

AN INEVITABLE CONSEQUENCE

The story of industrial deafness

INTRODUCTION

One hundred years ago, in 1907, a British government committee, *The Departmental Committee on Compensation for Industrial Diseases* said that "Boilermakers' deafness is unquestionably an injury due to employment". [3] A year later *The Annual Report, Factories and Workshops* said "It is generally known that men employed in certain trades are liable to have their sense of hearing seriously impaired, if not entirely destroyed in the course of time, as a result of long continued exposure to loud noises. One well known instance is that of boilermakers deafness, other occupations are the hammering of metal sheets and cylinders, use of pneumatic tools, beetling of cloth, engine driving and firing of guns." [4].

Yet it was to be more than 80 years before legislation was brought in to reduce the risk of damage to hearing at work. How could this have happened? How could millions of people have continued to be made deaf at work and no-one, or almost no-one, did anything about it.

Although the answer lay in the lack of action by government and employers, for half that time, they could not be accused of negligence. The story is rather one of changing attitudes and knowledge and of the development of the moral framework of society and technology.

One hundred years ago there was no general feeling in society that anything should be done about industrial injuries generally. Ten years before this time the Forth Rail Bridge was built. 71 workers are known to have died during the construction. It is indicative of the attitude at the time that it is widely believed that the figure was very much higher but such deaths were never properly recorded. The concept we now have that employers have a duty of care towards their employees was unknown. It was the attitude of both employers and employees that damage to their hearing was an inevitable consequence of their employment.

There was no legal obligation and no moral obligation in the context of the time for an employer to prevent his or her employees getting deaf. As Lord Justice Mustill said in the landmark case of *Thomson v Smiths Ship Repairers* in 1984 (about which we shall hear more) "while an employer must keep up to date, the court must be slow to blame him for not ploughing a lone furrow".

BEFORE 1900

There are references going back over several hundred years to the fact that some noisy occupations - in particular those involving the hammering of metal - will cause permanent deafness or tinnitus. Tinsmiths in the middle ages had "ringing in the ears". But the first authoritative reference was in 1831 when Dr Fosbroke,

writing in *The Lancet*, states that "Blacksmith's deafness is a consequence of employment." [1]

Loud noise damages the inner ear irreversibly. It is insidious. It "creeps upon them gradually" as Dr Fosbroke wrote. It is cumulative which makes it more difficult to guard against. It is like tobacco. One cigarette will not kill you and one day at work will not make you deaf. Neither will two or three – but where is the line? It is easy to say "one more exposure is not going to make any difference". Fosbroke's article stood almost on its own for 50 years before any real work was done on the subject. In 1886 a Glasgow doctor, Thomas Barr, found that about 75% of the boilermakers that he examined were deaf to the extent that they had difficulty in hearing (or could not hear at all) a public speaker. He compared these boilermakers with some in other occupations and found, for example, that only 8% of letter carriers suffered deafness to the same degree. Dr Barr says "It is familiarly known that boilermakers and others who work amid very noisy surroundings are extremely liable to dulness (sic) of hearing. In Glasgow we would have little difficulty in finding hundreds whose sense of hearing has thus been irremediably damaged by the noisy character of their work." [2] So it was clear by this time that workers in certain industries would be made deaf by their employment. As far as I am aware Dr Barr's research was the first work of its kind anywhere in the world. The extent of this research was modest but the first scientific link between employment and deafness.

ENLIGHTENED EDWARDIANS?

In 1908 Lloyd George as Chancellor suggested the introduction of a National Insurance Scheme that eventually became the 1911 National Insurance Act. It was the first contributory system of insurance against illness and unemployment. In this first decade and a half of the 20th century there was a growing awareness of industrial hygiene and industrial safety generally. It was well known that some workers were made deaf by their employment. Knowledge of this kind is disseminated throughout industry "on the grape-vine". It is passed from employee to employee and from employer to employer often in casual conversation. It is inconceivable that employers and employees and their families in large boilermaking companies were not aware of this. It was known simply because there were such large numbers of employees who were so severely deaf that no one could doubt it.

Now that the original trade of boilermaking has ceased it is probably worth explaining what the process involved. Boilers were made for steam engines – particularly steam ships – but the trade of boilermaking extended to the construction of the steel ships themselves. The riveting process that connected sheets of metal together consisted of putting a red hot metal dowel through a hole drilled through two pieces of the metal sheeting. The riveter on the outside hammered the rivet flat with a 14 pound sledgehammer. In today's terms the peak linear noise level exceeded 150dB and the $L_{EP,d}$ was probably in the order of 110dB even if it were a lone riveter working outside. More commonly there would be hundreds of such riveters often working in a shed and the $L_{EP,d}$ probably approached or even exceeded 120dB. But it was the "holder-on" who suffered the worst noise. That was the person who was stationed inside the boiler or within the double hull of the ship to hold the other end of the rivet in position. The "holder-on" was subjected to the noise of perhaps tens or hundreds of sledgehammers on the

outside, the nearest one within centimetres of his ear. His exposure would have been an $L_{EP,d}$ approaching 130dB. Hardly surprising they were deaf.

But the "inevitable consequence" attitude prevailed. *The Report of the Departmental Committee on Compensation for Industrial Diseases* in 1907 whilst admitting that boilermakers' deafness was due to employment added that "It does not, however, prevent a man from continuing at his trade, and it cannot, therefore, give rise to claims for compensation....."[3] The reason for compensation was not because you were damaged but because you could not continue in employment. The idea that employers were responsible for the general health of their workers was a concept not yet born.

TECHNOLOGY

It is easy to criticise the attitude to industrial deafness in retrospect but if put into context it is more understandable. Little improvement could have been made at this stage, even by a pioneering employer, because of the lack of scientific technique and knowledge.

There was no accurate method of measuring hearing loss. Thomas Barr measured it by the distance at which a ticking watch, a whisper or a shout could be heard (still used by consultants but not as the main test). Dr Rodger measured for how long the subject could hear a tuning fork as its sound faded away - sometimes comparing it with himself as a norm.[8]

There was no accurate and readily available way of measuring the level of sound or its frequency. Frequency was measured subjectively. Dr Rodger describes in 1925 how he "went down to the boiler shops in Leith with my pockets bulging with tuning forks" in order to estimate the predominant frequencies of boilermaking noise. [9].

Because accurate, objective measurements of the degree of deafness and the level of sound could not be made, no quantitative relationship between the two could be established. That is to say that it was not yet possible to predict the risk of deafness in a trade by knowing its noise level. There was research into deafness amongst cotton weavers in Lancashire in 1927 when 24% of workers were found to have some degree of deafness but otherwise little appears to have been done.[14] In most ways Thomas Barr's work in 1886 remained the best scientific work regarding noise induced deafness in Britain for 50 years.

Rolling cotton wool in Vaseline was about the only material that could be used to act as ear protection and this could not have been very effective. It was originally proposed by Yearsley in 1848 but, oddly enough, as an aid to hearing not as protection against noise. How this worked is not clear. The only thing I can think is that the Vaseline softened wax in the ear. But the idea that the same material could both improve hearing and protect against noise suggests it was not very effective at either job. In any case doing this in industrial conditions of the time was unlikely to have produced a very hygienic ear plug. The cotton wool in Vaseline technique was probably put forward as an answer to many things because it was commonly used at the time for protecting the ears whilst bathing.

In 1882 another doctor, Ward Cousins described an ear plug used by bathers but it was also recommended for persons working in loud noise "such as artisans in

factories, soldiers and sailors during the discharge of cannon, and all who were painfully affected by noise." It was a vulcanite (hard rubber) plug shaped like a rifle bullet. Such plugs were made by Dr Cousins but I presume only for his patients use.[7]. The first commercial ear plug was produced in 1914 – the Malloch Armstrong [11], spurred by the need for protection against gunfire in the 1914-18 war. But the simpler home made variety was probably more common. Some time later in 1933 a paper to the British Association still proposed the use of cotton wool and paraffin wax for riveters.[12].

PROGRESS AT LAST

There has never been a public debate on the effects of noise on hearing except for brief periods and specific issues. In the 1970s there was a brief debate on the dangers of loud noise on the hearing of young people in discos. Leeds City Council introduced a bye law limiting the noise in discos but this was quietly dropped when it turned out to be largely unenforceable. The public debate on noise has always been driven by its nuisance effect (or, in the 1950s by its alleged effect on the efficiency of workers). People understand nuisance. They experience it or think they experience it every day. It is immediate whilst loss of hearing is insidious. People do not know that they are getting deaf until one day they realise they cannot hear what people are saying to them. And then it is twenty years too late.

So it was in the 1930s that one of the driving forces was the number of motor cars that appeared in the streets and roads. I doubt if the large numbers of horse drawn vehicles were much quieter, but the relatively sudden change of character of the noise probably gave an increased awareness. And, as always with noise, it was probably used as a proxy for other fears. The Anti-Noise League - later to become the Noise Abatement Society - was the leading group in the campaign against environmental noise. It had on its council and associated with it, many eminent figures including doctors and scientists.[17] It will be of interest to those now working in the field that the first Noise Map of London was produced in the 1930s at a scale of 4 inches to the mile by Consulting Acoustician C. W. Glover. It was a map of the "whole County of London" and shows areas where "street noise is consistently excessive".

Deafness sometimes became a peripheral issue - some people thought that people in cities would go deaf because of the noise of the motor car – but rarely was it concerned with those in industry. One exception to the focus on environmental noise at this time was The Industrial Welfare Society. Founded in 1918 it was "an association of firms, corporations and persons, concerned with working conditions, beyond statutory requirements, as they affect the security, happiness and health of workers.....". The Council consisted of representatives of trade unions and employers associations as well as those representing individual companies and the Patron was the King. [18].

At the same time as the motor car spurred interest in noise, the radio and telephone industries provided the technical knowledge to develop measuring equipment and audiometry. In the second world war the advances in electronics which were necessary to produce modern fighting machines enabled such measuring equipment to develop. The first sound level meters of the 1930s had been *subjective noise meters*. They produced a noise which the operator could vary in level in one ear and compare with the noise being measured in the

other.[10]. A few *objective noise meters*, which were the forerunners of the present sound level meters, were produced in the mid 1930s. At the Anti-Noise League's Noise Abatement Exhibition in 1935 two "objective noise meters" were on display. One was produced by the National Physical Laboratory and the other by the Western Electric Company Ltd. But equally on display were subjective meters.[17]. It was not until about 1940 or 1941 that the first commercial sound level meters became available. One of the first was the General Radio Company's sound level meter [15]. It should be noted that the term "sound level meter" was an instrument specifically designed to make measurements which approximated to loudness, rather than the pressure level of a sound and was similar to a modern meter measuring A-weighted decibels. By the late 1940s sound level meters became more common. *British Standard* 1479, "Memorandum on the Use of Sound Level Meters" was issued in 1948. [19]

The other tool necessary to establish a quantitative link between noise level and degree of deafness was the audiometer. This measured the degree of hearing loss. Again by the mid-thirties there were some basic types available. The forerunner at the time was the Western Electric Audiometer available in the 1930s.[17] [20]. But again it was the development of electronics in the early 1940s which established audiometers in the commercial field. In 1948 the Amplivox Audiometer was available commercially.[21]

Following Sabine's work researchers had by now started to make measurements of the acoustic properties of materials. The electronic equipment to do so was similar to that later commercially available but at this time was confined to research establishments. Measurements of absorption coefficient were made by the National Physical Laboratory.[22] Methods of sound insulation were more widely known. These developments had first come about prompted by the need to improve the acoustics of concert halls and theatres.[10]. Noise reducing materials were produced commercially in the 1930s and 1940s such as anti-vibration mats (including typewriter mats), acoustic plaster and sound insulating walls. [17], [24], [25] Various "silenced" devices were produced including circular saws, motors, turbines, typewriters and railway carriages some of which were forerunners to today's technology. Others proved less enduring such as rubber blocks to build roads and rubber horseshoes.

Ear protection became commercially available. Already at the Anti-Noise League's Noise Abatement Exhibition in 1935 there were on display a variety of ear protectors including the Mallock-Armstrong, Luxon Ear Protectors, some plastic and rubber plugs, impregnated cotton wool such as Ohropax and Quies, the Auroprotector ear defender and Antiphones. There were advertisements for Soundex vulcanite plugs by Ardente. [17], [13], [14]. These were all plugs of variable effectiveness and it was not to be until the 1950s that effective ear muffs would be readily available.

There was an improving attitude with the development of the welfare state and the introduction of free medical treatment in the late 1940s. People generally began to believe they had a right to good health and that the state and others responsible for them had a duty to provide it. By this time it was well known within the medical profession that exposure to loud noise, particularly for prolonged periods, would damage hearing. Established companies with noise levels in the workplace in the order of 100dBA or more were probably now negligent in common law because not only did they know that their employees hearing might be damaged but they could

have found the means to measure and reduce noise, to measure hearing loss and to obtain ear protection.

In the next Bulletin we will hear about the actual knowledge that some employers had, Codes of Practice, the litigation that was necessary to move things on and the regulation finally brought about at the instigation of the European Union.

TIME AND MOTION

As we saw in part 1, by the end of the 1940s all the parts of the jigsaw were available to enable employers to protect their workers hearing. Knowledge of how to reduce that risk, by using baffles, enclosures or sound absorbent or by the provision of ear protection were readily available to anyone who made the effort. Materials to reduce sound and ear protectors were available. Research was being carried out in several countries, notably Scandinavia and the United States. In January 1953 Colin Johnston wrote an article in the British Journal of Industrial Medicine where he concluded that 100 to 112 phons represented the borderline for damage to hearing. These levels are approximately equivalent to 86 to 98dBA in modern terms.

Just as in the 1930s it was nuisance that drove progress in industrial deafness so in the 1950s it was the desire for more efficiency that drove it. This was the period when "Time and Motion Study" and similar techniques were used to determine how we could all work more efficiently. The 1959 film "I'm alright Jack" satirised this together with other issues of the time.

Attitudes, rather than knowledge, were still holding back progress. In the early 1950s British Rail carried out research into workplace noise both in the interests of efficiency and because of deafness. Its failure to follow up the initial work was to rebound on them 30 years later in the court case of Kellet v British Rail Engineering about which we shall hear more. The evidence brought out in the case tells us something about the attitudes that still prevailed.

In the latter part of 1951, tests of V51R ear plugs were carried out by a Divisional Medical Officer amongst employees in two boiler shops belonging to British Rail. The officer believed that boilermaker's deafness could be to a great extent reduced or prevented by the supply of protectors. These tests were reported to the Chief Medical Officer at British Rail with the recommendation that they should be issued regionally. A reply in early 1952 stated that there would be no objection to ear defenders being purchased and re-sold to staff, though the Railway Executive were opposed to the free issue of protectors.

Further correspondence between the Divisional Medical Officer and the Railway Executive took place during 1952, the former recommending the provision of ear protection for certain employees. In particular, in the case of a particular employee, he had "no doubt that continued exposure to the excessive noise . . . will in time cause permanent damage to his hearing". This was turned down by the executive on the grounds that they would receive similar requests from other employees which would be difficult to refuse.

Meanwhile, in 1952, similar tests of V51R ear plugs were also carried out at British Rail's Doncaster works. These tests resulted in a request for Management to supply

defenders for members of staff. This request was refused on the grounds of cost. The Doncaster Works Committee tried to persuade management to change its mind, apparently without success. In early 1953 a similar trial of V51R plugs was carried out at the Crewe Works. These were very satisfactory and the staff representative on the Works Committee asked that they be made standard issue. The outcome is not known but it seems likely that no ear protection was ever provided and certainly not on a consistent basis.

At the end of 1955 British Rail's Research Department approached Professor Burns of Charing Cross Hospital with the object of his investigating the loss of hearing of employees who worked in a noisy environment. Professor Burns said that above a certain sound threshold there was a hazard of progressive deafness. However Dr Newnam of British Rail expressed his concern that such a survey might precipitate Common Law claims. It seems that this put a stop to any further work and Dr Burns survey never took place though he did carry out further investigations into noise and efficiency.

In one sense one cannot blame British Rail because its attitude only reflected that prevailing at the time. Nevertheless the time had come when employers had to take responsibility for damage to the hearing of their employees.

QUANTIFICATION

In the *Transactions of the Association of Industrial Medical Officers* in 1955 Brian O'Brien says "Today a greater concern for the welfare of the industrial worker's health has focussed a good deal of attention on the effects of prolonged exposure to noise of a degree harmful to the sense of hearing. Efforts are being made to protect the ears both by reducing the actual volume of noise to which they are exposed and by augmenting the natural defences of the human ear". He further states that "recognition of such occupational deafness by courts of law and insurance companies has been forced by an increasing number of successful claims for damages." I have found no record of any of these early claims.

There were now more professional people specialising in acoustics and noise. There were physicists in the Building Research Laboratory, later to become the BRE. Physicists also worked on noise at the National Physical Laboratory and there were architects and engineers who had obtained experience of acoustics in the design of radio and television studios in the BBC.

There were articles on how to reduce noise at work throughout the 1950s – again for much of the time more concerned with efficiency than deafness. [31] In 1957 Cyril Harris published his book *Handbook of Noise Control*. This was, together with books by another American, Leo Beranek, to be a major work of reference for the next decades. There were articles in which the causes of deafness are discussed and the performance of ear plugs and muffs is shown. [33], [34], [35], [36]

In 1960, Burns and Littler broke through the final main difficulty, that of quantifying the "safe" level of noise. They suggested a specification for hearing preservation in chapter 17 of the book published by Butterworth "Modern Trends in Occupational Health". This specification was described in frequency bands.

In mid 1963 two Government Publications were to mark a turning point, in hindsight at least, even if they were not widely read at the time.

Noise - Final Report usually known as the "Wilson Report" was published in July 1963. Although dealing with all aspects of noise it discussed noise induced deafness and set down criteria for the safeguard of hearing. [38]. It suggested two alternative noise limits, both in terms of frequency spectra. The first was the figures from Burns and Littler which were in the old octave bands used in Britain and the US at the time. The second was a proposal by Aram Glorig, an American, of NR85. It is of interest to compare these. In the table below the Burns and Littler noise levels have been converted from the old octave bands to the current standard.

	63	125	250	500	1k	2k	4k	8k
B&L	98	94	89	85	84	80	80	80
AG	103	96	91	87	85	83	81	79

Noise and the Worker was published in 1963 by the Ministry of Labour. Although not referred to as a code of practice it was in essence just that and has been treated as such by the courts. It discussed ways of assessing whether an employer had a noise problem and how to conduct a noise conservation programme. It showed how to measure noise and reduce it and identified the danger levels of noise. [39]. Under the heading "The Danger Levels of Noise" the publication states that:

Before the effects of loud noise can be judged, therefore, it is not only necessary to measure the noise but to assess the amount of exposure to it during a normal working day or working life.

It is generally agreed, however, that if workers are exposed for eight hours a day, five days a week, to a continuous steady noise of 85dB or more in any octave band, in the speech range of frequency (500 to 4,000 cycles per second) it is desirable to introduce a programme of noise reduction or hearing conservation. (This is a level of noise in which normal speech cannot easily be heard; at a distance of a few feet communication can be achieved only by shouting.)

It set out Burns and Littler's figures as levels above which noise should be "avoided". The publication goes on to give examples of how noise levels have been successfully reduced at source in factory environments and how reductions in noise can be accomplished.

In 1970, following considerable research, Burns and Robinson at the National Physical Laboratory published "Hearing and Noise in Industry" [41] and the following year Robinson published "Estimating the risk of hearing loss due to exposure to continuous noise" [42]. This introduced the concept of noise dose and effectively of Leq – though commercial sound level meters were not available until the mid 1970s to measure Leq directly. Furthermore it introduced the use of A-weighted sound as the measure of exposure. Leq and A-weighting have remained the preferred measures ever since.

As a result of Burns and Robinson's work the third edition of *Noise and the Worker* was published in 1971 and gave the following table indicating *Levels of noise which indicate a serious hazard to hearing*.

Exposure duration	Maximum sound level
hours per day	dB(A)
8	90
4	93
2	96
1	99
½	102
¼	105

In connection with the danger levels of noise the publication says, in referring to the above table *It is . . . possible to give guidance which will help to protect most people against serious hearing loss. And Damage risk criteria should be regarded as maximum permissible levels and not as desirable levels. If possible the noise should be reduced to levels lower than the danger levels set out in [the table].* In 1975 ISO 1999 also used the same concept (Noise Immission Level) to estimate the likelihood of hearing damage.

In 1972 the "Code of Practice for Reducing the Exposure of Employed Persons to Noise" was published which again set down a level of 90dB(A) while emphasising that this did not guarantee protection of the most susceptible workers. This continued in force, without amendment, until 31st December 1989. It stated:

The Code sets out recommended limits to noise exposure. It should be noted that, on account of the large inherent variations of susceptibility between individuals, these limitations are not in themselves guaranteed to remove all risk of noise-induced hearing loss.

The limits set out in this section should be regarded as maximum acceptable levels and not as desirable levels. Where it is reasonably practicable to do so it is desirable for the sound to be

THE COURTS

Notwithstanding the warnings about 90dB(A) not being desirable the level stuck in the minds of both employers and the courts as being a "limit". Lord Cameron of Lochbroom, in finding for the defenders in the case of *McLeod v Wiggins Teape (Stationery) Ltd* in 1990, said *I am not satisfied that . . . the pursuer . . . was subject to levels of noise beyond the maximum acceptable limit of 90dB(A), let alone for material periods of time such that the defenders had been under a duty to take reasonable care to protect her from risk of permanent damage to her hearing.*

In 1983 at Newcastle upon Tyne Crown Court Mr Justice Mustill heard a case brought by shipyard workers - *Thomson v Smiths Ship Repairers*. It is significant because it effectively set the date that an employer would have become negligent

at 1963. Broadly the judge's reasoning for the date of 1963 was the publication of the two government documents – the Wilson Report and Noise and the Worker – and the fact that ear protection was available and the noise could be measured. His decision has been largely accepted by plaintiffs and defendants ever since. [40]

One exception to the 1963 date is of interest because it explains the whole principle behind the liability for negligence and explains why, as I related right at the beginning, it took 80 years to get proper protection for peoples hearing at work. In May 1984 James Kellett brought an action against British Rail Engineering for damage to his hearing. The main facts – that the plaintiff had been exposed to noise in his employment and that had it damaged his hearing were agreed by both sides so Mr Justice Popplewell was only asked to decide a number of specific issues. Amongst these were "Were the defendants negligent at any time since 1946 and if so from what date".

The plaintiff and the defendant agreed that the principles to be adopted in determining negligence were those set out in an earlier case of Stokes v Guest Keen and Nettlefold in 1968 (Weekly Law reports 1776 at page 1783). It is worth repeating this verbatim:

The overall test is still the conduct of the reasonable and prudent employer taking positive thought for the safety of his workers in the light of what he knows or ought to know. Where there is a recognised and general practice which has been followed for a substantial period in similar circumstances without mishap he is entitled to follow it unless in the light of common sense or newer knowledge it is clearly bad. But where there is a developing knowledge he must keep reasonably abreast of it and not be too slow to apply it and where there is in fact greater than average knowledge of the risks he may be thereby obliged to take more than average or standard precautions, he must weigh up the risk in terms of the likelihood of injury occurring and the potential consequences if it does and he must balance against this the probable ineffectiveness of the precautions that can be taken to meet it and the expense and inconvenience they involve. If he is found to have fallen below the standard to be properly expected of a reasonable and prudent employer in these respects he is negligent.

Having examined the facts regarding British Rail's actual knowledge of the situation as I set out earlier, Mr Justice Popplewell concluded that from 1955 at the latest British Rail Engineering were negligent.

STATUTE

The European Council Directive (86/188/EEC) of 12 May 1986 on the protection of workers from the risks related to exposure to noise at work started the road to legislation. This led to the Noise at Work Regulations 1989 which came into force on January 1st 1990. In summary these stated that:

There is a general obligation on employers - irrespective of whether an employee's noise exposure exceeds the levels laid down in the regulations or not - to reduce the risk of damage to their hearing to the lowest level reasonably practicable. There is also an obligation to carry

out a noise assessment in any areas where levels may exceed an $L_{EP,d}$ of 85dB.

Where noise levels are an $L_{EP,d}$ of 90dB or more there is an obligation to reduce - without the use of ear protection - as far as is reasonably practicable the exposure to noise. In addition there is an obligation to provide suitable ear protectors and take all practicable steps to ensure they are worn and generally to provide information, instruction and training to employees.

Where noise levels are less than an $L_{EP,d}$ of 90dB but an $L_{EP,d}$ of 85dB or more, there is an obligation to provide suitable ear protection at the employees request and to provide information, instruction and training to employees.

The Noise at Work Regulations 1989 are now replaced by the Control of Noise at Work Regulations 2005 which came into force for most employers in 2006. These effectively lowered the action levels by another 5dB.

The position for employees is now very much better than it was one hundred years ago but we should not think that everything has now been done. Thousands of people still have their hearing damaged at work either through their own thoughtlessness or ignorance or, still, through their employer's negligence. Although negligence can be compensated in the civil courts that is of little consequence set against with the effect of hearing loss. Deafness is still a severely under-rated disability and it is not yet time to sit back and say that we have done all we can.

REFERENCES

- [1] The Lancet 1831.
- [2] Proceedings of the Philosophical Society of Glasgow 1886.
- [3] Report of the Departmental Committee on Compensation for Industrial Diseases, 1907.
- [4] Annual Report, Factories and Workshops, 1908.
- [7] British Medical Journal, Oct 13th 1883.
- [8] The Journal of Laryngology, March 1915.
- [9] British Medical Journal, 1925.
- [10] The Engineer, 24th August 1934.
- [11] Malloch Armstrong Advertisement
- [12] Industrial Welfare, 1933.
- [13] Industrial Medicine and Hygiene, 1954, Vol 2.
- [14] The Diseases of Occupation, Hubert Turnbull, 1955.
- [17] Anti-Noise League's Noise Abatement Exhibition, 1935.
- [18] Industrial Welfare Society, 1938.
- [19] British Standard 1479, "Memorandum on the Use of Sound Level Meters", 1948.]
- [20] Laryngoscope, September 1937.
- [21] 1948 brochure for the Amplivox Audiometer.
- [22] Copy of absorption coefficients test table.
- [24] Times Review of Industry, February 1947.
- [25] British Journal of Industrial Safety Vol 1, nos 4 and 5. 1947
- [30] Business, April 1956.
- [31] Business, September 1956.
- [33] Times Review of Industry, 1958.
- [34] Personnel Management, Vol. 41, no 350 December 1959.
- [35] Noise in Factories, Department of Scientific and Industrial Research, 1960.
- [36] Bulletin of the North of England Industrial Health Advisory Service, September 1961.

[38] Noise - Final Report, HMSO, 1963.

[39] Noise and the Worker, Ministry of Labour, 1963.

[40] Thompsons v Smiths Ship Repairers. Decision of Mr Justice Mustill. 1984 Weekly Law Reports p 522.

[41] Burns W and Robinson D W. Hearing and Noise in Industry. HMSO 1970

[42] Robinson D W. Occupational Hearing Loss 1971. Edited by D W Robinson. Academic Press.