INTRODUCTION

Sound is a part and parcel of our daily life. It allows verbal communication between people. It offers pleasure in listening to music. It also alerts us with a knock on the door. Its quality evaluations enable a physician to diagnose heart diseases, or permeates an automobile mechanic to detect defects in the engine.

Yet, sound sometimes annoys us. How much a sound annoys depends not only on its quality, but also how we look to it. For example, a melody from a radio may be pleasant to one person, but will be a nuisance to another staying next door. Or, the sound of the jet taking off may be music to the pilot, but will be heart-breaking and resentful to the nearby residents. When sound becomes unwanted, it becomes a NOISE. Sound need not necessarily be loud to be annoying. A scratch in the record is enough to annoy a person as much as does a loud thunder. But problem arises when sound damages the most sensitive instrument of the human-being - "the ear".

Hearing

The human ear consists of levers, diaphragms, canals, membranes and hair cells; hence it can detect sound over a wide range of intensities (the loudest can be ten billion times intense as the softest) and frequencies (the highest almost thousand times greater than the lowest, 20 to 20,000
cycles/second (Webb, 1976). The threshold of hearing for a young person between 100 Hz and 4000 Hz is approximately 0 dB, which corresponds to a sound pressure of $2 \times 10^{-5} \text{N/m}^2$ (Webb, 1976). Above and below the frequency limits mentioned of 1000 Hz and 4000 Hz, the sound intensities of the threshold of hearing change (Webb, 1976). The maximum intensity to which an unprotected ear should be subjected is 135 dB (Eldred, Gannon & Von Grieska, 1959), and that levels as low as 80 dB may produce some loss (Glorig & Nixon, 1960). Threshold of pain is generally considered to begin at 120 dB (Webb, 1976). WHO suggests that sound at 75 dB is 'moderately loud', at 95 dB it is 'very loud', at 120 dB it is 'uncomfortably loud', and at 140 dB sound becomes 'painfully loud'.

Factors other than noise affecting hearing: Blow in the head or explosive blasts near the ear may rupture the ear drum, damage the hair cells or dislocate the ossicular chain. Disease can affect the middle ear or destroy the nerve hair cells in cochlea. Wax or even foreign bodies can cause hearing loss by blocking the auditory canal or rupturing the drum. Drugs like quinine or streptomycin can cause burns of the inner ear and deafness. Hearing loss may also occur due to ageing.

Industrial noise affecting hearing: Today, the spectrum of industrial houses is increasing and there is hardly any such establishment not producing noise, be it a wide band,
narrow band or impulsive - repetitive and non-repetitive. But, comparatively, little attention is paid to this problem area, probably because its effects on the workers are insidious than being immediately detectable as could be observed in exposures to toxic substances and inadequate guarding of machines. Noise also causes deafness after a prolonged exposure. 'Deafness' refers to any loss of hearing; it does not necessarily imply total loss. However, what effects the exposure to a particular noise can bring about depend on several factors—the overall noise level and its characteristics, its distribution during the working day, and its total duration throughout the expected working life—may act singly or together. This amounts to mean that longer the exposure, the greater the risk. It is well recognised a fact that a high pitched noise (one containing frequencies above 1,500 cycles/second) is more damaging that of low frequencies of equal loudness (Harris, 1957).

Noise can interrupt speech communication resulting in inefficiency and more seriously in accidents.

**Noise Control Programme**

Noise can be controlled by adopting various control measures. These may include administrative, engineering and the use of personal protective devices. Administrative procedures involve reducing of exposure to noise by task rotation or reducing hours of work. The engineering procedures may range from replacing used up machine parts to
completely changing the process. The difficulties in pursuing engineering procedures are many. Firstly, qualified and competent experts may not be available to solve difficult noise problems. Secondly, the available technology to solve certain noise problems is uncertain. Thirdly, noise control by engineering methods is often expensive. Even when money and technical expertise are available, efforts may turn out to be useless on measures that are totally unsuitable. Thus reduction of noise at the source becomes impractical. Hence, in such circumstances, personal protective devices (ear protectors) may be the only practical and economical method of reducing the risk. The various types of ear protectors (cotton wool, ear plugs, ear muff) reduce the noise emission level of the wearer, thereby lessening the load on the temporal lobes of the brain. Else (1973) observed that the protection afforded by hearing protectors depends on their level of attenuation.

Attitude: Attitude towards the ear protectors may be an important contributory determinant in job performance. Favourable or unfavourable disposition to it may cast an impact on efficiency. For example, a worker who expresses his willingness to use the ear protector may reflect better performance; while another who perceives it as a detrimental may show poor performance. Faulty, erroneous and misconceived attitudes may render workers suffer loss in production and increase in accidents and absenteeism.
Legislation

In the advanced countries, like the United Kingdom, the United States of America, etc., occupational noise exposure has already attracted considerable attention and, at present, noise induced deafness is made compensable. To reduce occupational exposure to noise, Acts, Codes, Limits and Standards have been evolved. In the United Kingdom, Section 2 of the Health and Safety at Work Act (1974) lays down general obligation for an employer to provide a place of work which is safe and healthy. Section 6 of the Act includes general duties for designers, manufacturers, importers and suppliers of equipment and machinery. This section will be used to achieve noise reduction at the design stage in new machinery. In 1972, the Department of Employment (U.K.) issued the Code of Practice for reducing the exposure of employed persons to noise. It lays down the maximum level of noise exposure (equivalent continuous level-Laq) for an eight hour working day to be 90 dBA. The system adopted of Laq meant that higher levels of exposure for shorter times could be accepted, e.g.

- 90 dBA for 8 hours total
- 93 dBA for 4 hours total
- 96 dBA for 2 hours total, and so on up to
- 108 dBA for 7 1/2 minutes total.

It being a Code of Practice, there was no legal force; but the Factory Inspectorate, in particular, use these recommendations as a guide to their action on industrial
noise. The British Occupational Hygiene Society, in 1971, issued the Hygiene Standard for wide-band noise following the same basic principles of the Department of Employment's Code with a slight difference. This states that on an assumption a working lifetime in injurious noise will be 30 years. It can be stated that an equivalent-continuous noise level of 90 dBA should not be exceeded habitually (8 hr/day, 5 days/week, and 48 weeks/yr) without hearing protection. American Standards follow closely the British Standards. In the case of noise, however, American Standards (85 dBA) differ in important essentials from their British counterparts.

In India, very recently, noise induced hearing loss has been incorporated in the Factories (Amendment) Act, 1976 as a Notifiable Disease and also made Compensable; yet attempt is trailing far behind to reduce noise. As the country cannot afford to cut down noise at the source because it involves quite a bit of financial commitment, it was felt necessary to study whether personal protective devices could be used in the establishments where noise level is high enough to cause adverse health effects. While the ear protectors are commercially available, it still remains unknown whether it can maintain health, comfort and efficiency of the weavers. Thus, the investigation attempts to evaluate the efficacy of the ear protectors in relation to psychological test performance, physiological cost involved and production.
Over the years, India has been tending towards modernization by more and more industrialization. While the dividends of industrialization are well appreciated by one and all, the ill-effects of it are often lost sight of. It is well noted that almost all the industries are producing noise to which a substantive proportion of workforce is exposed. Noise characteristics is also wide, ranging from intermittent and impulsive in nature as produced in hammering, riveting, soldering, drilling, etc. to loud continuous noise as prevalent in textile mills, power plants, chemical industries, etc. Traffic, railway and aircraft noise are special kinds by themselves, and contain both high and low frequency noise. Long continued exposure to it causes many faceted health problems. Further, poverty, illiteracy, malnutrition and ignorance of the facts of hazardous working conditions are aggravating the problem area (Supta, 1964; Das 1964; Ghosh, 1965).

Exposure can be reduced by engineering modifications and administrative controls, but these measures are quite expensive. An alternative to this could be the use of ear protectors in noisy work situations. The protectors would cut off both high and low frequency noise and thereby provide protective measures to the human hearing mechanism. As a
result, the workers will not suffer from hearing loss. The ear protectors might also facilitate better stability in physiological systems, job performance, and higher production. Thus, the protectors would be able to promote health, efficiency and comfort of a sizeable working population.
Objectives

In order to achieve the goal set out earlier, the objectives of this study have been to determine:

1) the intensity and spectral characteristics of noise prevalent in different industries.

ii) the hearing sensitivity of the workers exposed to noise.

iii) the attenuation characteristics of different types of commercially available ear protectors.

iv) the efficacy of ear protectors in different combinations in relation to psychological test performance, physiological cost and personal efficiency.

v) whether other environmental conditions (heat and illumination) remained unchanged during the study period.

vi) psychological and physiological changes due to exposure to noise in the laboratory conditions.

vii) the effect of noise on animal maze learning and biochemical changes in the laboratory conditions.