AVIATION NOISE DEAFNESS AND ITS PREVENTION

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NOISE is one of the features of uncontrolled development in a mechanical age—an undesired by-product of the machines which are employed for industrial and war operations. Noise as it affects Air Force personnel arises from the engine and propellers used in modern aircraft. The ill-effects of it have become apparent since the introduction of enclosed cockpits in multi-engined aircraft and the discarding whenever possible by pilots and crews of the flying helmet. In some instances resort has been made to various forms of ear plugs, but these either on account of construction or unsuitability cause discomfort and/or fail to afford the required protection.

Since the introduction of audiometry, studies made by different observers have helped to crystallize the clinical entity of acoustic trauma. Many types of sound stimuli are known to be injurious to the ear, but my interest has been mainly confined to those arising from exposure to aeroplane noise. The intensity level of such noises is in the region of 120-130 phons. In connection with flying it arises chiefly from three sources, namely, the engine, the propeller (mainly from the tips of the blades where the velocity is greatest) and the wind (slipstream).

Observations extending over a prolonged period have shown that in a healthy person without history or evidence of aural disease and whose history does not suggest damage by drugs or severe constitutional disease or familial deafness but reveals exposure to noise of an intensity such as I mentioned, a high tone loss must be suspected to represent the effects of acoustic trauma.

It is now generally accepted that the first evidence of such trauma manifests itself as a dip localized to 4,096 cycles per second both for air and bone conduction without involvement of frequency below or above this level, when a 6A Western Electric Audiometer is used. This drop may be restricted at

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first for some time at this frequency, but repeated and continuous exposure to noise may involve frequencies below this level. The individual may be unaware of any auditory defect and probably notices no disability so long as this loss is restricted to 4,096 cycles per second and is not very marked. Involvement, however, of lower frequencies such as 2,048 or 1,024 cycles per second will constitute a definite impairment of hearing. Results of hearing tests for speech confirm audiometric findings. Mistakes in hearing the spoken word often occur when accurate interpretation depends upon the ability to recognize consonants whose essential characteristics are highness in frequency and weakness in intensity. For example with a 50-60 decibel loss at 4,096 cycles per second, the candidate has difficulty in hearing words like sister, solicitor, etc., from a distance of 20 ft. with a forced whisper whereas he can hear low-pitched words quite easily.

The factors which influence the degree of hearing loss from acoustic trauma are :

(1) The total time of exposure. Individual ears respond in different ways. I have seen a dip at 4,096 cycles after 100 hours' exposure to aeroplane noise and again have seen only a slight localized drop after exposure for some years.

(2) The length of exposure at each period. The ears can recover with a rest at first but become permanently damaged if exposure continues.

(3) Loud sounds only cause damage.

(4) The character of the sound stimulus, whether continuous or interrupted.

(5) The type of protection adopted.

(6) The surroundings, whether in enclosed or open spaces. A smooth concrete wall will reflect 96 per cent. of the acoustic energy striking it.

(7) Previous disease. Previously damaged ears are more susceptible to acoustic trauma than normal ones.

The relation of the frequency to the resultant trauma is not clearly understood. Exposure of the ear to noise of pure tones of 512, 1,024, 2,048, 4,096 cycles per second show a maximum dip an octave above the frequency of the fatiguing note and not at the frequency of the fatiguing note. The common threshold curve with a 4,096 dip was not obtained for a series of tones of an approximate uniform intensity used to produce acoustic trauma. Subjects exposed to a fatiguing note of

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2,048 cycles per second showed a localized dip at 4,096. Sounds of low frequency (64-256) produce less acoustic trauma, and certainly no dip at 4,096, than those of high frequency and of approximately equal intensity.

On the other hand analysis of aeroplane noise by means at our disposal has shown that the frequencies of the highest intensity 110-115 db. are at the low end of the acoustic spectrum. Thus it would suggest that a low tone was causing a high tone deafness. Explanation is not clear and I believe that when dealing with a complex noise of high overall intensity, damage is inflicted by the excessive sound pressure on the most susceptible part of the cochlea, that is the basal coil. This by virtue of its situation may probably bear the brunt of the insult.

It is also possible that sudden instantaneous peaks of high intensity, which are not recorded by instruments at our disposal, may occur at 2,048 cycles per second at frequent intervals and thus be responsible for the dip at 4,096 cycles per second. Lastly the external auditory meatus which, as Littler has shown, has in its normal condition a characteristic natural period, may act as a resonator intensifying a frequency in a complex sound in the region of 3,000 cycles per second and thus cause a dip at 4,096 cycles per second.

As to the methods of protection so far as flying personnel is concerned in the Royal Air Force, the wearing of a flying helmet with telephones attached affords the fullest protection. Tests have shown that the characteristic dip at 4,096 cycles per second after exposure to noise does not occur. The other appliances such as ear plugs, plasticine, etc., afford a certain amount of protection, but it must be realized that if full protection against the effects of noise is provided by such appliances, intelligibility of speech becomes greatly reduced. They are, therefore, impracticable from the flying point of view where the use of telecommunication becomes necessary. It is comparatively easy by such means to reduce or damp down the high-pitched tones, and if as recent experiments have demonstrated, high notes of high intensity cause more damage than low ones of the same intensity this may explain the success obtained in protecting ears against the injurious effects of noise by the wearing of a helmet with telephones attached.

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