answered. Several physical mechanisms have been advanced for the conversion of microwave to acoustic energies including radiation pressure, electrostriction and thermal expansion [4,5,6]. A comparison of these three mechanisms for planar geometries reveals that the thermal expansion is the most probable mechanism since pressures generated by thermal expansion may be one thousand or more times greater than by the other possible mechanisms [10].

This paper investigates the frequency, displacement and pressure of the sound generated in the heads of man and animals exposed to pulsed microwave radiation. We assume that the auditory effect arises from the rapid temperature rise in the brain as a result of microwave absorption. Because this temperature rise occurs in a very short time, it creates thermal expansion of the brain material and launches the acoustic signal detected by the cochlea through bone conduction.

We consider the head to be perfectly spherical and consisting only of brain material. The impinging radiation is assumed to be a plane wave of pulsed microwave energy. Our approach is to first obtain the absorbed microwave pattern inside the head. The accompanying temperature distribution is then derived, and finally the equation of motion is solved for the acoustic wave generated in the head.

ABSORBED MICROWAVE ENERGY

Let us consider a homogeneous spherical model of the head exposed to a plane wave of pulsed microwave energy. The absorbed microwave energy I (r,t) at any point inside the head is given by

$$I(r,t) = \frac{1}{2} \sigma |\bar{E}|^2 \tag{1}$$

where σ is the electrical conductivity of brain material. The induced electric field $\bar{E}$ is given by

$$\bar{E} = E_o e^{-i\omega t} \sum_{j=1}^{\infty} i^j \frac{2j+1}{j(j+1)} [a_j \bar{M}_{olj} - i b_j \bar{N}_{elj}] \tag{2}$$

where E_o is the incident electric field strength, $\omega = 2\pi f$, f is frequency, a_j and b_j are magnetic and electric oscillations, respectively, and $\bar{M}$ and $\bar{N}$ are vector spherical wave functions. A derivation of equation (2) may be found in [11]; the detailed expressions are also given in [12].

For small animals such as cats exposed to 2450 MHz, and for humans exposed to 918 MHz radiation, the absorbed energy distributions inside the head computed using equations (1) and (2) show absorption peaks in the center of the head [13]. Plots of the absorbed energy distribution along the three rectangular coordinate axes of a 3.0 cm radius spherical head exposed to 2450 MHz and