THE GROWTH AND AWARENESS OF HEALTH AND SAFETY AT WORK, 1780-1900

Thesis presented for the Degree of Doctor of Philosophy

The University of Aston in Birmingham

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Summary

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This thesis examines the growth and awareness of health and safety at work between 1780 and 1900. In this period the hazards at work were increased by the intensification of production brought about by the Industrial Revolution, and new risks to health arose from the wider range of toxic substances in use by manufacturing industry. There is discussion in the thesis of the extent to which the problems were identified in an age of short life expectancy and limited medical knowledge. The sources studied have been largely medical, governmental, trade and press reports. The emphasis is on the first effects seen and recommendations made, and where possible, the extent of the problem and the effectiveness of any preventative measures adopted and examined. There is discussion of the growing involvement of the Government in industrial health and safety.

The subject is viewed in the light of modern thinking on industrial health but uses a classification appropriate to historical resources. Psychological and minor afflictions, neglected in the 19th century, are not considered. The available literature is reviewed in each section. Three detailed case studies conclude the thesis, two on the notoriously dangerous occupations of metal grinding and pottery, and one on occupational eye injuries. Each study is based on a different type of source material.

The thesis overall shows that there was extensive concern for health and safety at work, but no systematic approach and only *ad hoc* implementation of preventative measures; and that the rate at which conditions improved varied between different industries and different categories of workers. However, some modern principles of health and safety at work can be seen emerging, and the period laid the necessary medical, technical and legal foundations for developments in the present century.

HEALTH INDUSTRY ACCIDENTS TECHNOLOGY MEDICINE

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ABBREVIATIONS

B.J.I.M.	British Journal of Industrial Medicine
B.M.J.	British Medical Journal
J.S.A.	Journal of the Society of Arts
T.S.A.	Transactions of the Society of Arts
W.J.	Wellington Journal and General Advertiser for Shropshire and Staffordshire

PREFACE

> "Indifference to health and safety of workpeople has been a feature of both ancient and modern society. It is only since the 2nd World War, from the 1940's onwards that there has been a rapid growth in occupational health on a world-wide scale."
>
> (R S F Schilling 1981)[1]

There has perhaps never been a more appropriate time than the present in the wake of the implementation of the Health and Safety at Work Act 1974, to consider the history of occupational health in Britain. The Act is the result of the first comprehensive review of the topic by the legislature and it might be considered a measure of its impact that the very phrase 'health and safety at work', seldom heard before, has become a byword in everyday use; and possibly, as a result increased more than ever before people's expectations of healthy and safe conditions at work. It is appropriate therefore, before studying the history of the subject, to consider briefly the present philosophy and practice of occupational health and safety as embodied in the Act and its regime.

The Act was an enabling Act, a broad, generalized piece of legislation making provisions for the Secretary of State for Employment to act through the New Health and Safety Commission, to draw up both Regulations which are given the force of law by Statutory Instrument, and Codes of Practice on specific health and safety matters. The Codes of Practice act as guidelines for those enforcing the provisions of the Act as to acceptable standards of safety in the areas in question. Failure to comply with these Codes is not in itself a breach of law but it is however, indicative that the legislation has not been observed and such evidence can be used in court proceedings. Guidance notes are also issued by the Commission. These do not

1 R S F Schilling (ed.) *Occupational Health Practice* (2nd enlarged edition, 1981), p3.

form part of legislation and their observance is not compulsory as they are merely an expression of official opinion. Where they relate to technical subjects, they are representative of the views of highly qualified technical officials and set the technical standards to which the Factory Inspectors seek parallels.

The Act did not remove the existing legislation such as the 1961 Factory Act or 1954 Mines and Quarries Act. These continue side by side with the Act until such time as they are replaced by Regulations made under the 1974 Act. The purpose of the 1974 Act was to provide a comprehensive and integrated system of law to deal with the whole question of health, safety and welfare of workpeople. Such an Act was considered necessary due to the piecemeal legislation that had emerged since the beginning of the 19th century and which fell under the responsibility of several government departments.

The Act places new general duties on employers, one of the most important being the establishment of worker safety representatives and joint committees, which the employers must consult.[1] For the first time, the question of health and safety of workers in areas of employment such as public utilities, museum and art galleries and education services, was brought within the scope of government control. It established the Health and Safety Commission which is responsible for the new unified inspectorate, the Health and Safety Executive. New powers and penalties for enforcing safety laws were also provided including the issuing of improvement notices, prohibition notices and increased fines and threats of imprisonment. The Commission was also given comprehensive powers to make new regulations and draw up proposals to revise or extend existing legislation.[2]

[1] Such measures had already been in operation in premises controlled by the 1954 Mines and Quarries Act.

[2] 1974 Health and Safety at Work etc. Act c37. Several explanations of the Act exist amongst which are the TUC Handbook *Safety and Health at Work* (2nd edition, 1978), pp8-17 and Hamlyn's *Managing your Business Guides - Employees' Health and Safety* (1979).

Hence, the new Act, whilst not being specific, has far reaching consequences and is a turning point in the history of occupational safety and hygiene in Great Britain. But how can this new outlook on health and safety at work help an interpretation of the situation in the 19th century, when many of the problems were only just beginning to emerge?

INTRODUCTION

There are four factors in the work environment now recognized as influencing health which are:

1. Physical factors such as radiation, high and low atmospheric pressure, high and low temperatures, noise and vibrations.
2. Chemical factors, for example, dusts, poisonous fumes and gases, toxic metals and carcinogens.
3. Biological factors including viral, bacterial, fungal and parasitic diseases.
4. Psychosocial or stress factors.[1]

Although these perils have been present since man first worked and manufactured objects, their impact was greatly extended in the intensification of production brought about by the factory system of the industrial revolution. Under pre-industrial and proto-industrial conditions although workers may have laboured for long hours, they could have a greater degree of control over their work environment and were able, sometimes, to vary the task. The new factories, first horse, wind or water powered, but later worked by steam which could be operated continuously, demanded a more regular work pattern which involved long hours and shift work. Not only did this increase exposure to physical, chemical and bacteriological dangers to a level that the human body often could not tolerate, it also increased the stress factors by the more repetitive and monotonous work patterns contained within a strict time discipline. Moreover, the increasing division of labour could lead to a lowering of job satisfaction. In the light of modern knowledge of industrial health and safety it seems self evident that such conditions could cause physical and mental ill health but at the time was there any

[1] Schilling (1981), p584. Nicholas Ashford *Crisis in the Workplace* (1976), p73.

recognition of such, and if so, which aspects of health in which industries attracted attention?

The 1974 Act was largely the product of the Robens Committee set up by the Government in 1970, which in turn was the result of pressure from employers and Factory Inspectors unhappy with the existing legislation, as well as Trade Unions who were becoming aware of the new hazards at work. The Transport and General Workers Union in particular had become concerned with the increasing use of chemicals in the rubber industry and the incidence of bladder cancer, and the Boilermakers were dissatisfied by the lack of noise control. The TUC also put pressure on the Government for reform, advocating workers' inspectors with legal rights of inspection on similar lines to those existing in Sweden. One hazard which particularly caught prominent attention was asbestosis. Between 1939 and 1970 a factory handling asbestos in York had employed 2,200 people of whom 12% had developed the disease despite the factory being subject to the provisions of the 1931 Asbestos Regulations. With awareness of the great potential risks, workers handling asbestos demanded proper equipment and dockers refused to handle asbestos imports. Workers in hospitals, factories and schools where it had been used for lagging also demanded its removal.[1]

The Health and Safety Commission, responsible for much of today's directives on occupational health and safety matters, is made up of nine members reflecting various interests in the industrial sector. Three members are appointed by the CBI, three by the TUC, two by local authorities and the ninth member is independent. But in the 18th and 19th centuries, where did the impetus for change in work conditions and for the maintenance of standards come from? Were the industries which received

[1] **Chris Baker and Peter Caldwell** *Unions and change since 1945* **(1981), pp155-157. Dave Eva and Ron Oswald** *Health and Safety at Work* **(1981), pp35-37.**

attention those for which a single advocate fought for the cause or was the interest in industrial hygiene much wider and more comprehensive? What was the attitude of the workforce? Did it take any action to get better conditions? Although Trade Unions today play a role in promoting health and safety with the newly appointed workplace safety representatives,[1] did they have any influence in the early years of their existence? These kind of considerations all form part of the ensuing discussion.

The main emphasis of today's philosophy of health and safety at work is on preventative measures. Of the many preventative steps which can be taken, the preferred action is for a harmless (or less harmful) material to be substituted for a toxic material. Where this is not possible attempts are made completely to enclose or partially enclose and thus segregate the process. This limits the number of people exposed to the hazard at any one time. Where substitution or isolation cannot be carried out, often the most appropriate preventative measure is exhaust ventilation or dampening down of dust to reduce the amount of contamination in the atmosphere.[2] The Factory Acts require adequate ventilation of workrooms and all practicable measures possible to protect workers from the inhalation of dust, fumes and other impurities. Local exhaust ventilation (i.e. on the machinery itself) is only mandatory under special regulations for certain hazardous trades which include lead, asbestos and pottery processes. Elsewhere it must be provided where practicable.[3] Increased mechanization can also reduce the number of workers at risk.

1 However, Robert Taylor *The Fifth Estate: Britain's Unions in the Seventies* (1978), pp185-186, is very critical of the unions' role in this field, saying, a "crucial area of union neglect has been health and safety at work" and "no concerted action to combat death and injury at work has ever come from the unions."

2 Patrick Kinnersly however says it is no means of suppression or control, rather an excuse to leave it lying around a bit longer, instead of cleaning it up. *The Hazards of Work: how to fight them* (1973), p176.

3 Ibid. p178.

Today safety aspects are part of the initial design features of machinery and the Health and Safety at Work Act, section 6, requires that all suppliers to industry must first test their products as to their safety and health risks before they are introduced to the workplace. They must also provide the employers with adequate instructions on the use of such machinery and the responsibility for any injury resulting from improper use where no such instructions are issued is placed on the supplier.[1]

Although the aim is always to remove the hazard at source, in some cases this is not entirely practicable. In those cases, the employer may provide the workers with protective clothing and equipment instead of, or in addition to, isolation or ventilation. Despite it now being fairly general policy for employers to provide overalls and protective equipment, it is only mandatory in a few instances, e.g. protective footwear and gaiters in foundries, aprons with bibs and rubber gloves and boots for chemical workers, and overalls and protective footwear for those engaged in chromium plating. Where there is exposure to noise over 90 decibels over an eight hour day, ear muffs must be provided under the 1972 Code for Reducing the Exposure of Employed Persons to Noise. In many cases protection for the eyes must be supplied, the 1975 Protection of Eyes Regulation now specifying thirty-five instances, and where the equipment is provided but not used, the employee himself, can be liable to prosecution, an example of the trend of modern legislation to 'protect people against themselves'.[2]

Factory hygiene is also emphasized in modern practice as being important in reducing the level of disease. A number of statutory instruments contain requirements on cleanliness, lighting, heating, ventilation, sanitation and temperature, and although usually not required by law, the

[1] TUC (2nd edition, 1978), p36.

[2] Ibid. pp103-104, 107-111, 113-116. Kinnersly (1973), pp181-187.

practice of management in the last few decades has been to provide canteen facilities. The exceptions where mess facilities must be provided under section 64 of the 1961 Factory Act are when workpeople are employed in manufacturing or processing lead, arsenic or other poisonous substances. Under the 1961 Act a number of Welfare Orders have also been made on certain workers in jobs known to be dirty or to cause skin complaints such as bakehouses, cement works, dyeworks and tanneries. Normal requirements of the Orders which have the same statutory force as Regulations, are the provision of protective clothing, washing facilities, baths, drinking water and a dining room.[1]

No preventative system is complete without personal and environmental monitoring and the enforcement of certain standards. Environmental monitoring involves, for example, regular sampling of the atmosphere for noxious dusts and vapours, and checks on noise levels. The Health and Safety Executive uses a set of standards for acceptable concentrations of noxious substances in the atmosphere of the workplace. These are a combination of their own determined 'Hygiene Limits' and the 'Threshold Limit Values' (TLV) issued by the American Conference of Governmental Industrial Hygienists.[2] As to personal monitoring, except in some obviously hazardous processes like the handling of lead where medical examinations are required by law, the employer has no statutory duty to provide medical supervision. Even in cases such as byssinosis where early identification would considerably reduce thelevel of suffering amongst mill workers by enabling, at least in principle, them to change occupations, and where the medical profession working in the field of occupational health have recommended regular examinations for several decades, there is still no statutory duty on

1 TUC (2nd edition, 1978), pp44-57.

2 Ibid. pp73-74. Ashford (1976), pp115-116.

employers to provide such cover. The statutory duties which do exist have, since 1973, been carried out by the Employment Medical Advisory Service which also acts as an advisory service for employers, trade unions, workers and general practitioners. Many of the large companies and most of the nationalized industries do however employ their own medical officer or occupational health nurse, and in some areas where many small firms are concentrated, voluntary health schemes have been set up financed by premiums from the firms which join. There are detailed statutory regulations regarding the provision of first aid equipment and training in factories.[1] As will be seen in the chapters that follow, awareness of these various preventative measures and the origins of the many Inspectorates unified in the Health and Safety Executive, emerged in the period 1780 to 1900.

Stress is now recognized as an industrial health hazard and the World Health Organization defines occupational health as:

> "The promotion of the highest degree of physical, mental and social wellbeing of workers in all occupations; the prevention among workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his/her physiological and psychological conditions." 2

It is discussed in many books on industrial psychology including Mclean (1979), McDonald and Doyle (1981) and Lennart Levi (1981) to name but a few.[3] The trade unions are aware of theproblems of stress at work and its effect on health, and attempt to counter such stresses in their efforts to improve low pay, change incentive systems, obtain better deals for shift work and new forms of work organization. However, there is little legis-

[1] **Kinnersly (1973), pp190-192. Safety and Health at Work, Report of the Committee 1970-1972. Robens Report (C 5034), pp115-123. TUC (2nd edition, 1978), pp57-58.**

[2] **McDonald and Doyle** *The Stress of Work* **(1981), p1. The underlining is my own.**

continued/...

lative 'control' of stress at work. Under the 1974 Act, employers have certain legal duties to provide information on such hazards to health but there are no provisions under which improvements in the working environment to alleviate stress can be required.[1]

The first person to stimulate research into stress was W B Cannon in 1909, as his research made physicians aware that the whole of an individual's social environment and living conditions were important to health. However, the main scientific studies into the relationship between stress and health came in the early 1940's with the studies of Wolf and Wolff in 1943, and multiplied after the Second World War.[2] As pointed out before, however, stress was very much a product of the factory system and although not specifically discussed in the 19th century, the Acts introduced to limit hours of work did alleviate fatigue brought about by psychological as well as physical factors.

Industrial safety is often viewed as a separate entity from health questions but in fact it is closely related. An unsafe situation can lead to stress thereby increasing the likelihood of an accident occurring and where a health hazard exists, people will be less efficient and may act carelessly. Several theories of accidents exist apart from the simple assumption of accidents being 'pure chance' or 'act of God', that is, that all persons exposed to the same risk have an equal liability to accidents. Most research has however, been into accident proneness.

George Haggalund (1966) studied the origin of this concept and traced the term "accident proneness" to the writings of Eric Farmer in 1926.[3] All research into

[1] McDonald and Doyle (1981), pp71-78 [2] Mclean (1979), pp17-35

[3] An unpublished thesis from the University of Wisconsin by George Haggalund. Summary of which is published in Ashford (1976), pp108-111.

[3] Ibid. Alan Mclean *Work Stress* (1979); Lennart Levi (ed) *Society Stress and Disease Vol 4: Working Life* (1981).

accident proneness begins with the assumption that some people are more liable to accidents than others, and a wide variety of variables have been considered to explain this. One of the most frequently considered factors is the effect of the age of the employee. From the work of Sutherland (1950), Mayer (1956), Froggatt (1962) and many others, the findings indicate that during the workers' teens and early twenties the number of accidents is high. There is then a significant decline in the accident rate during the late twenties and a further, slight decline until the mid to late forties when the number of accidents occurring again rises until the end of the working life. However, the youngest workers are also the least experienced and thus the effects of age and experience can easily be confused. Powell (1971) attributes the peak amongst young workers entirely to inexperience, whereas Delauney (1957) associates it with inattention, indiscipline and disregard for danger. Others, like Parker (1953) and J A Smiley (1955) have looked at the physical conditions of the employees. Parker related accidents to blood pressure and Smiley found that there was a higher rate of chronic disease amongst his accident prone workers and also that the latter lost twice as much time through sickness as the accident free. Some other factors looked to as an explanation of accident proneness are, e.g. rate of production (H L Horney 1953), fatigue (Vernon 1926), length of service (Van Zelst 1954), smoking (Lowe 1960) and shift hours (Vernon 1945). An early writer, Boyd Fisher (1922), looked at psychological factors such as lack of awareness of potential accident hazards, intelligence, deficiency of language and excitable temperament,which being variables hard to measure, caused much speculation.[1]

All the above mentioned studies concentrated on the person involved in the accident to the exclusion of the

[1] **The literature on accident proneness is reviewed in: A R Hale & M Hale** *A Review of the Industrial Accident Research Literature* **(1972), pp127-147. Also see Ashford (1976), pp108-110.**

situation. More recent research, such as Faverge (1970) and Winsemius (1969) has concentrated on this latter factor. Faverge analysed situations leading to unreliability and accidents and stressed the concepts of breakdown and degradation of the normal working situation and Winsemius drew up a theory of task structures and the disturbance in the task activity. Little attention, however, has been given to research into the efficiency of preventative measures. The usual approach is that put forward by H W Henrich which lays stress on careful investigation with accidents which do occur, and then, by examining the data and calculating the costs of the accident, developing accordingly, systems of machine guarding and safety devices and safe working procedures.[1]

In the period under study, the question of 'cause' of accident tended, however, to be discussed only in rather emotive terms. Employers then (as sometimes now) took the view that accidents occurred not because of the work situation being dangerous but because of 'moral'defects (carelessness, laziness, dirtyness, etc.) in the employees or individual peculiarities in them which the employers did not see as their responsibility. This contrasts with for example the Marxist view put by Carl Gersuny (1981) which sees accidents as 'caused' by the pressure to maximise production put on the worker by the capitalist employer.[2]

For there to be any improvement in health and safety at work, there needs first to be an awareness of the existence of a problem. This aspect is discussed at length in the thesis in connection with various trades and there is evidence to show that many of the workmen were themselves aware that they were engaged in hazardous occupations although they were not always certain of the

[1] Hale and Hale (1972), pp16-17, p80. H W Henrich *Industrial Accident Prevention* (3rd edition, 1950). Ashford (1976), p108.

[2] Carl Gersuny *Work Hazards and Industrial Conflict* (1981), pp25-27.

exact source of danger. An example of this is found in the pottery industry, where in evidence before the Children's Employment Commission in 1843, workers in the glaze departments often referred to the pernicious effects of the glaze, some identifying lead as the cause, but others being unaware of the ingredients which made up the dip.[1] Employers were not always ready to admit to any ill health amongst their workers, and employees themselves might not want to confess to any suffering, being afraid of reprisals by the employer, with possible loss of job and earnings. When Dr Whitley, in 1863 for example, attempted to make inquiries about conditions in the White Lead Works, he met with a total resistance from the employers on any questions relating to health.[2]

For improvement however there needs to be more than just an awareness by workers, as they are not generally in a position to take steps to help themselves (other than to pay more attention to personal hygiene and to use more caution in handling toxic substances) and even an awareness by employers is not, by itself, usually enough to improve the situation. They may not possess the technical or scientific skills necessary to understand the problem and to overcome it by the methods mentioned above (such as the substitution of a poisonous substance by a less harmful, or an effective system of ventilation), quite apart from the fact that it may not be in their economic interest to change their methods of production. A poignant case of this in the 19th century was the lucifer match trade, where a substitute for the extremely noxious white phosphorus had to be found and even though amorphous phosphorus was produced within the period which answered the needs, its use increased the cost of producing matches and

[1] G W Elliott *Some descriptions of pottery manufacturers and working conditions 1557-1844* (1970) contains extracts from the 1843 Children's Employment Commission.

[2] Dr George Whitley 'On the Occurrence of lead poisoning among persons who work with lead and its preparations' *6th Report of the Medical Officer of the Privy Council* 1863, pp350-351.

hence, despite the value in improving health conditions amongst the matchmakers, its introduction was resisted by many employers. It thus also needs an awareness and interest by doctors and others in a position to investigate the hazards more fully and to suggest preventative measures and remedies suitable for alleviating the problem. To be suitably substituted, measures had to either be sufficiently cheap for the factory still to be able to compete with 'unimproved' factories or the improvement had to be universally imposed by legislation.

From an awareness that a hazard exists, it is necessary that there be an understanding of the true nature of the hazard and its effect on the human body before improvements in the work situation can be required. In the case of injuries resulting from accidents, this is fairly obvious although as mentioned previously, in the 19th century there was no consideration of industrial psychology in the approach to accidents. Many factory owners commented that the person injured had no right to be in the area of the works where the accident occurred, or had been careless in their manner of working. The preventative measures adopted involved guarding and encasing machinery but there was a reluctance to fence horizontal shafts above seven feet or machinery in areas where workers generally did not pass. One type of accident however, namely explosions, did attract both attention and research. The main sources of explosions were firedamp in mines and boiler explosions. These were costly to the employer, not only because of the damage done to plant but in the loss of workings and often large loss of skilled labour both by death and extensive injury. For these reasons, it was of great economic interest for the mine owner or boiler owner to adopt any safety precautions possible and to reduce the number of explosions to the minimum.

The case of industrial disease, on the other hand, is not so easy to identify. Even today with increased scientific knowledge as well as the sophisticated technical aids to help in medical examinations, there are still many undefined areas, for example, the case of coalminers' pneumoconiosis which lies in an undecided area of dust disease classification between those with a benign and those with a fibrotic action. Identification of disease in an individual can also, even now, be a problem. For example, *The Observer* reported in August 1979 on the case of a coalminer who was denied compensation as the Government Inspector said he had not got pneumoconiosis, despite three leading specialists deciding that he was suffering from the disease. The same difficulty in identification is found amongst sufferers of asbestosis and byssinosis.[1] Classic examples of this kind of identification problem in the 19th century are the mysterious deaths amongst woolsorters which were later identified as anthrax; the problem of which particles in the metallic grinding processes were the more dangerous, the iron or the stone; and the protracted debate at the end of the century as to the cause of miners' nystagmus, whether it was due to poor illumination or the position adopted at work.

In regard to medical knowledge the state of anatomical understanding was good by the end of the 18th century. The circulatory system had been described by Harvey in the 17th century and there was a good comprehension of how organs such as the lungs, heart and eyes functioned. In 1796 Edward Jenner performed the first vaccination against smallpox which opened up new possibilities in preventative medicine, but one area in which knowledge was lacking, was in the field of bacteriology. Although the Dutchman Leewenhoek had identified bacteria in 1683, he had not related bacteria to human disease. Without the knowledge of bacteria, infectious diseases could not be effectively

[1] The Observer, 1979, August 12th.

controlled. The popular theory to explain infectious diseases at the time was that of 'miasma', emanating from the earth, swamps and areas of rotting vegetation and excreta. The cholera outbreaks of 1831-32 and 1848 also led to an understanding that disease could be carried in polluted water but it was not until the work of Pasteur in the second half of the 19th century, that the significance of bacteria was understood. This paved the way for further research amongst which that of Koch stands out, with the identification of an anthrax bacilli in 1876 and cholera in 1883.

The hospitals of the early 19th century were troubled with septic infections after amputations and erysipelas. They were often overcrowded with totally inadequate systems of ventilation, and mortality was high especially from surgical operations. However, improvements were made in the late 19th century by Lister, with the developments in antisepsis and asepsis which increased the chances of carrying out successful operations. Another problem facing the medical world in the advancement of knowledge was the lack of bodies for post mortem examinations. Many relatives refused to allow such examinations and throughout the period there was a general appeal by doctors for co-operation in this matter. A further important aid, especially in helping to identify lung diseases, namely the X-ray, was only available after its discovery in 1895.[1]

As to industrial medicine, it was not a novel concept in the early Industrial Revolution. The first text book on occupational health was 'De Morbis Artificum' written in 1713 by Bernardino Ramazzini and translated into English in 1746. Percival Pott produced a monograph on chimney sweeps' cancer in 1775 and interest had been shown in the health of the army and navy, with Lind in the mid

[1] For a history of medicine in this period see: e.g. Charles Wilcock *Medical Advance, Public Health and Social Evolution* (1969), Donald Hunter *The Diseases of Occupation* (4th edition, 1969), pp41-47.

18th century showing the value of citrus fruits in preventing scurvy. Occupational medicine did exist as a branch of medicine in the 19th century, if only modestly but one group which could have contributed more to the stock of knowledge on industrial disease was the certifying surgeons. These were appointed under the 1844 Factory Act[1] to certify as to the age and strength of children employed in the textile mills. Some, notably Arlidge and Purdon, were outspoken on the health and working conditions of the people they examined, and concerned themselves fully in publicising the information in order to get reform, but the majority, as shown by Stephen Huzzard (1976),[2] remained silent being willing simply to accept the fee for the certificate issued and no more.

Once the knowledge of the cause and effect of an industrial disease is available, the next step forward is the dissemination of that knowledge. As will be seen, some doctors wrote prolifically, both in medical journals and in pamphlet and book form, on specific industrial problems particularly those found in the areas in which they practiced. The annual conference of the B.M.A. in 1876 was devoted to industrial diseases. Local medical societies in areas where particular problems arose such as Bradford (anthrax) and Sheffield (grinders' disease) held discussions and the Pathological Society in the late 19th century frequently devoted some of its time to the discussion of industrially-produced lung diseases as seen from autopsies. One of the notable contributors in this field was Dr Greenhow, who also made two invaluable reports to the medical Officer of the Privy Council in 1860 and 1861 on areas which suffered from excessive deaths from lung diseases.[3]

[1] The 1833 Factory Act brought in the idea of certificates but until 1844 it was carried out by local doctors of the parent's choice. Certifying surgeons were not officially appointed until 1844.

[2] Stephen Huzzard 'The Role of the Certifying Factory Surgeon in the State Regulation of Child Labour and Industrial Health - 1833-1973' MA Thesis (Manchester) 1976.

continued/...

Towards the end of the century some trades journals like 'Chemical News' and 'The British Clayworker' carried articles on health problems within their sphere of interest. The Society of Arts throughout the century kept industrial health questions to the forefront of its readers' minds, frequently isolating one particular hazard and offering a premium for suggestions on how to alleviate it. Over the period many governmental commissions were responsible for the compilation of a mass of evidence from various industries whilst the Factory Inspectors, appointed initially only to investigate the age and hours of employment of children, young persons and women, and later to report on accidents, frequently commented on industrial diseases seen on their visits. They disseminated ideas about machine guarding, and from their visits to factories were able to pass on ideas from one employer to another. Information to the general public was more limited. Newspapers tended only to report cases of accidents, for they were more dramatic than disease, and when they did touch on industrial disease it was more likely to be a horrific example such as the plight of the lucifer matchmakers and the white lead workers.

The means of preventing hazards at work are discussed in the following text and broadly speaking, between 1780 and 1900 were more successful in the case of accidents than disease. Scientific discovery in the 19th century generally was the result of individual study whereas today it is frequently the result of a team of scientists or specialists working on research and development. In the 19th century scientific discoveries relating to health and safety at work were more likely to be the result of an individual responding, for example, to the premiums offered by the Society of Arts, or an employer experiment-

[3] E H Greenhow 'Report on Districts with Excessive Mortality from Lung Diseases' *3rd Report of the Medical Officer of the Privy Council* 1860; 'Second Report on Districts with Excessive Mortality from Lung Diseases' *4th Report of the Medical Officer of the Privy Council* 1861.

ing with ideas in his own works. All the modern concepts of prevention (isolation, substitution, etc.) were used but, as will be seen, tended to be applied in an ad hoc manner, and lacked a modern systematic approach. The tendency was towards personal protection for the individual and attention to cleanliness rather than reducing the risk at source. This emphasis on cleanliness emerged from the 'Public Health Movement', which, inspired by the 'miasma' theory, was concerned with removing filth and inspiring cleanliness, in order to combat disease. It mirrored the 'self-help' ethos of the age and had the advantage to the employer that it cost him little and shifted responsibility for disease from him to the employee. By suggesting or implying that industrial disease was due to a worker's low standard of cleanliness, the employer had a further control mechanism in his hands.

Besides an awareness of a problem and of how to prevent it however, there is also the question of the appropriate social and economic climate and sufficient motivation for change. Schilling (1981) maintains that there are four prerequisites needed before a society will consider questions of occupational health and safety.[1] These are firstly that there should be a certain level of philosphy on humanitarianism. Secondly, an economic need for an efficient and healthy workforce. Thirdly, that the workers themselves should have sufficient prospects of improvement in their standard of living that they want good health and lastly, that the state of medical knowledge is such that action can be taken.

Of these, the latter has already been discussed. If we consider the third prerequisite, the poor standard of health and expectancy of early death from other causes coupled with general poverty, contributed to a low motivation to press for improvements in working conditions.[2]

[1] Schilling (1981), p3.

[2] This shown in the Sheffield case study in Part 3, which discusses deaths from all causes and not just occupational diseases.

Many employees spoke of industrial disease as an inevitable fact of their employment and despite advice when they fell ill to seek another trade, frequently returned to their former job on recovering their health even when alternative employment was apparently available.

The late 18th/early 19th century was an age of 'laissez-faire' and 'self-help' but it was also a period in which champions rose up for some obviously under-priviledged and disadvantaged groups in society. Jonas Hanway and Thomas Coram founded the 'Foundling Hospital' in London in 1745 for abandoned babies, and in 1792, William Tuke started the Retreat in York for the mentally sick, where, for the first time, chains and irons were abandoned. The case of slaves was taken up by William Wilberforce and that of prisoners by John Howard and Elizabeth Fry. Thus, it is not surprising that it was children and, to a lesser extent, women and young persons to whom attention was first drawn with regard to factory conditions and it was the plight of pauper apprentice labour in the textile mills which first drew Government concern. Escalating poor rates in the early 19th century engendered anxiety over the cost of maintaining poor relief and the question of Poor Law reform was debated, a Royal Commission being appointed in 1832. The Malthusian philosophy of poverty and poor relief slanted the debate towards the manifestations of poverty rather than to its causes. The Commission in making its report in 1834 was influenced by the ideas of Bentham and its recommendations were based on two principles; first that fraud should be prevented by refusing poor relief to the able-bodied except on very severe terms so that it would only be sought in cases of real need; and secondly, the principle of 'less eligibility', that is, that the relief should be less than the income of the poorest independent worker in order to encourage return to normal work as soon as possible.[1]

[1] **C Fraser Brockington** *A Short History of Public Health* **(1966); Maurice Bruce** *The Coming of the Welfare State* **(4th edition, 1968), pp91-97. Hunter (4th edition, 1969), pp43-44. M E Rose 'The Anti-Poor Law Agitation' in J T Ward (ed)** *Popular Movements c1830-1850*

A further mid 19th century movement important to the creation of a climate of thought appropriate to encouraging improvements in working conditions was the 'Public Health Movement'. Industrialization had brought about a migration of labour from rural areas to the towns, bringing with it problems of overcrowding, with inadequate housing and inefficient drainage and water supply, causing ideal conditions in which diseases could spread. The population had increased rapidly in the first decade of the 19th century adding to the problem. The main stimulus to reform was the outbreak of cholera in 1831 and the emergence to prominence of Edwin Chadwick, who became the secretary of the Poor Law Commission set up in 1834. His main contribution was his 'Report on the Sanitary Condition of the Labouring Population of Great Britain' of 1842. This was followed by a Commission into the Health of Towns in 1843 which reported in 1844/45 and led to the 1848 Public Health Act. This Act set up a central General Board of Health for a period of five years. The movement was very much concerned with the fundamentals of sewerage, drainage, ventilation and water supply.[1]

Changes in attitudes to questions of health and safety at work over this period are also reflected by developments in the law. In particular, the tort (i.e. civil wrong) of negligence was scarcely recognized in any field at the beginning of the 19th century and judges tended to take the view that a person could sue another only for a deliberate wrong. Although during the century judges did begin to award damages for injuries caused by negligence, including negligence at work, there was a tendency, in line with the general 'laissez-faire' attitude, to take the view that the workman accepted the hazards of the workplace when he accepted the employment.

[1] C H Hume 'The Public Health Movement' in J T Ward (ed) (1970), pp183-200. Bruce (4th edition, 1968), pp65-67. Brockington (1966).

This area of law became dominated by the resultant doctrine of 'common employment'. This doctrine originated in an 1837 case, *Priestly v Fowler* (when a baker's employee was injured through another employee of the baker loading a waggon badly) and was that an employee could not sue an employer in respect of an accident caused by the negligence of a fellow employee unless it could be shown that the employer had been negligent in employing the man for his duties in the first place. As fellow employees included supervisors, foremen, etc. the scope for litigation was extremely limited. This doctrine technically survived until it was abolished by statute in 1948, but its significance was diminished by a series of judicial decisions during the latter part of the 19th century. After the passing of the Workman's Compensation Acts of 1897, 1900 and 1906, which enabled an injured workman (or the dependents of one killed at work) to obtain some compensation from the employer through aribtration in the County Courts as an alternative to suing for negligence, it was of even less importance.[1]

In his consideration of the attitudes of employers in the 19th century, Gersuny (1981) maintains that since protection of the worker from the hazards to his health and safety is a cost to the employer, the private employer, and in some instances even the State as employer, will resist providing protection. Since according to Gersuny, such protection is always desirable to the worker, there is always conflict between employer and employee over health and safety at work. He sees this to be as much a facet of the class struggle as bargains over wages. Even in the context of the 19th century, however, this appears to be an oversimplification of the situation.

[1] Two other points to be remembers are: 1. until the Fatal Accidents Act, 1846 the dependents had no right to sue if the employee was killed, which led people to remark that it was cheaper to kill a man than maim him; 2. suing was always expensive for the common man but before the local 'County Courts' were created in the 1840's all civil litigation was done in London which made it even more costly.

To begin with the norms of society were different and while undoubtedly there were employers who exploited labour in hazardous conditions, others appeared indifferent providing little or no protection for health, while yet others took an initiative and introduced steps to suppress hazards at work.[1]

Pressure for change could come from several sources. There is little evidence of pressure from within the workforce itself, though it must have existed. Contrarily, in the case of the Redditch grinders, there is evidence of opposition to reform. These grinders were engaged in a particularly dangerous occupation and were paid 'danger' money. They believed that any improvements which reduced the level of dust in the workplace thus reducing the danger to health, would also affect the wages they received. They argued that wages would be further reduced as improvements lengthening the life of the pointer would create a buyer's market thus lessening their ability to command high wages. For workers to press for reform, presupposes an articulateness and degree of organisation in the workforce that seldom existed at the beginning of the period. Friendly societies and sick clubs were formed to make savings against sickness, old age and death, but they did not agitate for improvements in conditions at work. The early trade unions, as they appeared, were fundamentally concerned with wages and conditions of work in the sense of shorter hours and restrictions of entry, rather than with actual health issues. There were exceptions, for example, the Miners' Association which in the 1840's petitioned the Government for improved safety measures in mines together with the appointment of inspectors, and unions in the pottery industry which in the last two decades of the century campaigned for the use of leadless glazes but much of the labour occupied in unhealthy trades was unskilled and remained outside the union movement until the end of the

[1] **Gersuny (1981).**

19th or early 20th centuries.[1]

An important incident in the development of measures to promote the health of factory workers was the outbreak of fever at Radcliffe cotton mills, near Manchester, in 1784. The inhabitants of the neighbouring town were alarmed that the fever might spread beyond the mill and they invited Dr Percival and several other medical gentlemen from Manchester to investigate the cause of the contagion and advise on the best means of preventing its spread. In their report, Dr Percival and colleagues went much further than directed and commented on the conditions of the children and the nature of their work. Percival also set up a Board of Health for the Manchester area in 1795 and a year later, this Board published a report on the condition of children in the large cotton mills.[2]

The mills at Radcliffe were owned by Robert Peel, the elder. He was very much influenced by the above reports and was responsible for introducing the Bill which became The Health and Morals of Apprentices Act, 1802. The Act was limited in its application restricting the working day of pauper apprentices in cotton mills to twelve hours as well as stipulating requirements for education and the ventilation and limewashing of factories. As Hutchins and Harrison comment (1903) the 1802 Act was rather an extension of the Elizabethan Poor Law than a conscious attempt to provide for better conditions at work.[3] It was meant to be enforced by the Justices of the Peace but was ineffectual due to a conflict of interest since many of them were also factory owners.

1 **Henry Pelling** *A History of British Trade Unionism* **(2nd edition, 1971), pp13-122. Gives a general history of unions up to 1900.**

2 **A Meiklejohn 'Outbreak of fever in cotton mills in Radcliffe 1784'** *B.J.I.M.* **1959 Vol.16, pp68-69; Hunter (4th edition, 1969), p111. J V Pickstone 'Ferriar's and Kay's cholera: disease and social structure in cottonpolis'** *Bulletin 27, The Society for the Social History of Medicine* **1980, pp19-21.**

3 **B L Hutchins and A Harrison** *A History of Factory Legislation* **(1903), p2.**

The Radcliffe incident and the 1802 Act had however set a precedent: the public had been alerted to the question of occupational health and the Government had attempted to do something about it; in the next few years there was further minor legislation on youth labour in cotton mills and in 1831 a Select Committee on factory children's labour was set up under the chairmanship of the Tory philanthropist Michael Sadler. This led to the important step of establishing the principle of factory inspection, with the appointment of four Factory Inspectors under the 1833 Act.

J T Ward (1970)[1] has studied the groups involved in the early factory movement and Hutchins and Harrison (1903) have given a comprehensive review of 19th century factory legislation. Only the most general framework will be given for the present. One drawback of the early legislation was the limited areas of industry covered which was partly due to an absence of consensus on what constituted a factory. The 1802 Act was concerned only with cotton mills and the pauper apprentices employed in them. The 1833 Act extended coverage to all children and young persons working in cotton, woollen, worsted, hemp, flax, tow, linen and silk mills. The allied textile industries of printworks, bleach and dye works, and lace factories were only included in a piecemeal fashion between 1834 and 1864, and legislation on mines developed separately from 1842, after revelations of the harsh conditions in which children, young persons and women were employed. But legislation was slower in other sectors. The manufacture of earthenware, lucifer matches, percussion caps and cartridges, and the trades of paper staining and fustian cutting were only brought within the scope of the Factory Inspectorate in 1864 and other industries by the Factory Act Extension Act, 1867. Control of workshops, establishments employing fewer than fifty persons, were brought under Government legislation in the Workshops

[1] J T Ward 'The Factory Movement' in J T Ward (ed) (1970), pp54-77.

Regulation Act, 1867, but in this case, the local sanitary authorities were made responsible for the administration of the law. This requirement was a failure as there was a general unwillingness on the part of the local authorities to undertake the duty, so under the Factory Act, 1871, the administration of the Workshops Regulation Act was given to the Factory Inspectorate. The increasing workload on the Factory Department led to the appointment of more inspectors and the introduction of sub-inspectors.[1]

Although the early Factory Acts were concerned with hours of work and age of employment in the textile factories which indirectly had an influence on health and safety by reducing stress, there was no enactment against specific dangers. Due to pressure from the Factory Inspectors, legislation was drawn up with regard to the fencing of machinery and shafting in 1844 and although inadequate, provided a starting point for further developments in this field. With regard to health, the 1864 Act spoke generally of keeping the factory in a clean state and having ventilation to evacuate gases and dusts as far as practicable. The Factories Act Extension Act 1867 went a little further. It prohibited the taking of meals by children, young persons and women in rooms where the grinding and cutting of glass were carried out and also gave the Inspectors powers to require the installation of fans to carry off dust generated in grinding, glazing or polishing on a wheel. In 1878, the employment of children and young persons was prohibited in certain branches of white lead and other factories and an Act of 1883, required occupiers of every white lead works to draw up Special Rules which were to be given to the Chief Inspector of Factories for approval by the Secretary of State. An important advance was made in 1891 when the Secretary of State himself, was given powers to

[1] For a full list of the major 19th century Factory Acts see Appendix I.

draw up Special Rules whenever a process or machine had been declared dangerous or injurious to health or limbs.[1]

From the account which follows, it is evident that some employers introduced health and safety measures voluntarily, motivated sometimes by humanitarian and sometimes by economic principles. Then, as now, legislation was needed for large scale compliance with advanced ideas on health and safety. The time lag between the invention of a health and safety improvement, its first use, its widespread application and its becoming compulsory, are all considerations discussed in the thesis. Oliver MacDonagh (1958)[2] in discussing the question of a revolution in 19th century Government legislation has put forward a model which is useful to bear in mind when considering 19th century legislation on health and safety issues. He sees the origin of 19th century legislation in the sensational exposure of a social evil and rarely from routine and regular inquiries. As a result, legislation was drawn up with good intentions but with many inadequacies. The second stage in the model was the realization of the ineffectual nature of this first legislation and the fact the the original evil had been left largely or perhaps even totally untouched. This was due to the inadequate understanding of the real conditions by those drawing up the legislation and bias of the local magistracy who were to

1 The Factories Act Extension Act and the Workshops Regulation Act of 1867 were the first in the field of regulation of industrial conditions to use the device of subordinate legislation by Order of the Secretary of State (which did not have to be debated in Parliament, though either House of Parliament could annul the Order within 40 days of its being made). With the extension of the Factory Acts to all trades it had been found impossible to apply one uniform code and the Secretary of State was authorized to issue orders modifying the general provisions of the Factory and Workshops Act. The modifications, however, were definite, laid down in the Act. The Orders of the Secretary of State under the Factory and Workshop Act 1878 were concerned with widening or narrowing the classes of factory to which certain of the regulations contained in the Act itself applied. It was only later that the Secretary of State was given powers to make the detailed regulations themself.

2 Oliver MacDonagh 'The 19th century revolution in Government: a reappraisal' *The Historical Journal* 1958 Vol.1, pp52-67.

enforce it. As a result, executive officers were appointed to look at conditions and enforce the law. This led to a third stage in which the officers appointed soon realized the deficiences of the law and through their annual or occasional reports gave more evidence of the extent and nature of the conditions. They demanded new legislation and centralization to increase efficiency and uniformity in the application of the legislation. The fourth stage in MacDonagh's model was a change of attitude by the administrators and the realization that the problems could not be solved by one grand piece of legislation and that the original concept of the field of regulation was too narrow. The fifth and final stage was a move towards a more dynamic role for the Inspectorate in which they did their own research, consulted experts and collected statistics; and in which they not only advised Parliament but themselves drew up the regulations under their powers of delegated legislation.

This model is well illustrated by the way health and safety legislation developed in the 19th century and by 1900, as will be illustrated in the text, this fifth stage had been reached and the way laid open for the modern system of health and safety at work.

But why study the history of industrial medicine? Research in the present century into the history of medicine has predominately been the concern of the medical profession and has tended to look at the chronological development of medical discoveries, and the growth in the application of scientific knowledge to medicine. Other areas of interest have been histories of medical institutions and the biographies of personalities who have made some outstanding contribution to medical knowledge or welfare.[1] In short, the main

[1] **Examples of works on the great medical discoveries or specific institutions or personalities are:**
C. Singer *A Short History of Medicine* **(1928, 2nd edition by C. Singer and E A Underwood 1962); Douglas Guthrie** *A History of Medicine* **(1945); Henry E Sigerist** *A History of Medicine* **(1960);**

continued/

discussion has centred on the great medical achievements of a few individual doctors - Dr Woodward's 'To do the Sick no Harm' (1974) apart - and relatively little attention has been given to the medical profession at large, to the question of why such developments in medical science occurred when they did, or to the society at the receiving end of such treatment. As F B Smith writes, "patients loom small in medical history".[1]

To fill the gap there is a need for a wider approach to the subject of medical history, in order to examine more closely the relationship between doctor and patient, and the influence of medicine in society and vice versa; a need for more society-orientated studies, rather than doctor-orientated. This has been partly met by the growth of interest in the social history of medicine and the formation of a Society of that name, which aims to draw together scholars from the various branches of medicine, history and the social sciences.

Within this field there have been a number of studies on topics of public health and social and preventative medicine. These have generally followed the pattern of administrative or legislative advances at national or local level, or have been concerned with the technology of sanitation. Several biographies of notable 19th century exponents of public health have also appeared. Other themes touching this area include historical demography, the standard of living, poor law reform and poverty. With the growing feminist movement, it is not

[1] John Hugh Woodward *To Do the Sick No Harm* (1974); F M Smith *The People's Health 1830-1910* (1979), p9.

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continued

Charles Wilcock (1969); W Brockbank *Portrait of a Hospital* (1952); Jo Manton *Sister Dora* (1971); Cecil Woodham Smith *Florence Nightingale 1820-1910* (1951); R J Godlees *Lord Lister* (3rd edition, 1924).

surprising that there has been an equal interest in the health and welfare of 19th century women.[1] As to the question of the patient's role in medical affairs, F B Smith has made an invaluable contribution with his book entitled 'The People's Health, 1830-1910'. This contains an extensive account of Victorian medicine from the patients' point of view and is mainly compiled from medical and other contemporary periodicals. Smith surveys the welfare of the individual from childbirth to old age, making some attempt to assess the benefits to the individual arising from the large investment in sanitary improvements and changes in medical practice. His study, complementing that of Professor McKeown,[2] suggests that with the exception of vaccination against smallpox and the post-1880 developments in anaesthesia and antisepsis, medical science had little to offer the 19th century population in respect of better health and longevity, and that any improvements on these fronts were more likely to have come from improved diet and better conditions at home and work. McKeown however only uses negative evidence to support his statements that improvements came from improved diet.

[1] For example: G Rosen *History of Public Health* (1958); C Fraser Brockington (1966); S F Finer *Life and Times of Sir Edwin Chadwick* (1970); R J Morris *Cholera 1832* (1976); E A Wrigley *Population and History* (1969); D V Glass & D E C Eversley *Population History: essays on historical demography* (1965); Arthur J Taylor *The Standard of Living in Britain in the Industrial Revolution* (1975); John Burnett *Plenty and Want: a social history of diet in England from 1815 to the present day* (1966); M E Rose *The Relief of Poverty* (1972); Margaret Llewelyn Davies (ed) *Maternity: letters from working women* (1915, reprint 1978); C Dyehouse 'Working Class mothers and infant mortality in England' *Journal of Social History* (1978), Vol.12; F F Cartwright *A Social History of Medicine* (1977).

[2] T McKeown & R G Brown 'Medical Evidence related to England's population changes in the 18th century' *Population Studies* 1955; T McKeown *The Modern Rise of Population* (1976); McKeown consistently argues the case for the ineffectual effects of vaccination in the past.

Although several of the general industrial histories make passing reference to the health of the workforce, on the whole, the subject of industrial health has been neglected, and to stimulate research in this area the Society for the Social History of Medicine is to devote its 1983 conference to this topic. The main exception in this neglected area is the condition of child labour which has received some attention, many of the writings being based on the extensive reports of the Parliamentary Commissioners in the 1830's and 1860's. Another exception is George Rosen's work on the diseases of miners in which he details their diseases from the ancient world to the present century (1943), reviewing the material in the light of how it was understood at the time. Recently Stephen Huzzard (1976) has assessed the role of the certifying surgeon, both in regards to state regulation of child labour and on industrial health. He examines the development of their role and their value to society.[1]

The standard reference book on industrial hygiene however is Donald Hunter's 'The Diseases of Occupation' but, although this contains a number of historical chapters, it is written by a medical practitioner for members of the medical profession practising in occupational health. When he turns his attention to individual occupational diseases, his interest lies more with the current state of knowledge of the disease, with a brief outline of the historical chronology of events which led to its identification and treatment, and there is no discussion of the wider social implications. Another problem with the book is that over the years a number of new editions have appeared, each containing additional material on recent advances but there has been no real re-assessment of the historical material in the light of the new, so that the

[1] Marjorie Cruickshank *Children and Industry* (1981); Clark Nardinelli 'Child Labour and the Factory Acts' *The Journal of Economic History* 1980 Vol.XL, pp739-756; Ivy Pinchbeck *Children in English Society Vol.II* (1973); G Rosen *The History of Miners' Disease* (1943); Stephen Huzzard MA Thesis (1976).

historian, who has not already been confused by unfamiliar medical jargon, may well find its contents impossible to digest.[1]

Other medical practitioners, in particular Andrew Meiklejohn and W R Lee, have also written historical accounts of occupational medicine. Meiklejohn has concerned himself with the studies of prominent 19th century writers on industrial health and the significance of their work in relation to modern understanding. He has also looked at lung diseases amongst coal miners, and silicosis and lead poisoning in potters. Lee has written more generally on the emergence of an industrial health conscience amongst the medical world. The main outlet for their writings has been the British Journal of Industrial Medicine, which has also reprinted some of the 19th century essays in this field. Another aspect of industrial health which has received attention is the progress in factory and mine legislation and the roles played by their corresponding Inspectorates.[2] But many occupational diseases have received no attention at all from historians. Moreover, there has been no attempt to take a broader look at the subject of industrial health and safety during the period of industrialization or to look at the emergence of a 'safety conscience' and to assess the value of the preventative measures suggested or adopted. The extent and incidence of industrially-induced disease from the Industrial Revolution to the end of the 19th century is unknown in many industries, as is the extent of the awareness of such problems amongst

[1] *The Diseases of Occupation* was first published in 1955. The 6th edition appeared in 1978.

[2] For example: Treve Holman 'Historical Relationship of Mining, Silicosis and Rock Removal' *B.J.I.M.* 1947 Vol.4, pp1-29; A Meiklejohn 'History of Lung Diseases of Coal Miners in Great Britain 1800-1943'- in three parts, *B.J.I.M.* 1951 Vol.8, pp127-137, 1952 Vol.9, pp93-98 and pp208-220. A Meiklejohn 'Thesuccessful prevention of silicosis among china biscuit workers in the North Staffordshire Potteries' *B.J.I.M.* 1963, Vol.20, p255-263. W R Lee "Emergence of Occupational Medicine in Victorian times' *B.J.I.M.* 1973, Vol.30, pp118-124; J T Ward *The Factory System Vol.2* (1970).

workers, employers and the public at large. This thesis attempts to shed some light on these questions.

There are many problems facing the historian investigating medical subjects, not least of which is the problem of terminology and the changing use of medical terms over time. For example, on turning to any 19th century medical literature, the term phthisis will be met. This term was attached to a kind of wasting illness for which there is no exact modern equivalent and due to the fact that it was often accompanied by pulmonary tuberculosis, it was often used as a synonym for pulmonary consumption. Diagnosis was difficult in the absence of x-rays and advanced pathological techniques, and was mainly based on physical symptoms and on the patient's own report on how he or she felt which is open to misinterpretation. In many cases the symptoms may have had their origins in an unhealthy occupation.

In studying occupational health specifically, other problems are encountered. How, for example, can we be certain that effects on morbidity or mortality rates are caused by occupational factors rather than by infectious diseases, home environment or poor nutritional value of the diet? Other considerations to bear in mind are those like the mobility of labour between occupations. Many industrial diseases were not immediate in effect but lay latent for several years before any symptoms were felt, in which time the worker might easily have changed jobs and would therefore be unlikely to associate his illness with his former occupation and so the cause of the illness might thus go unrecorded. Another problem was the reluctance of some workers to admit to any form of industrial disease, as it might jeopardise future employment and thus they might return answers of good health to any enquiries. The final recorded cause of death might also hide a long history of some other illness. Many workers were weakened by occupationally-linked asthma or bronchitis, but were finally carried off by heart disease or one of the infectious diseases, which as seen earlier, remained uncontrollable until the germ theory and knowledge of transmission was fully understood. Whilst infectious diseases were causing the death of a large percentage of the population, the true extent and significance of occupational disease was hidden from general observation.

A further major problem in studying 19th century industrial health is the limitation of sources. Arlidge's textbook, 'The Hygiene, Disease and Mortality of Occupation' (1892), is an invaluable starting point and most of the medical journals carried articles on industrial health at some stage in the century, the output of such articles increasing proportionally as the century progressed. Several doctors also wrote detailed papers and pamphlets on the notable industrial diseases of their area.[1] Apart from the medical sources, there are numerous Parliamentary reports, both from special commissioners appointed to certain topics and from the annual reports of the Inspectors of Factories and Mines. The reports made to the Medical Officer of the Privy Council are also a rich source of material, particularly those of 1860 and 1861 containing Dr Greenhow's surveys on lung diseases.

Statistical material is available from some of the medical journals and also from the Registrar General. Births and deaths were registered from 1837, although there was a considerable amount of under-registration to begin with and it was not until 1855 that the reports contain information on selected causes of death, given by registration districts. A decennial report giving statistics of death rates for different trades and occupations was then made. Other records of morbidity and mortality rates can be found in some of the reports made by the Local Medical Officers of Health.

[1] **For example: Dr Holland and J C Hall on the Sheffield Trades, Dr Purdon on the flax industry in Belfast and Dr Peacock on millstone makers.**

Information other than from medical practitioners or Government is not so easy to find. The Society of Arts, from its inception, took an active interest in industrial hygiene and offered various premiums for ideas on health and safety. Occasionally there are reports of other societies making similar awards. Contemporary newspapers often provide information on the occurrence of industrial accidents, although seldom make reference to industrial disease. The interest of employers and employees is particularly difficult to assess, as, apart from the evidence in Parliamentary reports, little material appears to have survived. The prescription books of the doctor attached to Styal cotton mill appears to be an exceptional survival. Information on the existence of sick clubs and benefit funds is sometimes available as will be seen in the case of the Worcester potteries, but care has to be taken not to read too much into the limited, available records about such institutions. Few firms appear to have kept their own records of sickness absence or if they did, the records have not survived. The Deanston mills of Perthshire do appear to have kept just such records and although still in existence in 1945 have now disappeared.[1] The various trades journals occasionally provide information and it may well be that the records of trade unions might reveal further material; but as this thesis is primarily concerned with the growing awareness and recognition of industrial disease and only secondarily with subsequent movements for reform, time has not permitted an examination of these sources. Secondary sources suggest that their attention was more concerned with hours of work and levels of pay, than with industrial accidents or disease. The reduction in hours of work must have reduced the incidence of accidents, although the connection between the two may not have been recognized at the time.

[1] Styal and Deanston Mills will be discussed in Part One under 'Organic Dust Diseases'. The Worcester Potters are dealt with in Part Three.

Coupled with the problem of sources is that of how to classify the material obtained. There are two basic ways in which industrial disease can be examined. It can either be classified, as now, by type of disease, that is physical, chemical, biological or psychological, or by examining each industry in turn, as Ramazzini did, and observing which complaints most commonly occurred. Neither method would be entirely satisfactory for the 19th century. To take each industry as a separate entity would incur much repetition as certain problems were not isolated to one industry. For example, lead poisoning was found amongst white lead workers, lead smelters, potters, filecutters, glass cutters, plumbers, foundry trade workers and many others. To look at industrial health solely by disease categories would also not be satisfactory as 19th century physicians tended to be concerned with diseases in their own locality, linking them with individual industries rather than regarding them as an example from within a larger category of disease. This is particularly noticeable with the dust-inspired illnesses which went under such names as "miners' asthma", "pointers' rot", "black-spit","card-spinners' asthma", "the pounce", "millers' creeping pneumonia", "potters' lung" and "grinders' asthma" to name but a few. A modern classification (Table I, Schilling 1981) however, shows a far wider range of industrial disease than was recognized in the 19th century, when attention was directed mainly at the toxic substances. For this reason, a simplified classification of disease has been devised (Table II) under which each industry is discussed separately unless information was drawn together at the time which saw the disease on broader terms. By this method needless repetition is avoided and while using the benefits of 20th century medical knowledge it is possible to make use of the material produced by 19th century observers without over-stretching it. Industrial accidents have been treated as a category on their own.

TABLE I: Classification of Industrial Disease, according to R S F Schilling 1981

Category	Examples of Type of Agents or Factors	
1. Physical	Radiation High or Low Atmospheric Pressure High or Low Temperature Noise Vibration	
2. Chemical	Drugs Dyes Explosives Fertilizers Fibrogenic Mineral Dusts Paints Pesticides Plastics Solvents Wood, plant and organic dusts	
3. Biological	Viral Diseases:	Rabies Hepatitis, types A & B
	Bacterial Diseases:	Anthrax Brucellosis Leptospirosis Tetanus Tuberculosis
	Fungal Diseases:	Dermatopyloses Histoplasmosis
	Parasitic Diseases:	Ancylostomiasis Schistosomiasis
4. Psychosocial	Work Organization:	Leadership style* Communication* Worker participation and fulfilment" Security*
	Type of Work:	Repetitive Overloaded Underloaded Shift Work

Source: R S F Schilling *Occupational Health Practice* (2nd Enlarged edition, 1981), p584.

* These factors may help to promote well-being; short-comings or lack of them may cause ill-health.

TABLE II: Classification of Industrial Disease used in this Thesis

1.	Toxic Metals	Arsenic Copper Lead Mercury Phosphorus Zinc
2.	Dust Diseases	Organic dusts Inorganic dusts
3.	Gases and Vapours	
4.	Infectious Diseases and Fevers	
5.	Skin Disease and Occupational Cancer	
6.	Physical Agents	Eye Diseases and Injury Compressed Air

In order, however, to see the problems of, and growth in awareness of, health and safety at work in the 19th century more specifically, three short case studies have been made on the Sheffield Grinders, Worcester Potters and the Glasgow Eye Hospitals. Although sources on industrial health are limited, the three studies reflect different problems of industrial hygiene. The Sheffield Grinders are well known for having been employed in an unhealthy trade and an attempt is made to evaluate the truth of the allegations, the real extent of the problem and how it was approached. The pottery trade is usually discussed in relation to the North Staffordshire area, where environmental factors were also responsible for the high incidence of lung diseases and so it is of interest to examine the health of the workers at the Worcester potteries, where the extent of production was smaller and the atmosphere of the surrounding region less subject to pollution. The study of the Eye Hospitals in the Glasgow region shows the extent of what might appear at first a minor industrial problem and the efforts made to help sufferers from eye injuries at work.

This thesis then is mainly concerned with the growth in awareness and understanding of hazards to health and safety at work between 1780 and 1900 amongst the medical profession, Government, employers, employees and general public, the way in which such knowledge was disseminated and the resulting action. But the Robens' Committee on Safety and Health in 1972 reported:

> "Every year something like 1,000 people are killed at their work in this country. Every year about half a million suffer injuries in varying degrees of severity. Twenty-three million working days are lost annually on account ofindustrial injury and disease."

And,

> "Apathy is the greatest single obstacle to progressive improvement." [1]

This was said of an age in which are claimed to have been rapid advances in occupational health. What then could be the position of industrial medicine in the 19th century when industrialization was a new phenomenon and knowledge of certain industrial diseases only just emerging?

[1] Robens Report (1972), p1 and p151.

PART ONE

INDUSTRIAL DISEASE

1. TOXIC METALS[1]

Metals are employed in industry not just in their pure form but also as salts, as well as inorganic or organic compounds. The toxicity of these salts and compounds is not necessarily the same in degree or effect as the toxicity of the metal itself, the variation being due to the differences in chemical structure and physical form. Not all metals are harmful but several produce serious, adverse effects on health and others can prove fatal.

There are three ways in which toxic metals can enter the bloodstream. These are through the skin, ingestion or inhalation. Absorption through the skin is not particularly important for metals with the exception of mercury and some lead compounds. As for gastro-intestinal absorption, although of minor importance today, it was of far greater significance in the 19th century, when rules on hygiene were not strictly enforced, when food was often consumed in the same areas of factories and workshops as toxic materials were handled, and washing facilities were often absent. The most important method of entry for occupational poisons to the bloodstream is, and was, absorption through the lungs.

The harmful substances can be inhaled in the form of dust, vapour or fumes. However, it does not necessarily follow that all inhaled material is absorbed but once it is in the bloodstream, the poison is transported throughout the body. It is thus able to attack many vital organs, in particular those of soft tissue like the liver and kidneys

[1] Although this section is entitled toxic metals, it also includes a discussion of the non-metal phosphorus and the semi-metal arsenic. Both these substances were in wide use industrially throughout the 19th century and both caused industrial poisoning in the same way as the toxic metals. For this reason, they seem more logically included in this subdivision of occupational disease rather than any other. Hence, in the remainder of this section, when the term metal is used generally, it also includes these two substances.

or the nervous system. Some toxic substances can also be stored in the body for an indefinite period, such as lead in bone and mercury in the kidneys, and they are then released over a period of months or years. Metals and their salts and compounds can also cause irritation of the skin, exciting dermatitis and ulcers. Some are also carcinogenic, causing cancer of the skin or when inhaled, lung cancer.

As the action of each metal and its compounds varies considerably, the following discussion deals with each metal separately, the order being purely alphabetical and of no significance to their relative importance as an industrial hazard.[1]

1.a. Arsenic

Arsenic and its compounds were used in many industries in the 19th century; in the enamelling trade for example and, at the beginning of the century, as an ingredient in pottery glazes. White arsenic was used in the preservation of hides, skins and furs, and it was also used in the manufacture of glass to remove the greenish tint caused by iron oxide. Some of the aniline dyes contained arsenious acid, although the main use of arsenious acid was in the production of arsenite of copper, known in the trade as emerald green. During the last century this was extensively used in the arts as a colouring pigment.

> "It affords colour for wall-papers, artificial flowers, fruits and seeds, and at times, most shamefully, for articles of confectionery. It also is an ingredient in the coloured composition used by printers and lithographers, and gives the gay green hue to the muslin-like material worn by ladies under the name 'tarlatan'."[2]

[1] For general information on the toxicity of metals see: Hunter (4th edition, 1969) pp232-233, and Jeanne Stellman and Susan Daum *Work is dangerous to your health* (1973) pp242-244.

[2] B.M.J. 1878 August 17th, p243.

Arsenic, if swallowed, shows the symptoms of a traditional poison, that is nausea and faintness, followed by violent vomiting and diarrhoea, cramps, convulsions and coma, but this type of acute poisoning is usually associated with suicide cases, or when taken to procure an abortion or used for criminal purposes. In industry, where arsenic and its compounds are handled, the resultant illness is more likely to be chronic poisoning caused by exposure to the harmful fumes and dusts. It can affect the nerve endings in the hands or feet and cause heart disease. The fumes and dust also act as an irritant on the skin causing rashes and ulcers, or the nose which often leads to bleeding, or the eyes resulting in corneal damage.[1] Where it comes into local contact with the skin, it can cause skin cancer and after years of exposure to inhaling the dust, some people develop lung cancer.[2] In the 19th century, arsenic compounds were also used in medicine, in particular for the treatment of syphilis, psoriasis and other skin ailments.[3]

[1] Stellman & Daum (1973) p245; J.A.C. Brown *Pears Medical Encyclopaedia* (1977) p57.

[2] Hunter (4th edition, 1969) pp337-338. In 1820 the Cornish physician, John Aynton Paris, alleged that during his time in Penzance (1813-1817), he had noticed that the arsenical fumes from the smelting works had sometimes caused scrotal cancer amongst the tin smelters. Later investigations were made into the subject but it was never substantiated. In 1879, Haerting and Hease discussed the lung disease found amongst the miners of Schneeberg and decided that the cause of the illness was the inhalation of arsenical dust.

[3] Hunter (4th edition, 1969) p338; Brown (1977) p57.

The centre of the arsenic industry in Britain was based around the tin and copper mining areas of Cornwall, with the Devon Great Consuls Mine being the largest producer. This was because the extracted ore was made up of copper, tin, arsenic and sulphur. Arsenical vapours, among others, were present in smelting and refining the ore. Bryan Harvey in the British Journal of Industrial Medicine of 1970, quotes an early reference to arsenical vapours in copper smelting from the travel book of the physician William George Manton, who, in 1794, visited a copper smelting house in Hayle, Cornwall. He wrote:

> "Nothing can be more shocking than the appearance which the workmen in the smelting houses exhibit. So dreadfully deleterious are the fumes of arsenic constantly impregnating the air of these places and so profuse is the perspiration occasioned by the heat of the furnaces that those who have been employed at them but a few months become most emaciated figures and in the course of a few years are generally laid in their graves. Some of the poor wretches who were ladling the liquid metal from the furnaces to the moulds looked more like walking corpses than living human beings." [1]

In order to obtain the arsenic, the ore was first crushed and then roasted or calcined. The sulphur and arsenic were thus driven off in the form of vapour and conducted along long flues in which the arsenic was deposited, whilst the sulphurous fumes passed on into a tall chimney and then into the atmosphere. The arsenic was then removed from the flues, crystallized and later reduced to a powder ready for sale.[2]

From the evidence of the medical journals, illnesses arising from the work of obtaining arsenic appear to have been only minor. A report from Mr Reed of Pool in Cornwall in 1878, stated that when the arsenic dust came in contact with the skin, it proved irritating and pustules might develop but that amongst the workmen, there were some individuals who 'literally wallow in it' when they

[1] **Bryan Harvey 'Notes & Miscellanea: who started it all?'** *B.J.I.M.* **1970, Vol. 27, p83.**

[2] **J.T. Arlidge** *The hygiene, diseases and mortality of occupation* (1892) p432

collected the arsenic from the flues and who did not seem to suffer at all.[1]

There is no indication in the reports of any preventative methods being adopted by the workmen, although it seems possible that they were.[2] A report of the production of arsenious acid in Silesia in 1854 spoke of the workmen as wearing:

> "a leathern dress, carefully fastened round every part of the body, and also over the head, which is further protected by a leathern helmet, furnished with glass eyelits. Under the helmet the mouth and nostrils are covered with a wet sponge or moist linen for the purpose of filtering the air necessary for respiration."[3]

In its use in industry, a case of arsenical poisoning in the enamelling trade was reported by the Medical Times in 1843 but a greater hazard connected with this occupation was lead poisoning and more attention at the time was directed towards this problem.[4] As with other industries in which vapours and fumes were mixed, only the main source of danger tended to be identified with the effects of others

[1] *B.M.J.* 1878 August 17th, p244. In 1899 however, (*B.M.J.* 1899 April 15th, p926) there appeared a report from the Tavistock Board of Guardians, noting the number of cases coming on the parish for support who had been disabled from the arsenic works due to respiratory disorders. The same was true in the Parish of Calstock. They believed it was due to the inhalation of arsenical fumes.

[2] In the *B.M.J.* 1897 February 27th, pp547-548, the case is reported of an 8 year old girl who had fallen into a flue in which arsenic had accumulated at the East Pool dressing floors, Camborne, Cornwall. She was rescued quickly but was covered in arsenic dust and although she received professional treatment, she died ten days later. The report in the journal does not state that she died of arsenical poisoning, but it is implied, hence for it to be said that some workmen did not suffer at all after working in the flues, it would seem that they must have worn some form of protective clothing.

[3] Charles Tomlinson *Cyclopaedia of useful arts, Volume 1* (1854) p71.

[4] *The Medical Times* 1843 October 21st, pp39-40. See pages 84-85 for a discussion of lead poisoning in the enamelling trade.

being speculated on from time to time. Similarly in the pottery industry, the effects of using arsenic in the glaze were overshadowed by the use of lead glazes. Before the identification of anthrax, many tanners and furriers blamed any illness in their trade on the presence of white arsenic for preserving the hides and furs. Some cases of arsenical poisoning were traced to the use of aniline dyes but on the whole such incidences were rare.[1] The main source of occupational arsenical poisoning in the period 1780 to 1900 came instead from the use of the colouring agent emerald green.

Emerald green went under several trade names. Dr Guy in his report of 1862 mentions the names Emerald, Scheele, Schweinfurt, Brunswick, Vienna and Mineral green as all being virtually the same product. To this list, Hunter adds Paris, French, Parrot, Mitis and Imperial green and states that the makers of the pigment in various countries were continuously changing the name in order to try and hide its poisonous nature.[2]

The chemical composition of emerald green was about six parts arsenious acid to two parts oxide of copper and one part acetic acid. The arsenic contact of the various pigments listed above varied between 58 and 71 per cent.[3]

1 Hunter (4th edition, 1969), p335. Also, *B.M.J.* 1877 October 6th, p507. See pages 77-84 for a discussion of lead poisoning in the pottery trades.

2 Dr Guy 'Report on alleged fatal cases of poisoning by Emerald Green and on the Poisonous effects of that substance as used in the arts.' *5th Report of the Medical Officer of the Privy Council* 1862, p129. Hunter (4th edition, 1969), p334. In the *J.S.A.* 1862, October 31st, p739, further names are given which are, Swedish, Siskin, Neuweid and Mountain Green.

3 Dr Guy (1862), p129; *J.S.A.* 1862 October 31st, p739.

One of the problems of using emerald green as a colouring agent was the fact that it was readily separable from the material to which it was attached. Hence, complaints were frequently made of people being made ill from the dust arising from rooms decorated with emerald green wallpaper and children being poisoned after sucking toys painted in arsenic green.[1]

The green pigment was discovered in the early 18th century, but it was not extensively used until the 19th century when the colour was in vogue.[2] In 1845, the Medical Times reported on observations made in France on the poisonous effects of 'Vert de Schweinfurt' on men employed in the paper staining trade to brush the paper after the colour had been laid down in order to make it more brilliant. The atmosphere was thus impregnated with fine particles of the colouring dust, the inhalation of which caused much illness.

> "The workmen suffer from coryza,[3] swelling of the nostrils, lips, and eyelids, these parts frequently become the seat of a papular, or inflammatory pustular eruption, the head aches, the strength fails, cholic sets in, and in the more advanced periods of the disease, the scrotum becomes oedematous, and the seat of an eruptive disease."[4]

[1] *B.M.J.* 1878 August 17th p243. For information on the effects of arsenic in paper-hangings see: *J.S.A.* 1857 and 1858 for a series of comments. It was a topic reported in various journals, for example, *Chemical News* 1860 February 4th, p108, and was also commented upon in local newspapers, e.g. *W.J.* 1858 September 18th, which reported on the fact that the rooms of the Commissioner of the Inland Revenue Department had been prepared in arsenic coloured paper and the possible ill effects that might result. *J.S.A.* 1862 October 31st p738, reported on the death of a child after sucking artificial grapes coloured by the use of emerald green.

[2] Paris green was said to have been discovered in 1712 and Scheele's green in 1742. Robert T. Legge 'The History of Industrial Medicine and Occupational Disease', *Industrial Medicine* 1936, Vol. 5, p420.

[3] Coryza = nasal catarrh

[4] *The Medical Times* 1845 April 12th p29.

The main outcry against the use of arsenic green in Britain however, came in the 1860's, following the inquest into the death of Matilda Scheurer in 1861.

Matilda Scheurer, aged 19, was employed in the trade of making artificial flower leaves. She had died in great pain and suffering from arsenic poisoning and at the inquest, the surgeon attending her said that he had visited the deceased on four occasions within the last eighteen months. Each time she had exhibited the same symptoms. It was also noted that the sister of the deceased had died in similar circumstances.[1]

The inquest was reported in The Times and other journals of the day, causing much public interest in the subject, with the result that several inquiries and examinations into the composition of the pigment were carried out. The Ladies Sanitary Association made investigations of the artificial flower trade and found other instances of death with symptoms similar to Scheurer's, and Professor Hofmann made an analysis of the quantity of arsenic found in the finished product. It was also discovered that certain confectionery products were adulterated with arsenic colouring.[2] The mood of the public on the discovery of the extent of the problem can be seen from the following report in the *British Medical Journal* of 1862:

> "A lady in full dress, duly decorated with a modern wreath of 50 green leaves, carries on her head 40 grains of white arsenic - enough to poison herself and 19 friends. The nodding sprigs and sprays are to the eye of science very much what funeral plumes are to the world at large - an indication of death. Death to those who make them, we already know that these leaves are; and death or poison to those who wear them, we may anticipate they cannot fail to be. We have of late years taken to surrounding ourselves with arsenic in our dwellings. We rejoice in arsenic paper-hangings; and our wives and daughters keep up a continual dust of arsenical powder flying around them,

[1] **Dr Guy (1862) pp151-153. *Chemical News* 1861 November 30th p292. *B.M.J.* 1861 November 30th p598.**

[2] **Dr Guy (1862) p127. B.W. Richardson 'Unhealthy Trades: Lecture V', *J.S.A.* 1876 February 11th p207.**

> either from their heads of their dresses. Green tarlatanes, Professor Erdmann of Leipsic says, contain as much as half their weight of Schweinfurt green. The colour is, it seems, merely laid on with starch, and comes off on the slightest friction; so that our fair charmers in green whirl through the giddy waltz actually in a cloud of arsenic dust. Twenty yards, under crinoline régime, are required for the modern female dress, and twenty yards of green tarlatane would contain about 900 grains of white arsenic. Well may the fascinating wearer of it be called a killing creature. She actually carries in her skirt poison enough to slay the whole of her admirers she may meet with in half a dozen ball-rooms. We are satisfied that our brethren, ever ready in such a cause, will lend their very powerful aid in arresting this enormous error. It is, we are sure, enough that they should point out the facts to their friends and patients, to arrest the evil, which is clearly so dangerous and destructive to the life of the producer, and so full of danger to those who make use of the product." [1]

Of all the reports which followed, the most important was Dr Guy's to the Medical Officer of the Privy Council in 1862. He looked at the industry of making the emerald green pigment and at four trades which used it as a colouring agent. These were printing in colours, the making of green paper for ornamental use, the manufacture of emerald green wall-paper and artificial flower making. The green colouring was also used in many other industries, for example, printing on woven fabrics both for furnishing and dresses, venetian and other blinds, glass, japanned goods and toys.[2]

The largest works for making emerald green pigment in 1862 only employed a handful of workmen and the process was conducted in the open air but there had been a time when it had been an indoor occupation. An employee who had been at the works prior to the changeover complained that, when he had initially taken up the employment, after only four to six weeks, he had suffered with blotches under the nostril and on the scrotum. The latter had begun as a red rash and then formed a brown scab. The

[1] *B.M.J.* 1862 February 15th p177.

[2] Hunter (4th edition, 1969) pp334-335, From a report by the Medical Society of London in 1880.

hospital for skin diseases told him to change occupations for a while, which he did-and the complaint soon cleared up. On the whole, the production of emerald green, especially when carried out in the open air, was not as hazardous as the use of the colour, the worst suffering in the production being met with amongst the packers of the final product.[1] Their symptoms varied but included some of the following: sneezing, itching at the nostrils, a rash on the face, especially around the nostrils, itching at the bends in the arms, armpit or scrotum, also rashes and boils in these areas and slight headaches.[2]

Of the processes using emerald green, the least harmful was printing in colours, mainly because the quantity used was small. However, in the making of emerald green paper for ornamental use, much suffering was met. Most of this work was carried out in London and produced such items as showcards and invitations. It also produced wrappers for chocolate and sweetmeats, a particularly bad practice. It was said that as much as half an ounce of pigment was used to tint both sides of a sheet of white paper. The pigment was mixed with warm size and water, and then applied by brush and/or hand. It was then hung up to dry and later hot pressed.

The work necessitated much handling of the poison, which with careless practices was then transferred to the face. Workmen usually began to suffer after working with the colour for only two days and generally, where possible, would abandon the job for other work. The first symptom was usually a papular rash around the nostrils which spread behind the ears. Later it extended to the arm joints, inside the thighs and on the scrotum. Sometimes the fingers became inflamed and the nails dropped off. When the employee stopped working with the green powder, these symptoms generally retracted, only to return when he next

[1] **Dr Guy (1862), pp129-130.** [2] *Ibid.* **p130; no worker suffered from all the symptoms.**

worked with the colour. Some also felt the symptoms when using bronze powder but to a much lesser extent. It was found that workmen in the same room who were not themselves handling emerald green, were subject to fits of sneezing and headaches.[1]

Similar conditions were met with in the manufacture of emerald green paper-hangings but due to the use of a stronger size, the quantity of dust floating in the atmosphere was less. Consequently, the effects on the workmen were less marked.[2] One illustration of this is the case of a man who had been employed in the manufacture of paper-hangings for twenty-two years. At times he had worked with emerald green paper for as long as six weeks at a time and although he usually felt some minor discomfort, he sometimes escaped without any illness.[3] It was said in 1862 that the demand for the paper had declined dramatically from previous years. This can probably be accounted for by the fact that although the hazards of arsenic wall-paper had been realised since 1839, the first death attributed to it was in 1858.

The above three trades thus showed some inconveniences and occasional illness from the use of emerald green but the severity of the attacks was reduced by the workmen only using the colour for a few days at a time. In that manner they escaped the more serious consequences and seldom lost a day's labour. The manufacture of artificial flowers,

1 *Ibid.* pp138-143.

2 However where machinery was used there was in fact more dust than when hand done, because the size used was less and the process quicker.

3 Dr Guy (1862) pp143-144.

4 1896 Interim Report of the Departmental Committee appointed to inquire into and report on certain miscellaneous dangerous trades (C8149) p9.

leaves, seeds and fruits however, was usually conducted by young women, who worked with the green colour for several weeks in succession. Matilda Scheurer was said to have worked on the colour continually for eighteen months before her death and Dr Guy found that this was not an isolated incident. He sought information on the subject from the surgeon, Mr Paul, and from Dr Davis, who both resided in the Brunswick Square area of London where most of the manufactories were situated. Both confirmed tha large number of girls coming to them seeking relief from poisoning, the usual symptoms being, tenderness in the pit of the stomach, vomiting of greenish matter, general weakness, and rashes on various places of the body, not necessarily those parts which were exposed. Some firms did try and take precautions. At one works, towels were provided to hold across the face, but many girls would not use them due to the inconvenience and even those who did, seem to have suffered with the disease at times.

Three principle processes were used to produce artificial leaves and flowers. The first consisted of brushing the pigment, in the form of a thin paste made with gum and water, onto leaves cut from sheets of muslin. The second was dusting it onto the leaf which had previously been dipped in melted wax and the third, in cutting and embossing by means of dies, several layers of muslin previously coloured emerald green. In some cases the leaves were then dipped in melted wax and were thus referred to as 'waxed' leaves, others were left unwaxed and called 'fluffed' leaves. The most harm came in dusting the leaves, when the green powderwas dispersed everywhere, and if the leaves were left unwaxed, the colour was easily shaken or rubbed off.[1]

By the 1860's the dangers of using arsenic green had cleanly been identified. Both France and Germany had taken

[1] Dr Guy (1862) p144-150.

precautions to protect their workers employed in trades using coloured pigments, by restricting the use of emerald green,[1] but no such measures were implemented in Britain. Despite the fact that by 1860, the Government had issued regulations on the employment of children, young persons, and women in certain trades, it was still very much influenced by the philosophy of 'laissez-faire' and to restrict the use of a specific material by law, would have been seen as an unprecedented interference in the natural running of manufacturing concerns. Dr Guy himself, did not believe that the material should be banned or restricted, although, in line with movements in other hazardous trades, he felt that persons under 18 should be prevented from entering the trade of artificial flower making. He considered that if the girls were only to work with the colour for a couple of days at a time, (like the men in the paper trade) the severity of the attacks would be reduced. As the first symptoms were quick to come, it was possible for the employees to know when they should cease to use the colour and the employers should ensure that they changed work. He felt that it was a duty of the employers to provide freely ventilated and uncrowded workshops but that the workpeople could do much to help themselves by giving better attention to cleanliness and making sure that they scrubbed fingernails and hands after handling the poison, and that they did not consume food in the workshop. As another precaution, he felt that there was something to be said for the registration and inspection of workplaces, although he admitted that this would be difficult to undertake in practice.[2]

1 *B.M.J.* 1861 November 30th p584. Bavaria had originally issued an edict on 21st July 1845 prohibiting the hanging and sale of arsenic green wall-paper but had repealed this in 1848 on the condition that the green was permanently fixed. Dr Guy (1862), p128.

2 Dr Guy (1862) pp156-162.

Despite Dr Guy's detailed investigations and recommendations, the evil appears to have continued, unchecked by any Government regulations. Unlike other industrial diseases, which were usually solely a problem of the workshop, the effects of arsenic green were also felt by the purchaser of the final product. Following complaints by the public of the ill effects of arsenic wall-hangings, the Medical Society of London, in 1877, set up a committee to consider the problem. It made its report in 1880 and concluded:

> "That the time has arrived when some checks should be imposed upon the free and unrestricted sales of poisoned articles, with a view to making it compulsory that such articles should be advertised as containing deleterious matter, in order that purchasers might at least, be aware of the danger they were incurring in their use."[1]

The issue seems generally to have flared up again at this time, with the 1879 reports of the Factory Inspectors containing information on several visits made to firms which handled colouring agents. They observed several differences on the 1862 situation with many employers being unwilling to use emerald green except when specifically ordered by a customer. Most, on their own initiative, had instituted some kind of precaution to reduce the risks of poisoning to their workforce. In some places the girls were only allowed to work with the colour on alternate days; in others, when an order for emerald green was taken, everyone worked on it so as to spread the risk and complete the assignment quickly. In the trade of making artificial flowers and leaves however, emerald green was still, by far, the main agent used to obtain a green colour. One careless practice, observed by the Inspectors, was a young girl who moistened her brush in her mouth instead of in the bowl of water provided.[2] As the workers appeared to neglect simple rules of health and hygiene, the Inspectors felt

[1] 1896 Interim Report Misc. Trades (C8149) p9, and Appendix II, p30.

[2] Reports of the Inspectors of Factories: Year ending 31st October 1879 (C2489) pp50-54.

that the trade would benefit from being brought under s39 of the 1878 Factory Act which prohibited the taking of meals in certain types of workshops. Hence, in January 1880, it was prohibited to take meals in the workshops of any processes of artificial flower making, paper staining, paper colouring and several other industries where dry powders or dusts were used.[1]

1880 also saw the Society of Arts setting up a committee to look into the practicability of preventing the use of arsenic in making wall-paper.[2] In the same year, Messrs. Woollams and Co. were awarded a medal by the Council of the Sanitary Institute for their paper-hangings 'free from arsenic' which had been exhibited at the Croydon Exhibition.[3] In 1883, two more committees were set up, one to look at arsenical wall-papers, the other into the use of arsenic in domestic fabrics. These were established under the influence of the National Health Society. One fact arising from the 1883 reports was that arsenic was not only used in green colourings, but was also to be found in mauves, reds and fawns.[4]

The attention of these committees appears to have been directed more towards the potential harm to the public than to the effects of the manufacturing process on the labourers, but by the changing of public demand, the position was also improved for the workforce. As has been observed, the employers themselves appear to have been reluctant to use the colour because of the dangers to the workers but had continued to do so because no suitable substitute could be found to satisfy the demands of the public for bright green. From the continued pressure of Factory

[1] For details of these orders see page 73 where they are discussed in relation to lead poisoning.

[2] *J.S.A.* 1880 April 16th, pp443-444; *B.M.J.* 1880 May 1st, p669.

[3] *The House Decorator and School of Design* 1880 August 20th, p151; *B.M.J.* 1880 September 25th, p512.

[4] *B.M.J.* 1883 March 3rd, pp425-426, June 23rd, pp1218-1219.

Inspectors, backed by information supplied by the certifying surgeons, on this and cases of poisoning from other toxic metals, arsenical poisoning, along with lead and phosphorous poisoning, became a notifiable industrial disease to the Chief Inspector of Factories from January 1st, 1896. However, a Government departmental committee set up in the same year to inquire into the industry of paper staining and colouring, found that there had been an almost universal substitution of mineral colouring materials by vegetable so that arsenical poisoning at work had, in fact, become rare.[1]

Thus, by 1900, the risk of arsenical poisoning from the use of emerald green had almost been eliminated due, not to any universal regulations by Government, but the fact that the purchasers of the product were as vulnerable as the operatives. With the general growing awareness by the public of the dangers they faced from arsenic wall-paper and other products coloured with emerald green, demand for these products declined, although it took several decades, from the first death attributable to arsenical wall-paper in 1858, before this trend had any noticeable effect on the trades concerned. What appears surprising, considering the extremely poisonous nature of arsenic, is that there were not more fatalities and that some workers handling the substance appear to have suffered only minor inconveniences. Absence from work through sickness was comparatively rare, probably because employers attempted to ensure that operatives worked with the arsenite of copper colouring for a short period of time. Although employers were generally willing to initiate precautionary measures on their own without compulsion, and in this instance, in the long run, there was no need to resort to universal legislation to restrict the use of arsenic colourings, the

[1]However, they still found the occupation to have many of the evils commonly associated with dusty occupations. 1896 Interim Report Misc. Trades (C8149) pp9-12. *B.M.J.* 1896 August 22nd, pp451-452.

measures adopted tended to be along the lines of changed working patterns and emphasis on personal cleanliness. As will be seen repeatedly in the discussions on other hazardous occupations, one of the main lines of recourse was the advocacy of more attention to personal hygiene. There is no evidence of research being undertaken to find safer methods of using arsenic colourings; instead the problem was solved, eventually, by less noxious (but otherwise probably inferior) dyes being substituted for those based on arsenic. These were accepted because they were safer for the consumer.

1.b. Copper

Although copper is highly toxic if digested in the pure form, it is of only minor significance as an industrial poison. Copper is not easily vapourized, but when it is, the resulting fumes are irritating and can cause metal fume fever. The basic symptoms of this illness are irritation of the lungs and intestine, resulting in fever, chills, vomiting and diarrhoea. The patient generally recovers within a couple of days. There was, however, little association of copper with this illness in the 19th century.[1]

Copper dust can also be an irritant causing bronchial trouble when inhaled. In the 19th century there were reports of it discolouring the hair and teeth so that copper workers often had a greenish appearance.[2] The French writer, M. Perron, claimed that the clock makers in the Bescancon region were slowly being poisoned by their daily handling of copper, but the evidence is not

1 The disease was also associated with other metals, in particular zinc, and a fuller discussion will appear under this heading, 1.f. on pages 106-110.

2 *B.M.J.* 1888 April 28th, p888; Arlidge (1892) pp442-443.

entirely convincing as he said it resulted in tubercular phthisis and although copper dust may help to predispose such a condition, equally likely to do so were the crowded and ill-ventilated rooms in which the watch makers worked.[1]

Copper smelting was held to be an unwholesome occupation and around the 1860's there was much sensational writing on the obnoxious effects of copper smoke. At times, it was said that the smoke in the environs of the South Wales copper works was so thick that it was impossible to see across the valley. Around Swansea, the countryside was described as being:

> "entirely denuded of vegetation while the hillsides have not a blade of grass upon them, but are converted into a mass of detritus of gravel and stone." 2

The smoke affected the livestock kept in the neighbouring fields. The Welsh farmers called the illness effydrdod. It caused the bones of the cattle to become brittle and the teeth to fall out. The problem, however, was not so much the copper but the impurities in the copper ore which caused arsenic and sulphurous acid to be formed. These were particularly noticeable during the process of calcining. When this sulphurous acid came into contact with the moisture in the air, it was easily converted into sulphuric acid and it was this which denuded much of the neighbourhood of vegetation.[3]

The nuisance was greater when a reverberating furnace was used and worse still when fluor spar was added as a flux. This caused fluric acid to be produced which was

[1] *B.M.J.* 1863 August 29th, p240.

[2] Quoted in G. Phillips Bevan *The Industrial Classes and Industrial Statistics* (1876) p57. It originally appeared in the Report of the Commissioners appointed to inquire into Noxious Vapours, 1862.

[3] Phillips Bevan (1876) p58. *J.S.A.* 1876 January 21st, pp149-150.

said to roughen the window panes in the neighbourhood.[1] However, a local doctor to the smelting plant, examined the inhabitants of the area and found that although it was true that the smelters themselves suffered from bronchial afflictions, their families were relatively free of disease.[2] Dr Ballard, in his extensive report on noxious vapours to the Local Government Board in 1878, confirmed that the effects of copper smoke on the inhabitants were not as bad as had been suggested, although by this date, the use of reverberating furnaces and fluor spar were almost obsolete. Strangers to the area might find the smell and taste of the smoke disagreeable, but no specific disease could be traced to its inhalation.[3]

Attempts were made to lessen the quantity and unpleasant elements of the smoke, in particular the firm of Messrs. Vivian & Son. They had been experimenting with methods of arresting the sulphurous acid vapours from the 1820's and by the time of Dr Ballard's report, were apparently quite successful in reducing the smoke except in certain types of weather, when it still fell back on the town.[4]

1 Phillips Bevan (1876) p58.

2 *Ibid.* pp58-59. Dr Williams also advanced the theory that the superior potency of the copper smoke killed any germs of spreading disease and so provided the inhabitants with comparative immunity from them.

3 Dr Ballard '3rd Report of the Inquiry as to Effluvium Nuisances arising in connection with various manufactures and other branches of industry', *8th Annual Report to the Medical Officer of the Local Government Board* 1878, pp259-270.

4 Ballard (1878) pp265-270; *B.M.J.* 1865 August 26th, p223 talks of Messrs. Vivian & Son taking up a German patent to make sulphuric acid from copper smelting smoke; also in *Chemical News* 1867 January 19th, p36.

1.c. Lead

During the 19th century the incidence of lead poisoning in Britain and other developed countries was high, not only in industry but also in domestic life. In the latter, the well known sources of danger were the lead glazes used on earthenware, lead-based paints and the consumption of drinking water contaminated through being supplied from lead cisterns and piping. Some foods were also tainted with the substance. Wine was sometimes adulterated with lead oxide to counteract its acidity and flour could become infected by the practice in some mills of stopping up the cavities in the millstones with lead.[1] In manufacturing industry, lead was extensively used for its malleability and the readiness with which it fused at low temperatures. It could thus easily be united with metals, acids, oils and other substances to make paints, pigments and compounds, and hence, was one of the most useful metals for the arts. However, it was also one of the most dangerous, being a treacherous poison.[2]

Lead poisoning was thus present in many branches of industry. It could occur at the extractive and smelting stages of lead production but was more commonly associated with the manufacture of white lead and pottery. These two trades became the focal point for attempts to control lead poisoning. Cases were, however, found in other industries, a few of which were the enamelling of iron plate and hollow metal ware, printing, filemaking, shotmaking, dyeing where yellow chromate of lead was used, steelmaking, and the japan and lacquer trades. Lead poisoning was also common amongst painters and plumbers.[3]

[1] A Meiklejohn 'The Successful Prevention of Lead Poisoning in the Glazing of Earthenware in the North Staffordshire Potteries' *B.J.I.M.* 1963 Vol. 20, p170. *B.M.J.* 1864 August 27th, p250; 1865 June 17th, p622; case of lead poisoning from flour in France. *B.M.J.* 1866 July 7th, p7; case of lead poisoning from flour in the U.S.A.

[2] *B.M.J.* 1869 April 17th, p356.

[3] *B.M.J.* 1899 February 11th, p359.

The use of lead in the pottery industry is one of the few cases in the field of the history of occupational medicine which has received the attention of medical historians. Both A Meiklejohn in the Milroy lecture for 1963 and D J Evans and A E Jones in 1974, studied the development of statutory measures and new methods of glazing which led to the successful prevention of lead poisoning in the North Staffordshire pottery industry.[1] The data for these papers is the series of Governmental enquiries which were conducted in 1843 and 1862 by the Children's Employment Commission, Dr Greenhow's Report to the Medical Officer of the Privy Council of 1860, the Departmental Committee appointed to report on the conditions of labour in the Potteries in 1893 and T E Thorpe and T Oliver's investigations into the use of lead compounds in the manufacture of pottery of 1899, as well as the ensuing legislation when it occurred. Discussion of the pottery industry needs to be re-opened however in order to supplement Parliamentary reports with material from the medical journals and elsewhere, because although the Government provided extensive accounts of conditions, it was not usually the first to discuss the problem. The enquiries were often the response to a former public outcry. There were also other bodies besides the Government who were interested in reform to reduce the annual number of sufferers from lead poisoning, one of the earliest of which was the Society of Arts.

1 A Meiklejohn (1963) pp169-180. A Meiklejohn 'Health hazards in the North Staffordshire Pottery Industry 1688-1945' *Journal of the Royal Sanitary Institute* 1946, Vol. 6, pp516-524. D J Evans and A E Jones 'The Development of Statutory Safeguards against pneumoconiosis and lead poisoning in the North Staffordshire Pottery Industry' *Annals of Occupational Hygiene* 1974, Vol. 17, pp1-15.

The disease of lead poisoning was known as colica pictonum or plumbism, and Meiklejohn in his paper includes a useful history of the original identification.[1] The name colica pictonum suggests one of the most frequent symptoms of the disease, namely colic. This manifested itself in the form of an excruciating pain at the pit of the stomach. The abdomen became hard with the contraction of the muscles and obstinate constipation set in. The general countenance was dull and sallow. The symptoms could occur suddenly or build up slowly over time, the first signs then being a continued problem with indigestion and disorders of the bowels. After several attacks of colic, or occasionally without having suffered it at all, the victim might be struck by lead palsy. This chiefly affected the upper extremeties, in particular the muscles of the hand and forearm. Initially there was a loss of power leading gradually to a wasting away. The loss of power was mainly in the muscles at the back of the forearm, hence when the arm was raised, the hand fell under its own weight in the characteristic wrist drop. Another feature of lead poisoning was a blue line on the gums but this was not present in all cases.[2]

Treatment of chronic cases was difficult and required a long absence from work, often with a period of hospitalization. The following notes are taken from a case book dated 1855 of R C Garner of the North Staffordshire Infirmary and are a good illustration of this point:

1 Meiklejohn (1963) pp170-171. It was called colica pictonum (colic of the Pictones) as lead poisoning occurred as an epidemic in France in the province of Poitou, home of the Celtic tribe of Pictones, in 1572. Citois traces the source of lead to the adulteration of wine. Lead poisoning is also occasionally referred to as saturnine poisoning; Saturn being the alchemical name for lead.

2 Andres Rabagliati 'Potters and Lead Workers and their diseases' *Great Industries of Great Britain* Vol. III, pp93-96.

"January 12th:	Samuel Weston admitted under Dr Wilson. Worker in lead - 12 years of age - Unhealthy looking lad. States he has been a dipper for two years. A month ago whilst at work was suddenly seized with a violent pain in the belly, which in a day or two was followed by an aching pain in both knees. Belly continued painful and began to swell. Two or three days after his legs began to lose their power. Had a violent belly ache once before. Bowels usually costive. On admission there was a very distinct blue line along the lower gum and teeth, legs completely paralysed. Belly rather swollen. The wrists quite dropped. Is unable to stand or move his hands. Complains of much pain in the belly.
February 10th	Gradually improving.
February 16th	Can clasp his hand close. Blue line still distinct.
February 22nd	Can straighten the hands better, more power over his legs.
March 2nd	Improving. Walks much better. Is not yet able to bend his hand up at all.
April 25th	Not much improved. Made an outpatient. Walks about pretty well but puts his feet down as if he had no control over them. Blue line on the teeth still distinct.
May 29th	Re-admitted. No improvement. Can not straighten the hands at all.
July 26th	Discharged. Walks better and has much more use of the hands." 1

Some sectors of the population were more susceptible to lead poisoning than others, particularly children and young women. A further problem with exposure to lead is the fact that it can be stored in the bones of the body for long periods of time and thus has a cumulative effect.[2]

[1] R C Garner's Case Book, North Staffordshire Infirmary 1854-1855. Held at the North Staffordshire Medical Institute Library in Stoke-on-Trent.

[2] Stellman & Daum (1973), pp252-253. Inorganic lead is stored mainly in the bones. The anti-knock component in petrol today which causes so much concern about lead poisoning in children, is organic lead or tetraethyl lead. This is stored mainly in the brain. This leads to symptoms of mental disturbance, inability to sleep and general anxiety.

There seems to have been some disagreement as to whether the mining of lead ore caused plumbism or not. Thomas Oliver maintained in 1891 that:

> "The lead miner never suffers. Dr Montgomery, of Blanchand, and Dr Robertson, of Stanhope, both of whom have practised for many years in the dales of Durham, have never met with a case of lead poisoning in the miner."

Others were equally firm in their opinion of its absence[1] yet occasionally cases were reported and William Webb (1857) recalled the blue line being present in the miners of Derbyshire and of their suffering a form of colic which was locally known as 'Belland'.[2] The reason for the low incidence of plumbism amongst lead miners was due to the type of lead ore found in Britain. Lead was generally discovered in the form of galena or the sulphide and, due to the insolubility of this salt, the chances of the miner developing lead poisoning were rare, the risk varying with the particular chacteristics found in each mine.[3]

After the ore had been raised to the surface, it was washed, crushed and then smelted. These processes were often carried out in close proximity to the pit entrance. The washing of the ore was reputed to pollute the local streams and kill the fish, and smelting, which released both lead and sulphurous fumes, was considered prejudicial to health. Thackrah, in fact, labelled smelting as a 'fatal' occupation. The smoke arising from this process, like the

[1] Thomas Oliver 'Lead Poisoning in its acute and chronic manifestations' *B.M.J.* 1891 March 7th, p506. Thomas Hayes Jackson 'Diseases of Miners of Akendale and Swaledale' *B.M.J.* 1857 July 25th, pp619-620. Dr William Robinson 'Lead Miners and their Diseases' *B.M.J.* 1893 August 19th, pp415-418.

[2] William Webb 'The Lead Miners of Derbyshire and their Diseases' *B.M.J.* 1857 August 15th, pp687-688. Robert H Powell 'Observations on the effect of lead upon operatives' *B.M.J.* 1863 March 21st, p290. T Ogier Ward *On the Medical Topography of Shrewsbury and its Neighbourhood* (1841) p71 & p88.

[3] Arlidge (1892) pp290-291.

copper smoke, destroyed surrounding vegetation and infected cattle and other livestock with colic which was described as 'Belland' or 'roaring'.[1]

Meiklejohn (1954) made a short study of the Leadhills area of Scotland in which he quoted an article by a surgeon called Mr J Wilson, which had first been published in the Scots Magazine of June, 1754. It was entitled, 'An Account of the Disease called Mill-Reek' and is an early reference to lead poisoning amongst smelters. The disease was called mill-reek because although at some stage it infected all the local inhabitants, it was more noticeable amongst the lead smelters, and was caused by the 'reek' or 'smoke' rising from the smelting mills. Wilson believed that if the patient acted on the first symptoms, he was likely to recover, but if he waited, it was almost certain to end fatally. The cure consisted of administering medicines to clear out the system. Wilson suggested several precautionary measures to reduce the chances of succumbing to the poison, one of which was the taking of a glass of sweet oil, either pure or mixed with water, before work each day and eating oily and fatty foods.[2] These beliefs continued into the 19th century, for Webb, in 1857, tells how the Derbyshire miners and smelters ate fatty matter in the belief that it helped to immunise them against plumbism. Similarly at the Pontesford works in Shropshire, on feeling the first symptoms of a sweet taste in their mouth, the lead smelters drank half a pint of sweet oil provided by the master of the works for that purpose.[3]

[1] Arlidge (1892) p291; *B.M.J.* 1857 July 25th, p619; T Ogier Ward (1841) p88. A Meiklejohn 'The Mill Reek and the Devonshire Colic' *B.J.I.M.* 1954, Vol. II, p41. C T Thackrah *The Effect of Arts, Trades and Professions, on Health and Longevity* (2nd enlarged edition 1832) pp90-91.

[2] This article is quoted in full by Meiklejohn (1954), pp41-42.

[3] *B.M.J.* 1857 August 15th, p688; T Ogier Ward (1841) p88.

In general, lead miners seem to have accepted the risks without question. They seldom resorted to medical aid for help, having their own remedies for relief,[1] but they rarely had the severe symptoms of the disease which will be seen in other processes in which lead was handled. Conditions in the mid-19th century were not as bad as those reported by Wilson in 1754 as some changes in production methods had taken place. Until 1780, much lead was lost in the smoke escaping from the furnace. Even in the early 1800's, Meiklejohn says of Leadhills, that it was estimated that about one tenth of the lead smelted escaped in this way. In 1778, Bishop Watson, published an essay entitled 'Derbyshire Lead Ore', in which he suggested that the lead in the smoke might be precipitated by bringing it in contact with water, or the vapour of water in its ascent, or by passing it through long, horizontal flues, before releasing it to the atmosphere. Soon after this date, long flues were adopted at the Grassington Smelting Mills in the Yorkshire Dales. Later condensers were added which increased the amount of lead retrieved from the smoke. At Leadhills, a systems of chambers, flues and water sprays, were not incorporated into the works until the early 19th century. Plumbism amongst lead smelters was reduced but the reason for employers adopting this system was not so much concern over the welfare of their men but because they found substantial financial benefit in the retrieval of lead. In the first seven months of operating the new system at Leadhills, 58 tons of lead were recovered from the flues, which was valued at £1,300.[2]

By the mid-19th century, this system of flues and chambers to deposit the lead, culminating in a tall chimney to disperse the smoke at a high level, had been generally

[1] T Ogier Ward (1841) p88. They mostly relieved themselves with the use of castor oil.

[2] Robert T Clough *The Lead Smelting Mills of the Yorkshire Dales* (1962) pp79-80. Meiklejohn (1954) p41.

adopted throughout the country as it greatly added to the profitability of smelting.[1] In his report to the Medical Officer of the Privy Council in 1863, Dr Whitley was able to say that with the new precautions, plumbism was now rare and T Sopwith, the agent of the lead works at Allen Mill, Northumberland, reported the evidence of local medical men confirming this and stating that previously the disease had been widespread.[2] There must, however, still have been some risks of plumbism, particularly when cleaning out the flues to collect the lead. Dr Ballard, in 1878, also found that despite the tremendous financial gains in adopting such retrieval systems, several ill conducted mills still existed. One such, in Derbyshire, frequently allowed as much as one twelfth of the lead ore smelted to escape in the smoke emitted from the chimney. He described several methods of production in operation at the time, the most hazardous to the worker being the 'ore' hearth method. Ballard recommended that all works should adopt the system of long flues, culminating in a tall chimney away from habitation in order to carry off the destructive sulphurous fumes.[3]

When the Government Departmental Committee looked at the lead industries in 1893, they found that the process of smelting was not particularly harmful and that only isolated cases of lead poisoning occurred. These only displayed the milder symptoms of the disease and most cases could be prevented with care and attention to hygiene. They recommended that no females or young persons, the most susceptible to the poison, should be allowed to clean out the flues, and that those employed in this task, should be provided with respirators and overalls and not work in the flues for more than two hours at a time. All such workers

[1] T Ogier Ward (1841) p88. The Pontesford works had recently erected a tall chimney.

[2] Dr George Whitley 'On the Occurrence of Lead Poisoning among persons who work with lead and its preparations' *6th Report of the Medical Officer of the Privy Council* 1863.

[3] Ballard (1878) pp278-293.

should also be made to have a bath before leaving work, the employer providing a plentiful supply of hot and cold water, soap, nailbrush and towel.[1] These kind of recommendations were common to most industries where lead was handled and will be met with again, many of the investigators thus believing that much of the blame for illness was due to the careless habits of the workpeople themselves. Such views, however, ignored the fact that most workpeople did not have either a bathroom or running water at home, so were not totally to blame for any lack of cleanliness.

Although mining and smelting with lead ore only presented the worker with a slight risk of lead poisoning, the same cannot be said for the conditions met with in the white lead works. Here the severest effects of lead poisoning were found. R E Lane in an article in 1949, 'Care of Lead Workers', gives only the briefest outline of the dangers inherent in the industry, his first reference being to the 1880's but almost a hundred years earlier, in 1788, the Society of Arts had recognized the dangers and offered two premiums for improvements, while Hunter refers to an article written in 1678 by Vernatti which is probably the earliest reference to lead poisoning amongst white lead workers in Britain.[2]

The two premiums offered by the Society of Arts were for ideas to find alternative ways of preparing the white lead and for a substitute to be found which was free of the noxious qualities but could be used in the same way. White lead was used in the preparation of paints and it proved difficult to find a substitute with the same qualities and which could perform the same functions. The only medal awarded under these schemes was in 1795, to a Mr Ward.

[1] 1893-94 Conditions of Labour in various Lead Industries, Dept. Ctte. Report (C 7239) p16.

[2] Ronal E Lane 'The Care of the Lead Worker' *B.J.I.M.* 1949, Vol. 6, p126. *T.S.A.* 1788, Vol. VI, Preface xviii. Hunter (4th edition 1969) p242.

He received a gold medal for his method of preparing white lead,[1] but whether it was ever used or not is unknown and cases of plumbism amongst white lead workers continued to be a frequent occurrence.

In the 1830's, Thackrah reported on the poor health of these workers, describing them as all looking sallow and pale but with those employed in the white beds and packing departments being by far the worst affected. In these two branches, the workers soon complained of headaches, drowsiness, sickness, obstinate constipation, colic, inflammation of the bowels and in the most marked, lead palsy. Eyes were also affected, as was the nervous system generally. The employees did not usually commence such work until the age of 20 and many did not stay long. Of those who remained, few continued beyond the age of 45 and Thackrah said that at least a third of their working life would be spent laid up in bed, suffering with colic or palsy. The oldest operative he could discover was a man of 54 employed at a Hull works, but he was then unable to work and had only spent sixteen years in the trade. In that time, he had been laid up twenty-eight times. Each time the disease had become more serious and at one stage, he had remained in bed for nineteen weeks, scarcely able to move a limb. At the time of inquiry, he was partially paralysed, with no motion in his wrists and only a weak action in his legs so that he was just able to move around with the aid of crutches. The main preventative measures suggested by Thackrah were cleanliness, regular washing, linen covers for the face while at work and not eating food in the workshops. He also recommended eating fatty foods.[2]

The main process employed throughout the century to produce white lead was known as the 'Old Dutch', 'Stack' or

1 *T.S.A.* 1795, Vol. III, pp221-228.

2 Thackrah (2nd enlarged edition 1832) pp103-106.

'Dry' method. It had been introduced to Britain in about 1780 and consisted of thin sheets of lead[1] being placed on top of small earthenware pots which contained acetic acid. The pots were arranged side by side and surrounded with tan bark. They were then covered with planks and a further row of pots placed on top, and so on, until the area had been filled. This was known as the 'blue-beds' and at this stage there was no danger to the workmen. Then, by the heat induced through the fermentation of the tan bark, the acetic acid slowly volatilized, by which the lead was first changed to the subacetate and then the carbonate form. This process took about fourteen weeks. When it had been completed, the stacks were then referred to as the 'white-beds'. Girls entered to remove the carbonate of lead, carrying it out on trays on their heads, first to the rolling mills, where the white was separated from any remaining metallic lead, and then to stoves to dry.

The most dangerous operations for the workers were breaking up the white-beds and placing the carbonate of lead in the stoves to dry. Originally the beds were broken up in the dry state, but under the powers of the 1891 Factory and Workshop Act, the Secretary of State for the Home Office issued Special Rules for the trade which included the provision that the white lead had first to be wetted before breaking up in order to reduce the dust on removal. After the white lead had been dried in the stoves, it was ground, washed and dried again to form a fine powder. The powder was packed in casks, a task which again was hazardous because of the fine particles which pervaded the atmosphere.[2]

1 Dr Whitley (1863 Lead) p350. Originally the lead was put into the vessels in rolls but this required more handling to separate the carbonate from the metallic lead and so they changed over to flats.

2 Some firms already wetted the white-beds before breaking them up, before the Special Rules were enforced. *B.M.J.* 1891 March 7th, p507; Dr Whitley (1863 Lead) p351; *J.S.A.* 1876 September 8th, p932. Reports of the Inspectors of Factories for the half year ending 31st October 1875 (C 1434), Alexander Redgrave's Report, pp 12 1893-94 Dept. Ctte. Report Lead Industries (C 7239) pp7-8; Factory and Workshop Act Special Rules 1891 - See Appendix II.

Towards the end of the century the 'Chamber Process' was adopted by some firms. This was very similar to the 'Old Dutch' process except that a chamber was used instead of the stacks and the time of corrosion was reduced to four or five weeks. The risks to the worker were virtually the same.[1] Other methods were experimented with; one of the earliest being Thuard's Process, at the end of the 18th century. This was based on the principle that if a basic solution of a salt of lead which had been produced from lithal was submitted to the action of carbonic acid gas, a carbonate of lead would be precipitated. Although the process at the time looked promising, especially due to its low cost and short time scale, the resulting carbonate proved to be inferior to the white lead produced in the stacks.[2] None of the other processes were ever used on a large scale and the 'Old Dutch' process persisted until the end of the century.

With this process, the workers in the white-beds could not avoid getting the white lead dust on their skin and clothing. Lead poisoning thus occurred both through inhalation and through the skin.[3] Although it was generally held that the extent of the problem was great and numerous cases of death were reported in the Medical Journals;[4] there are no actual statistics of the numbers involved. Dr Whitley in his 1863 report, found firms engaged in the trade to be very unhelpful in giving any information at all and he was refused entry to the largest London works being told that he

[1] 1893-94 Dept. Ctte. Report Lead Industries (C 7239) pp8-9.

[2] *J.S.A.* 1893 March 24th, pp447n. 1893-94 Dept. Ctte. Report Lead Industries (C 7239) p9. Reports of the Inspectors of Factories for the half year ending 31st October 1876 (C 1693) Alexander Redgrave's Report, pp24-25.

[3] And with careless workers through ingestion.

[4] *B.M.J.* 1880 April 24th, p636; 1882 April 15th, pp558-559; 1883 July 21st, p126; 1886 March 27th, p625; 1889 October 26th, p923. *The House Decorator and School of Design* 1880, Vol. II, September 3rd, p187. Reports of the Inspectors of Factories for the half year ending 30th April 1876 (C 1572) Alexander Redgrave's Report, p36.

would receive a similar reception at the other London establishments. In consequence, he visited the two largest concerns in Newcastle-upon-Tyne, each of which had a medical man attached to it, but one would give him no assistance and the other, although willing to discuss cases, would not give any exact figures as to the amount of illness caused by the trade.[1] The reluctance to give information is probably indicative of the extent of the problem.

In the second half of the century, lead poisoning became a topic of public interest starting with the publication of Dr Whitley's report in 1863 and Charles Dickens 'The Uncommercial Traveller' (1867), in which he described, in detail, a visit to one of the London white lead works.[2] In the mid '70's, the topic was constantly highlighted by the Factory Inspectors in their annual reports, in particular by Alexander Redgrave and by the '80's, demands for improvements were coming from several quarters. One of the most distressing aspects of these reports is the swiftness with which the lead poisoning attacked the workers, who were mainly young women, and how, even after a severe attack, they continued to return to the trade, only to succumb again. The following case history is a typical example of a young lead worker:

> "In December 1874, Bridget M., aged 27, a strong fresh-coloured Irish girl, came under my notice for treatment. She had been working at the lead mills for only five weeks; she was suffering from severe colic, with constipation; this was relieved after a few days suffering. She went again to her work, and, in about a fortnight, she returned to me with much more persistent colic, faintings, and constipation of the bowels. She was again relieved, strongly advised to be scrupulously clean and to drink plenty of the diluted acids prepared for them at the works. I saw her after this several times; after about seven months, the cumulative action of the lead produced paralysis, which gradually completely

[1] Dr Whitley (1863 Lead) pp350-351.

[2] The extract from 'The Uncommercial Traveller' is quoted in full by Hunter (4th edition 1969) pp245-247.

> affected the left side of the body. When I again saw her, she was thus paralysed; the face was pinched and wasted; she was intensely anaemic; her hearing was much affected. From her appearance, she would then have been taken for nearly double her age; her suffering from colic was dreadful in its intensity; it came on intermittently, and resisted for some weeks treatment to cure it. When I last saw her some months after I had given up treating her, the paralysis was in no way improved; the deafness was complete on the left side, hearing dull on the right; her teeth were rotting away; and, for all pleasures and purposes of life, she was blighted." [1]

The risks were well known both by workers and employers. Dickens quotes an Irishwoman in the trade as saying:

> "some of them get lead pisoned soon, and some of them gets lead-pisoned later, and some, but not many niver; and tis all according to the contitooshun, sur; and some contitooshuns is strong and some is weak." [2]

Labour, in the London white lead works, seems mainly to have consisted of young Irish girls, attracted by high wages of around 9/- a week. The high wages were presumably the reason why they continued to return to the trade after bouts of poisoning, despite being warned of the risks of doing so. The medical officer attached to a Newcastle works, had told Dr Whitley that he had often had to prohibit girls showing signs of lead poisoning from working, as the girls had insisted on continuing their employment even though they had been told that the only known cure was to cease working with lead.[3] According to Dr Whitley, the position in 1863 was an improvement on former times due to advances in sanitation and manufacturing processes but he gives little indication as to what these changes were.

Dickens remarked on respirators, gauntlets and overalls being issued to the workers and the habit, in the particular firm he visited, of frequently moving the women around the various processes, so as to reduce the length of exposure

1 W Holder 'Diseases Affecting Lead Workers' *B.M.J.* 1876 October 14th, p490.
2 Hunter (4th edition, 1969), p247.
3 Dr Whitley (1863 Lead), p351. *B.M.J.* 1869 April 17th, p356.

in the more hazardous departments. The works he visited, however, do not appear to have been typical, judging from the report on the London white leads works made by Alexander Redgrave in 1875. The only precaution he found common to all manufacturers was the provision of soap and water. Redgrave had been aware of the dangers of white lead works for some time and in 1875, he requested his Sub-Inspectors to make special inquiries into the subject, so that definite conclusions could be drawn as to the actual prevalence of danger and best means of averting it. The Sub-Inspectors, unlike Dr Whitely, appear to have met with little resistance to their questions. Although it was found that the majority of employers felt it was sufficient to provide just soap and water, a few did go further, issuing gloves and respirators, or providing caps and dresses for the women and canvas boots and trousers for the men. Medicines and acid drinks were often made freely available to the workers and many employers provided the services of a surgeon for those who fell ill. A few exceptional employers continued to pay their employees when absent due to sickness. Other managers did as Dickens had observed, and split the tasks amongst all workers so that the length of exposure in the white-beds and at the stoves was kept to a minimum.[1]

But not all the precautionary measures introduced by the more enlightened employers were welcomed by their employees. There was, for instance, a general lack of co-operation on the issue of wearing protective clothing. The workers complained that the gloves provided made handling the pots awkward and that the long overalls were cumbersome. They referred to the respirators as muzzles and stated that in hot weather they made breathing difficult. Some managers were strict in enforcing their rules, with some refusing to pay wages unless the respirators and gloves issued were worn. Some employed a man to check that the

[1] Reports of the Inspectors of Factories for the half year ending 31st October 1875 (C 1434) Alexander Redgrave's Report, p13.

workers had washed thoroughly before meals or going home, sending those back to the wash house who exhibited the least bit of white lead, but other employers were more casual in their approach. In one works visited by an Inspector,

> "no precaution existed but a trough of hot water and supply of soap. He (the Inspector) saw a man shovelling the fine powder of lead into a hopper, but the manufacturer pointed out how carefully the man used his spade so as not to cause the fine dust to rise. With a respirator the work would have been done in half the time, and possibly was accelerated when their backs were turned. At this place too, where a man is said to be stationed at the outer gate to see that these people are washed before they go out, the Sub-Inspector saw a woman go out, covered on the hands, face, hair and clothes with white lead; and the sanitary guardians explained that the woman was not gone for good, but only to fetch some beer, which when consumed on the works would of course carry with it no considerable quantity of lead dust into the stomach." [1]

Redgrave also observed changes in production methods which reduced the necessity of exposure to clouds of lead dust. Apart from separating the carbonised lead from the residue lead in a wet, rather than a dry state, some firms had also introduced machinery to supersede the casting of lead by hand. By 1875, it was also possible to wash and brush the earthenware pots by machinery before re-use, whereas previously the operation had been performed by hand, if at all. It would appear that the more humane manufacturers were willing to try out any precautions possible, despite expense to themselves, whereas other employers felt that the hazards were well known in the area and the wages they paid were accordingly high. Whenever an operative offered his services, he was in effect accepting the consequences of the trade. Knowledge of the effects of the trade were probably greater than in many industries, as the employment was concentrated in two main areas; the east end of London and Newcastle-upon-Tyne.

[1] *Ibid*. pp14-18. In evidence taken from sufferers of lead poisoning at the works.

Although, undoubtedly, more cases of plumbism occurred in the ill-conducted works, even those which strictly enforced precautionary measures or where the workers painstakingly followed the rules on cleanliness, were not immune from the poison. Following further inquiries in 1879, Alexander Redgrave submitted to the Secretary of State, a case under the provisions of section 39 of the 1878 Factory Act, for prohibiting the taking of meals in any part of the factory or workshop where deleterious materials were used. As a result, on January 20th, 1880, Special Orders were issued prohibiting the taking of meals in:

> "1. Every Factory or Workshop in which white lead is manufactured, except any room thereof used solely for meals.
>
> 2. Every part of the Factory or Workshop in which part dry powder or dust is used in any of the following processes:
>
> Lithographic Printing
> Playing CardMaking
> Fancy Box Making
> Paper Staining
> Almanack Making
> Artificial Flower Making
> Paper Colouring and Enamelling
> Colour Making." [1]

The matter, however, did not rest here. The Board of Guardians, in areas where white lead works were situated, began to direct the attention of the Home Office to the large number of cases seeking relief due to the effects of lead poisoning and the consequent burden this placed on the ratepayers. The first to do so were the Shoreditch Guardians, following the death of Hannah McCarthy at the Shoreditch Infirmary. The issue was discussed in the House of Commons on April 6th, 1882,[2] and later, in the report of Workhouse and Infirmary Visiting Committee, the medical officer of the Infirmary, Dr Forbes, reported that in the eighteen months up to the 3rd May, 1882, 23 patients had been admitted

[1] Reports of the Inspectors of Factories for the half year ending 31st October 1880 (C 2825) Alexander Redgrave's Report, p28.

[2] *B.M.J.* 1882 April 15th, pp558-559.

suffering directly from the effects of lead. Of these, three had died. The remainder had stayed in hospital for periods ranging from three to four weeks, to as much as six months. On leaving, many probably remained paupers for the rest of their lives, being unfitted for further work. The Guardians felt that it was time that Government legislation enforced all manufacturers to take simple precautions in order to try and reduce the severest symptoms.[1]

Following Shoreditch, the Board of Guardians for the unions of Gateshead, Popular, Newcastle-upon-Tyne and Holborn, all sent representations demanding an enquiry into the matter. The Holborn union had claimed that in the twelve months prior to June 22nd, 1882, there had been 54 patients admitted to their local infirmary suffering from lead poisoning. These had consisted of 48 females, all from the white lead works, and 6 males, some from the lead works but others were painters or in other trades handling lead. Many of the victims from the white lead works had only been at the trade for three weeks when they had first applied to the hospital for relief.[2] In response, the Government set up an enquiry, headed by Alexander Redgrave. He visited all the white lead works in the country (with the exception of one or two) and reported that the

> "temporary illness and permanent disability far exceed anything that has come before the public."

Even at a works where excellent precautionary measures were enforced, he had discovered that in the eighteen months between May 1881 and October 1882, there had been 234 applications for medical attendance, of which 134 had been

[1] **1883 White Lead Poisoning Communication to the Secretary of State with Report by Chief Inspector of Factories (C 3516) p1.**

[2] *Ibid.* **pp3-5;** *B.M.J.* **1882 May 27th, p787; August 5th, p215.**

due to the harmful effects of lead.[1] There had been some changes since his investigations in the mid '70's, with a far greater number of firms taking some form of precautionary measures. Some had gone as far as to issue a set of elaborately printed rules to be observed by their employees.[2] Redgrave, unlike many of his contemporaries, was not against the employment of women in trades handling lead. Instead, he recommended the need for the Government to enforce a set of regulations on details of dress and sanitary arrangements, in order to bring the remaining ill-conducted works in line with the rest. These ideas were incorporated in the Factory and Workshop Act, 1883.[3] The rules were not as comprehensive as those already enforced by some manufacturers, but included most of the general recommendations on hygiene and cleanliness, which, if followed, would go a long way to reducing the number of severe cases of lead poisoning.[4] The Act was well intended but due to the magnitude of the problem, proved inadequate and a new set of Special Rules was issued in 1891. The emphasis was, again, on dress and sanitary arrangements but the Rules also included a section on special ventilation for certain processes, and the requirement, mentioned previously, of watering the white-bed before breaking it up. The position regarding responsibilities of owners/managers, of superintendents and of employees was classified. Employers could no longer adopt the attitude that after providing water and soap it was the duty of the operative to take care of himself.[5]

[1] He gives no indication of the size of the labour force.

[2] 1883 White Lead poisoning Communication (C 3516), pp7-13. Appendix II contains copies of some of the Rules enforced by owners of white lead works.

[3] 1883 Factory and Workshop Act 46 and 47 Vict. c53. For schedule on white lead see appendix II.

[4] For a comparison of the regulations enforced at some factories and those required by the 1883 Act, see appendix II.

[5] See Appendix II.

1893 saw both coverage in the national press and the setting up of a further Departmental Committee to look again at the subject. This made the new recommendation of excluding female labour from all direct contact with white lead, further recommending that females under twenty should not be employed anywhere in white lead works. It was suggested that such rulings should not be enforced until January 1st, 1896, to allow a period of changeover.[1] In 1894, white lead works were scheduled as a dangerous trade and the 1895 Factory and Workshop Act also made lead poisoning, along with phosphorus and arsenical poisoning and anthrax, a notifiable disease to the Chief Inspector of Factories with effect from the 1st January, 1896.[2] But whilst the 'Old Dutch' process continued to be practiced, no amount of modification could eliminate all the risks of lead poisoning, and since no other method produced a white lead which would answer the requirements of the paint manufacturers, the 'Old Dutch' process was destined to continue.

The production of red lead, which was used in the manufacture of glass, in certain polishing powders and as a basis of some paints, was less detrimental to health in its production, with only isolated cases of plumbism being reported. To produce red lead, the metallic lead was placed in a melting oven. This had an opening at the top and at the sides through which the lead was occasionally raked and turned. The red lead did not break up into a powder quite so easily as the white lead and altogether, the process required less handling, hence the reduced risk to the worker. Those who faced the greatest danger were the furnacemen, who might be exposed to lead fumes escaping from the oven if there was an insufficient draught in the chimney.[3]

[1] *B.M.J.* 1893 January 7th, pp27-28; December 23rd, pp1391-1392. 1893-94 Dept. Ctte. Report Lead Industries (C 7239), pp3-13.

[2] *B.M.J.* 1894 January 20th, p165. 1895 Factory and Workshop Act 58 and 59 Vict. c37, s29.

[3] Dr Whitley (1863 Lead) p352. 1893-94 Dept. Ctte. Report Lead Industries (C 7239), p15.

Of the industries in which the various forms of lead were used, the manufacture of china and earthenware presented the greatest risk of lead poisoning. Here, lead was used as one of the ingredients of the glaze dip. As Meiklejohn (1963) has shown, the problems of using lead glazes were realized in the 18th century, but the incidents cited refer to cases of lead poisoning arising from the use of the finished product rather than amongst the operatives producing the ware.[1] Amongst the workforce, those who suffered from lead poisoning were those,

> "employed as 'dippers' and their youthful assistants, the ware-gatherers, the glost placers, and ground placers.... During the process of dipping, the workmen's skins come into direct contact with the glaze; in carrying the glazed vessels to the kilns, the children's hands and clothes are stained with it; and during the process of baking the ware, all who enter the kilns are exposed to leaden fumes and dust. Mr Robert Baker, in reporting on the health of these potters, states that the species of paralysis from which workpeople suffer affects chiefly the upper extremities, and is attended with excessive muscular emaciation, the loss of power and substance being most remarkable in the muscles which supply the thumb and fingers. He found that this local paralysis was not unusual; that lead colic was much more rare, but that the grey line along the margin of the gums was so common as almost to cease to be remarkable."[2]

Despite the attention given to the search for a leadless glaze, the problem was not solved during the 19th century, and in the 1890's, the numbers suffering from the poison caused so much concern that the Government was forced to take action. Any improvements over the period in reducing the risk of succumbing to the disease, were in

[1] Meiklejohn (1963), p170; Meiklejohn (1954), pp42-44. Concerns the the case of Devonshire colic - whereby workers suffered lead poisoning from the effects of cider on the lead glaze of the vessels it was kept in. Wedgwood in a letter to his partner Bentley in 1773, referred to the works on lead poisoning by Dr Percival of Manchester, the then recognized authority on the subject. Percival's writings concerned the effects of the acids of preserving fruit on the lead glaze. Wedgwood was probably concerned about the adverse effect on demand that such knowledge would bring, hence his interest in trying to overcome the problem.

[2] *B.M.J.* 1896 June 12th, p550.

improved sanitary measures and by changing the method of preparing the lead glazes to reduce their solubility.

As in other areas, the Society of Arts was one of the first to identify the problem, offering a gold medal or twenty pounds in 1793 to anyone who could prepare a suitable glaze for earthenware without the use of lead.[1] No awards were made until 1820, when John Rose of Coalport, Shropshire, was awarded a gold medal for his glaze prepared from felspar. Two years later, in 1822, another gold medal was awarded to J. Meigh of Staffordshire, for his black manganese glaze.[2] Although the new glazes were used on a small scale by their inventors, they had little impact on the pottery trade as a whole for the colours were not deemed to be as good as lead-based ones.

Other leadless glazes were suggested during the century but, like the earlier attempts, did not prove satisfactory substitutes for the lead glazes and only had a limited use.[3] After the initial enthusiasm and optimism over the glazes invented by Rose and Meigh, the Society of Arts withdrew its premium in 1823, but in 1852 renewed the offer, saying:

> "Lead has been used for giving a ready flow to the glaze, but is objected to, on account of its seriously affecting the health of the workmen. Although several plans have been proposed for superseding it, they have been found to act prejudicially on the colours and tints of colours used for giving effect to artistic designs." 4

[1] *T.S.A.* 1793, Vol. XI. This was later extended in 1821 to also exclude arsenic from the glaze.

[2] *T.S.A.* 1820, Vol. XXXVIII, pp42-44; 1822, Vol. XL, pp44-46.

[3] *Factory Inquiries Commission 1833*, Frank Cass & Co. Ltd. 1968, p78; *J.S.A.* 1876, p680; 1899 March 3rd, pp324-336; *The British Clayworker* 1898 July, pp106-108.

[4] *J.S.A.* 1852 December 31st, p65.

Although the main concern of the early factory legislators was the textile industries, the 1816 Select Committee to inquire into children's employment as Meiklejohn has shown, also examined the conditions of children in the potteries. For example, Josiah Wedgwood II gave evidence on the dangers of lead glazes to the dippers. Again, in the 1843 Children's Employment Commission Inquiry, the report of Dr Scriven, covering the North Staffordshire pottery area, was important in illustrating the great extent of lead poisoning and nervous disorders to be found amongst dippers. Those examined, although often not knowing the actual ingredients contained in the glazes they used, were aware of their harmful effects and the need for concern over personal hygiene. The actual number of dippers employed at each potbank was small but, due to dipping being a skilled occupation, the tendency was for them to remain within the same department, thus allowing the lead to accumulate in their bodies with severe effects. At work, it was usual for their arms to be emersed in the glaze solution as far as the elbow and hence lead poisoning occurred not only through inhalation and ingestion but also by absorption through the skin.[1]

After this initial awareness of the problem and the unsuccessful attempts at producing a satisfactory leadless glaze, the question of lead poisoning in the pottery industry appears to have remained silent until the 1860's, when Dr Greenhow made reference to the blue line in dippers in his 1860 report to the Medical Officer of the Privy Council and Dr Whitley confirmed the occurrence of lead poisoning in his 1863 report. However, from the evidence given by potters to Dr Whitley, it would seem that some minor changes in the ingredients of the glaze had occurred, a fact confirmed by the 1863 Children's Employment Commission who

[1] G.W. Elliott *Some descriptions of the Pottery Manufacturers and Working Conditions 1557-1844* (1970); Meiklejohn (1963), pp171-172; Dr Whitley (1863 Lead), pp352-353.

were of the opinion that the glazes then in use were less detrimental to health. In the early 19th century, some glazes had included arsenic in their composition, which, as seen in a previous section, was a dangerous poison in its own right, but by 1863, the use of arsenic had been abandoned. The level of lead content was also said to have been reduced, Dr Whitley finding that the best white glaze contained one eighth white lead, whilst the best china glazes were composed of one ninth lead which included some red lead. Another practice that had been adopted by some potters was the fritting of lead, i.e. melting it with a certain portion of silicous matter before adding it to the glaze, thereby rendering it less poisonous.[1]

In 1862, the potters had sent a memorial to the Secretary of State[2] on the need for legislation to protect children in the pottery industry and as a consequence of their pressure and that of the above reports, the pottery trade was included within the Terms of the 1864 Factory Act. This prohibited the employment of children under eight in the industry.[3] After this achievement, the issue was neglected until the mid '70's, when in 1876 Dr Richardson revived interest by devoting an entire lecture in his series of talks to the Society of Arts to the question of potters' diseases. In the same year, Arlidge also read a paper on this topic at the British Medical Association's annual meeting.[4] Both brought up the question of plumbism. Although in the 1880's the main focus on lead poisoning was in connection with the white lead workers, Arlidge continued to study the case of the potters. In a paper

1 Dr Greenhow (1860), p109; Dr Whitley (1863 Lead), pp352-353; Meiklejohn (1963), p172.

2 Quoted in Evans & Jones (1974), pp11-12.

3 Meiklejohn (1963), p172.

4 *J.S.A.* 1876 February 4th, pp186-193; *B.M.J.* 1876 October 14th, pp488-489.

in 1887, he showed that the majolica girls,[1] as well as the potters, suffered the disease, the cause being traced to their habit of wetting their brushes with their lips.[2] Arlidge felt that the Special Regulations drawn up for white lead workers under the 1883 Act, should be extended to the potters.[3]

The 1890's saw a hive of activity in Government circles on the issue of lead poisoning in the potteries. This has been discussed, in detail, by Meiklejohn and to a lesser extent by Evans and Jones. Following the revision of the rules for the white lead workers in 1891, a request was made by the Superintending Inspector for North Staffordshire for a review of the situation in the Potteries. The consequence of this was that in December 1892, the Home Secretary declared the manufacture of earthenware a dangerous trade within the meaning of the Factory and Workshops Act, 1891, section 8.

There was some conflict between employers and employees over the proposed rules to regulate the trade. The employees wanted the Rules to outlaw the use of lead glazes altogether; the employers wished to continue the use of fritted lead, declaring that the disease was really the result of the workers' negligence of sanitary precautions.[4] To resolve the situation, the Home Secretary appointed a Committee in 1893, which presented a report within three months. It concluded that lead poisoning could be attributed to a number of factors; to eating food with unwashed hands or partaking of it in the rooms where lead was worked;

1 Majolica is earthenware imitating that of Renaissance Italy and is a coloured ornamentation on opaque, white enamel. Majolica girls were hence responsible for decorating this ware.

2 J.T. Arlidge *Diseases of Potters: their causes and prevention* 1887, pp11-17.

3 See Appendix II.

4 Meiklejohn (1963), p173.

to dirty clothing; to glaze being allowed to drop onto the floor where it became dry and powdery; to operatives holding the pencil used for painting in the mouth or rubbing the eyes with dirty hands; and to near sightedness resulting in operatives working too close to their work. Moreover some youths and young women appeared to be constitutionally more susceptible to lead poisoning. The Committee recommended a series of Special Rules, much in line with those for white lead workers.[1] These, with slight amendments, became the Special Rules of 1894.

Following a review of the situation a year later, it was decided that better statistics were needed and so, in January 1896, lead poisoning became a notifiable disease to the Chief Inspector of Factories. During the first year, 1,030 cases were reported of which 432 were amongst china and earthenware employees. Due to the high number occurring within the Potteries, Miss Paterson and Miss Deane of the Factory Department, made special investigations in 1897 of the 404 cases of plumbism reported from 132 factories in the North Staffordshire potteries area. They found that,

> "Lead poisoning still prevails in the Potteries, and is unchecked, owing to the superficiality of the factory regulations intended to act as safeguards, and the difficulty of fixing responsibility for the observance of rules."

They revealed many distressing cases where young people, who had only worked in the lead processes for a short period, succumbed to the poison and died in convulsions. Such stories were picked up by the press for national coverage. Miss Paterson and Miss Deane also found that the effects were particularly noxious on young married women, who had frequent miscarriages and still births.[2]

[1] 1893-94 Conditions of Labour in the Potteries, Dept. Cttee. Report (C 7240), p5 and pp7-9.

[2] *B.M.J.* 1897 April 3rd, pp868-869; 1898 September 10th, pp726-727.

In the Potteries themselves, the Women's Trade Union League, was actively involved in trying to get changes. In 1898, it set up a reform committee which began a programme of popular agitation.[1] They demanded the use of leadless glazes and restrictions on the employment of women and children in the lead processes. In response, some firms asserted that they had been using fritted leads since the 1850's and had been continually experimenting to achieve a suitable, leadless glaze. The greatest barrier, as the employers saw it, in reducing the level of lead poisoning, was the apathy of the workers to realize the precautions necessary in handling the materials. The Government, concerned by the situation, invited Professor Thorpe and Professor Thomas Oliver to examine the possibilities of diminishing the dangers by using fritted or leadless glazes and to enquire how well they were fitted for the manufacturers' needs. They were also asked to see what other preventative measures were possible.[2] Soon after their appointment, a deputation from the Potteries was received by the Home Secretary, asking, among other grievances, for the victims of lead poisoning to be brought under the 1897 Workmen's Compensation Act. Questions were continually being asked in Parliament on the subject and in order to get expert, official information, Dr Thomas Morrison Legge was appointed in July 1898 as the first Medical Inspector of Factories. The Special Rules of 1894 were also amended; the main change being the exclusion of any person under 15 from dipping houses and the monthly examination, by the certifying surgeons, of all women and young persons in certain named departments. There was also emphasis on better exhaust fans to draw off the dust.[3]

Thorpe and Oliver reported back in 1899. Thorpe had made extensive trials and experiments on the various glazes and Oliver had looked at the production of earthenware abroad. They felt that manufacturers could do more than they were doing at the time; that many products did not need lead

[1] *The British Clayworker* 1898 May, p62. [2] *B.M.J.* 1898 May 28th, p1410.
[3] *B.M.J.* 1898 June 4th, p1496; June 18th, p1610; August 13th, p435.

glazes; and that where it could not be dispensed with, fritted leads should be used.[1] The manufacturers complained that they would be financially ruined but agreed to abandon the use of raw lead and to frit all lead in glaze.[2] In 1899, a new set of Special Rules were drafted, based on the suggestions of Thorpe and Oliver, and sent out to the pottery owners. The Potters agreed with the general principles of the Rules but not some of the details and insisted on arbitration on the disputed points. The employees also had some grievances with the draft, as they were opposed to the monthly inspection without coverage under the Workmen's Compensation Act. Arbitration proceedings commenced in late 1901.[3] Hence, at the end of the period under study, the question of lead poisoning in the Potteries was still partially an unsolved problem although the activities in the closing years of the 19th century marked important steps in the direction of reform.

Lead poisoning was not restricted to the pottery and white lead workers; cases were also quite frequent amongst the file cutters of Sheffield.[4] While the file was cut it was rested on a bed of lead but although lead dust arose with every blow of the chisel, it was claimed that it was the careless habits of the workers in neglecting to wash which caused the disease. Plumbism was also present amongst enamellers of iron. Phillips Bevan indicated its presence in this trade in 1876, but most reports came in the 1890's, when the enamel trade was reviewed under the 1893 Parliamentary Committee. The main centre of production of enamelled ware was Wolverhampton and the Black Country. The 1893 report

1 *B.M.J.* 1899 April 1st, pp829-830. *J.S.A.* 1899 April 7th, pp459-460.

2 *B.M.J.* 1899 May 6th, pp1116-1117; July 22nd, pp241-242. *The British Clayworker* 1899 August, p146.

3 *B.M.J.* 1899 December 23rd, p1752-1753. *The British Clayworker* 1900 September, pp224-225; 1902 January, pp374-376.

4 See the Sheffield case study, pages 343-344.

stated that when 'common tinning' occurred, the mixture contained 60% lead to 40% tin. In higher quality goods, the percentage of tin used was increased. Here, as with file cutting, the main cause of the disease was said to be the negligence of the workers. In 1894 a case was brought before the Wolverhampton Police Courts by the local Factory Inspector, concerning two young women who had neglected to wear the respirators provided by their employer. They were fined 10s 6d each, including costs.[1]

Another industry, revealed in 1863 by Dr Whitley to contain the risk of lead poisoning, was the glass trade. The danger was not only from the red lead used as an ingredient in making glass, but as the Children's Employment Commission report of 1864 showed, the leaden discs, used by the glass cutters to grind the glass, could also be a source of plumbism, as could the putty powder used for polishing the ware. This powder was composed of tin and oxide of lead.[2] Cases were also common amongst painters and plumbers, and cases of lead poisoning were often referred to as painter's colic. In the British Journal of Industrial Medicine for 1953, there is a reprint of an 1825 publication entitled, 'The Painters and Varnishers Pocket Manual', in which the injurious effects of lead were illustrated and various recommendations were made to aid recovery or to try and ward off the poison in the first place.[3]

[1] Phillips Bevan (1876), p65. 1893-94 Dept. Ctte. Report Lead Industries (C 7239), pp18-20. *B.M.J.* 1894 June 30th, p1432. Other reports in *B.M.J.* 1893 July 22nd, p187; 1894 November 17th, p1128; 1896 May 2nd, p1111; 1897 December 25th, pp1867-1868.

[2] Tomlinson (1854, Vol. I), p761. Dr Whitley (1863 Lead), p356. 1864 Children's Employment Commission I (3414), J.E. White's Report, p146.

[3] George Rosen 'Occupational Health Problems of English Painters and Varnishers in 1825' *B.J.I.M.* 1953 Vol. 10, pp195-199. Some examples of painter's colic are: *The Lancet* 1835 August 22nd, pp687-688; September 12th, p795; 1837 January 28th, pp653-655; July 8th, p560. *The Medical Times* 1843 January 28th, p286. *B.M.J.* 1874 December 5th, p712. Cases amongst plumbers: *B.M.J.* 1889 August 31st, p487. *The Lancet* 1832 April 21st, pp69-70.

Other isolated cases of plumbism occurred in a variety of industries, many being where dyes used for colouring contained some form of lead pigment. One such example was in 1872 when a number of lead poisoning cases occurred at a gingham factory in America. The source of the illness was eventually traced to the use of a dye which contained chromate of lead.

> "A needless amount of the pigment was used in this instance; and the weavers habitually threaded their shuttles by sucking the yarn through the eye of the shuttle with their mouths. A hook was devised and ordered to be used for threading; and the dyeing was ordered to be more carefully conducted. The epidemic speedily ceased." 1

Other cases were found amonst engineers and foundry trade workers where lead was used as an ingredient in some of the mixtures or for fixing joints. Sometimes old lead was melted down for re-use and the fumes released could prove a source of danger.[2]

Apart from white lead works and the pottery trade, the cases of lead poisoning could usually be accounted for by careless practices and negligence of simple rules of hygiene. In the case of the former two occupations, however, the dangers were far greater and some changes in production methods were necessary before the problem could in any way be solved. Alternatively, it needed a substitution of materials but by 1900, no such products had been found which would answer all the requirements of the manufacturers. However, some attempts had been made to try and control the disease and cut down the more serious effects of the poison. Although the Government had stepped in to enforce regulations, after pressure from several sources, it was more to bring the ill-conducted works in line with best practices rather than to introduce new ideas on precautionary measures.

1 *B.M.J.* 1872 August 3rd, p131. Other examples are in dyeing cotton yarn, *B.M.J.* 1895 January 5th, p40. Coloured Cardboard Box Making, *B.M.J.* 1888 March 10th, p555; Paper Bag Making, *B.M.J.* 1888 April 28th, p907; Temporarily whitening soiled lace with white lead, *B.M.J.* 1858 January 9th, p39.

2 *B.M.J.* 1871 January 21st, p61; 1872 February 10th, pp154-155; 1885 February 28th, p438; 1893 June 17th, p1264; 1894 March 10th, p540;

Several employers had already shown an interest in the welfare of their workers and had issued their own rules and regulations to promote health before the Government Special Rules were introduced in 1883. Examples of regulations found by Alexander Redgrave in his 1883 investigation, on which he drew up his recommendations for the Government Special Rules, are given in Appendix II, and although unfortunately not citing the name of the works concerned they do show the care some employers had already taken in protecting their workers. In some cases, these private regulations went further than those set by the Government. There was however some annoyance on the part of even the 'better' employers at the Government's attempts to ban the use of lead in glazes altogether; many employers feeling that they had sufficiently discharged their duty to their employees if they fritted the lead. Any further responsibility lay with the employee whose carelessness, it was argued, was still a major cause of lead poisoning.

1.d. Mercury

Mercury, often known as quicksilver, was used in several sectors of industry in the 19th century, due to its properties as a solvent. Amalgams[1] were used for various processes, including gilding and the silvering of looking glasses and, by 1780, the practice of using such amalgams was well established. Other 19th century industries which handled compounds of mercury were the hatting and furrier trades, as well as the making of barometers.

Mercury differs from other metals in that at normal room temperature it takes the form of a liquid. In the truly metallic form, it is not poisonous because it is not absorbed,

[1] Amalgams are alloys of metal with mercury.

but its soluble salts can be very dangerous and when mercury is left, freely exposed, it vaporizes at room temperature causing toxic fumes to be emitted.[1] Once in the body, mercury is stored in the kidneys but its most dramatic effects are on the nervous system. A person suffering from mercury poisoning initially develops emotional problems such as anxiety, indecision, embarrassment and depression. As the disease progresses, he might develop a slight tremor of the hands, making legible writing impossible, and gradually, with continued exposure, further disorders of the nervous system occur such as speech difficulties, loss of co-ordination, staggering gait and disturbed vision. In extreme cases the teeth may also become carious and fall out. During the illness there is often a serious change in mental ability and personality. The expression as 'mad as a hatter' refers to the fact that hatters often became deranged after working at their trade for several years due to the use of a mercury solvent to soften the felt in the hats. There is also an acute form of mercury poisoning, causing a sudden, severe burning pain in the mouth, followed by ulceration and abdominal trouble. This form of poisoning, however, was not very common in industry.[2]

By 1780, the fact that gilders were liable to mercury poisoning was already known, for Ramazzini had written in 1713:

> "We all know what terrible maladies are contracted from mercury by goldsmiths, especially by those employed in gilding silver and copper objects. This work cannot be done without the use of amalgam, and when they late drive off the mercury by fire they cannot avoid receiving

[1] Brown (1977), p511. Stellman & Daum (1973), p255.

[2] *J.S.A.* 1876 January 21st, p150. John Darwell *Diseases of Artisans with Particular Reference to the Inhabitants of Birmingham* (1821) - Quoted in full in A Meiklejohn 'John Darwell MD (1796-1833) and Diseases of Artisans' *B.J.I.M.* 1956 Vol. 13, pp148-149. Pears Medical Encyclopedia (1977), p512. Stellman & Daum (1973), p255.

> the poisonous fumes into their mouths, even though they turn away their faces. Hence craftsmen of this sort very soon become subject to vertigo, asthma and paralysis." 1

But at that stage, there was little more than an awareness of the problem, for the only preventative measure known was a change of occupation. The Society of Arts took an early interest in promoting safer methods in mercury-using trades. Water-gilding was in fact the first occupation for which they tried to secure better conditions for workmen, offering a premium for ideas on improvements as early as 1771.[2]

The process of water-gilding involved the following series of actions. The metal to be gilded was first brushed over with a solution of nitrate of mercury and then covered with a layer of amalgam of gold and mercury. The article was then heated over a charcoal fire to expel the quicksilver and afterwards burnished, hence the workmen were exposed to pernicious fumes especially during the heating process.[3]

In 1774, the Society of Arts made its first award of twenty guineas to a Mr J Hills. His apparatus worked much in the same way as the modern fume cupboard in a chemistry

1 Ramazzini (1964 translation), p33. Also quoted in Hunter (4th edition 1969), pp292-293. Mercury poisoning was recognised as far back as the Roman period amongst miners of quicksilver. At one time it was also common amongst surgeons and their patients as it was extensively administered as a medicine, particularly for the purpose of keeping down a fever or for treating syphilis. For early references to poisoning amongst miners see: Monamy Buckell, Donald Hunter, R. Milton and Kenneth M.A. Perry 'Chronic Mercury Poisoning' *B.J.I.M.* 1946 Vol. 3, p56.

2 Sir Henry Truman Wood *A History of the Royal Society of Arts* 1913, p. 270.

3 Dr George Whitley 'On the Occurrence of Mercury Poisoning amongst persons who work with mercury and its preparations' *6th Report of the Medical Officer of the Privy Council* 1863, p358.

laboratory, except that the draught to extract the fumes was created by bellows operated by a treadle, rather than by a fan. In conjunction with this, he produced a glass screen to be placed in front of the object being gilded. A small opening was left in the screen through which the craftsman was to work, wearing leather gauntlets. Although the water gilder who had been employed to test the apparatus continued to use it after the award, there is no evidence that it was adopted elsewhere and in 1811, forty years after the initial announcement of the premium, the Society made a further award. This time the preventative proposal followed an entirely new line; a protective mask, suggested by Richard Bridgen. It consisted of a covering for the nose and mouth, connected to a tube which led to the back of the head, so that the air breathed in was not that directly contaminated with mercury fumes. For a pure air supply it was suggested that the tube could be extended through a window to the outside. Despite the novelty of the idea, and its theoretical effectiveness, the likelihood of its being put to practical use was remote, since it would have been inconvenient and burdensome to wear, and it is not surprising that no mention of it in use has been found.[1]

Although these safety precautions were only rarely put into practice, Thackrah saw the use of a glass screen by several operatives in 1832. Dr Whitley in 1863 also observed the same precaution being taken but such action was only only possible for small articles. Even then, it was not entirely effective for some gilders adopting the practice, still suffered from mercury poisoning.[2] Preventative

[1] Truman Wood (1913), pp270-271. D Hudson & K Luckhurst *The Royal Society of Arts 1754-1954* (1954), p103. *T.S.A.* 1811 Vol. XXIX, pp138-142. The premiums offered by The Society of Arts were usually renewed by several years until it was felt that the best practical means of remedying the problem had been put forward.

[2] Thackrah (2nd enlarged edition, 1832), p113. Dr Whitley (1863 Mercury), p358.

measures were, however, successful in gilding buttons, where it proved possible to isolate the process from the operative.

> "This was formerly done at great loss, both of the material and of health of the work-people, over an open fire, but is now managed by placing the buttons in a wire cage, within a furnace, constructed to preserve and condense the fumes of the mercury by allowing of their escape into a vessel containing water, instead of being diffused through the room and poisoning the work-people. Under the present arrangement, a woman can sit without danger and turn the handle of the cage, thus exposing all the buttons in succession to the action of the fire." [1]

It is interesting to note that the first named benefit is to the saving of materials rather than the safety of the workers and like many other improvements, the reasons for employers adopting new methods are open to question. In an allied trade of silvering mirrors, it would seem that economic forces and technical problems governed the initiative for improvements rather than an overwhelming concern for health and safety.

The cause of mercury poisoning in the silvering of looking glasses was the use of an amalgam made up of tin and mercury. The original method of production was to flatten a sheet of tin foil and cover it with quicksilver. The mirror glass was then slid on and the excess mercury collected in vessels and used again, hence the air in which the worker carried on his employment was constantly permeated with mercury fumes.[2] The workers suffered from chronic poisoning, the effects on the nervous system first being noticed by tremors in the fingers which later developed into general debility. Thackrah maintained that few could bear the employment daily and many took the precaution of working alternate days. Chambers in his lecture to the Society of Arts in 1854 said that,

[1] Tomlinson (1854 Vol. I), p264.

[2] Arlidge (1892), p440.

> "Looking glass makers and water gilders are constantly coming into hospitals for mercurial paralysis; and when they go out of the hospital they are not fit for much else than the workhouse. There are two ways of remedying this; one is to give them some protection against the poisonous fumes; and the other is to improve and cheapen rival modes of gilding and silvering, in which mercury is not used." 1

Although the effects of mercury poisoning were as devastating as those of lead poisoning the trades employing mercury, unlike the white lead works and potteries, attracted little attention. One reason for this apparent lack of interest could well have been that the numbers engaged in the trades were comparatively few, hence, in aggregate the incidence of the disease would have appeared low. Whitley in 1863, reported on a visit made to one of the larger manufactories which silvered looking glasses. Here the work force consisted of only nine men and one boy directly involved in silvering, with a further thirty less directly involved.[2] The large factories were often the better conducted and arranged works, hence the risks of mercury poisoning were reduced. The cases thus arising in the smaller workshops would not have caught the attention of the general public to the same extent as the large number of young girls suffering from lead poisoning as a result of working in the white lead works.

In 1875, after examining both white lead works and trades using mercury compounds, Alexander Redgrave observed that some processes using mercury were just as dangerous as lead-using trades and similar precautions to those he had recommended for the lead works should be implemented.

> "In the silvering of looking glasses by quicksilver there is the same danger to health from the incidious metal getting by contact into the system, and precisely the same means might be adopted to render those engaged in this trade actually free from any danger. But beyond the provision of water for the

1 Thackrah (2nd enlarged edition 1832), pp111-112, *J.S.A.* 1854 June 9th, pp492-493.

2 Dr Whitley (1863 Mercury), p359.

> purposes of ablution, absolutely no provision is made by the manufacturers for preventing disease." [1]

Some continental works had already adopted more extensive precautions with little beneficial results. The British Medical Journal in 1861, published a translation of a German report on the Bohemian silver manufactories.[2] At these works strict rules were enforced. No food was allowed to be consumed in the workshops and the employees, mainly young men between the ages of 16 and 24, had to wash out their mouths twice a day with astringent water. They were not allowed to work more than eight hours a day and after a fortnight at the job, had to leave for a period of eight to fourteen days. Even with these precautions it was said:

> "All these workpeople are diseased. In the very first weeks after their entry, grey deposits are formed on the teeth; the mucous membrane of the mouth becomes red and swollen; and, at a later period, excoriations[3] appear on the lips and gums, with ptyalism,[4] loss of smell, hoarseness, ulceration, and swelling of the lymphatic glands and of the tonsils with the exception of the newcomers, all have ulceration of the fauces.[5] Tremblings of the extremities, nocturnal pains in the head and in the limbs, loss of teeth, and swellings on the bone, gradually appear."

These symptoms were also found in men who had left the work for four or five years. Abortions among pregnant women had been so common that married women had been banned from the work.[6]

1 Reports of the Inspectors of Factories for the Half Year ending 31st October 1875 (C 1434) Alexander Redgrave's Report, p20.

2 The Bohemian Silvering Manufactories were presumably state-owned.

3 Excoriations = removal of part of the skin by abrasions.

4 Ptyalism = Ptyalin is an enzyme contained in saliva.

5 Fauces = opening between mouth and throat.

6 *B.M.J.* 1861 May 11th, p478.

Although many British manufacturers did not introduce protective measures against mercury poisoning, new technology proved to have a greater impact on the health of the employees. Water-gilding was gradually replaced by methods of electro-plating whilst silvering was undertaken by a different method.

Thomas Drayton had begun experiments to try and find new ways of silvering mirrors in 1840. His motivation appears to have stemmed from the technical problem of silvering large surfaces by the old method and the impossibility of silvering anything other than flat surfaces, rather than any efforts to improve health conditions amongst the workers. His experiments led to a method of silvering in which silver was deposited from nitrate of silver and the use of mercury was altogether eliminated from the process. In promoting this method, Drayton did point to the fact that as well as the process being cheaper, quicker and more adaptable, the workers were no longer exposed to the fumes of mercury and their health was thus not endangered.[1] However, despite being quicker and safer, it did have several disadvantages which were not always acceptable. The surfaces were sometimes spotted and the dark colour of the coating gave the mirror a black effect, thus not all the manufacturers adopted the new method. Experiments continued but in the 1870's the quicksilver methods was still being used in some factories. In an attempt to solicit public opinion to force manufacturers to adopt the new methods, Redgrave appealed to the public that, when buying mirrors, they should demand those made by the 'patent' process rather than those produced with quicksilver. The influence of this request would appear to have been minimal however, as with a similar unsuccessful appeal concerning the purchase of matches.

[1] Thomas Drayton 'On the Manufacture of Pure or fine Silver Looking Glass', *T.S.A.* 1846-7, pp142-144. He was awarded the gold medal for his work.

And the amount of suffering amongst silverers was nowhere near the horrific level of disease inflicted on match makers.[1] Even so, by the time Arlidge wrote in 1892, he was able to report that due to almost universal adoption of modern methods of production, mercury poisoning amongst silverers was rare.[2] It is to be presumed, therefore, that by this date there had been further developments in the techniques of silvering which made the take up of the new technology more attractive to manufacturers.

Water-gilding was similarly, gradually replaced by a new process, that of electroplating. Although the principle of electricity had been discovered at the end of the 18th century, it needed further advances in scientific knowledge before electroplating was possible. This became practicable from about 1840 and from the 1850's onwards, reviews of water-gilding reported that electroplating was being used by some manufacturers. Nevertheless, Arlidge observed in the 1890's that water-gilding was still preferred for some items such as sword handles, as it was said to wear better.[3] Even though the new methods removed the dangers of mercury poisoning, electroplating was not without its own hazards, as it used the salts of hydrocyanic acid:

> "The cyanogen gas given off from the cyanide solution appears to have an injurious effect on the health, especially in badly ventilated workshops. The hands of the people engaged in plating and gilding are also subject to ulceration, and the ulcers are difficult to heal. Eruptions also, in some cases, will break out over the body of the workman in consequence of inhaling the deleterious fumes." 4

1 See phosphorus, pages 97-106.

2 Tomlinson (1854, Vol.I), p782.; *J.S.A.* 1876 June 23rd, pp784-785. Reports of the Inspectors of Factories for the Half Year ending 31st October 1875 (C 1434) Alexander Redgrave's Report, p20. Arlidge (1892), p440.

3 Tomlinson (1854, Vol. I), p758. *B.M.J.* 1878 August 17th, p243. Arlidge (1892), p441.

4 Tomlinson (1854, Vol. I), pp575-576.

Of the other trades handling mercury compounds, Dr Whitley reported on the dangers attendant in making barometers. The main hazard was the occasional bursting of tubes in which mercury was heated but over the whole country, only about 100 people were employed in the trade and cases of poisoning were rare. The hatting and furrier trades were a well known source of danger. In these, the skins of rabbits and musk rats were brushed with mercury nitrate in a process known as felting. The use of nitrate of mercury was said to be indespensible to the process and no attempts seem to have been made either to substitute an alternative method of felting or to make the existing process safer. Another occupation which used mercury nitrate was that of the taxidermist and occasional cases of poisoning were reported.[1]

Mercury then, despite being a source of much danger, did not engender as much public sympathy for the operatives handling the material as did some of the other toxic materials handled. The trades which used mercury compounds only employed a small number of people so that the hazards were not seen to be on such a large scale. Investigators such as Dr Whitley and Alexander Redgrave, however, did recognize its perniciousness and expressed the opinion that occupations handling mercury compounds should be subjected to the same restrictions as recommended for white lead works. The reduction in mercury poisoning came about as a result of technical changes in production methods which eliminated the use of mercury. These changes had been occasioned by difficulties of silvering and gilding certain types of ware with mercury compounds rather than for humane reasons. By the time the Government made mercury poisoning a notifiable disease in 1899, it was already becoming a rare occurrence.[2]

[1] Dr Whitley (1863 Mercury), pp360-361. *J.S.A.* 1876 January 14th, p133. *B.M.J.* 1878 August 17th, p243. Arlidge (1892), p442.

[2] *B.M.J.* 1899, April 2nd, p1009.

1.e. Phosphorus

Although phosphorus was used in the production of some forms of vermin paste, explosives and pharmaceutical products, the quantity used was small and insignificant. In these industries too, it was usual to handle the phosphorus in a damp form which was less hazardous than in the dry state. Equally the numbers engaged in the manufacture of phosphorus from bones were not large, being not more than 60 or 70 in the whole of Britain in 1862, and only a handful of these worked on operations where phosphorus fumes were involved.[1] The industry which gave real alarm, as far as phosphorus poisoning was concerned, was the lucifer match trade and here the resultant disease went under the name of 'phossy jaw'.

Phosphorus does not occur freely in nature because when in contact with air it readily oxidises. There are three allotropes of phosphorus, two of which were used for industrial purposes in the 19th century. These were white and red phosphorus. White phosphorus, which was also referred to as yellow or common phosphorus, is highly inflammable and takes to flames at 30°C, thus it has to be handled with care. It is also very volatile at room temperature, giving off fumes of phosphorus trioxide which are extremely poisonous and were the source of trouble in the lucifer match trade. Red or amorphous phosphorus, on the other hand, is much more stable and has none of the poisonous hazards of the former.[2]

[1] Dr Bristowe 'Report on the manufactures in which phosphorus is produced or employed, and on the Health of the persons engaged in them' *5th Report of the Medical Officer of the Privy Council* 1862, p164. Arlidge (1892), p459.

[2] Dr Bristowe (1862), pp162-163. Hunter (4th edition 1969), pp374-375.

The first friction match, the lucifer match, was invented in 1826 by John Walker. It did not contain any phosphorus being composed of a wooden splint one end of which had been dipped into a paste of potassium chlorate, antimony sulphide and gum arabic. However, it was soon found that by using white phosphorus, the splint was more readily ignitable. In fact, they were often too readily ignitable, causing fires where boxes were exposed to the sun or jolting, and it was necessary to keep them in a metal container. These phosphorus matches were first manufactured in Germany and Austria in 1833 and were known as congreve matches. They soon became popular and by 1840 had ousted lucifer matches although the name of the latter remained and was adopted to describe any form of match.[1]

Initially match production was not considered hazardous, but in about 1845 a surgeon in Vienna discovered that it was one of the most dangerous and unwholesome of occupations. It was found to have a serious effect on the jaw bone causing necrosis.[2] Similar reports soon followed from other countries and by 1850 the disease was familiar to medical men and manufacturers alike. The victim was usually first only aware of a dull toothache which he took to be a common ailment, only later discovering it to be a disease of the jaw bone itself. Initially, the pain was slight but on continued exposure to the phosphorus fumes, the disease spread with the pain increasing proportionally. The teeth became loose and were often extracted or fell out of their own accord. Abscesses formed and the jaw bone necrosed. The lower jaw was more frequently attacked than the upper and in order to attempt to stop the spread of the disease, surgeons often resorted to cutting away the affected jaw bone.[3]

[1] Hunter (4th edition 1969), pp376-377.

[2] Necrosis = the death of a small part of the tissue.

[3] *B.M.J.* 1856 September 6th, pp756-757; 1863 August 29th, p244. Dr Bristowe (1862), pp176-177. *The Medical Times* 1846 February 28th, p423 - Reports from France. *J.S.A.* 1876 January 21st, p150. Phillips Bevan (1876), p135. Hunter (4th edition 1969), pp377-378.

> "The disease gradually creeps on, until the sufferer becomes a miserable and loathsome object, spending the best period of his life in the wards of a public hospital. Many patients have died of the disease; many, unable to open their jaws, have lingered with carious and necrosed bones; others have suffered dreadful mutilations from surgical operations, considering themselves happy to escape with the loss of the greater portion of the lower jaw." [1]

The basic method of production of white phosphorus matches consisted of first dipping the wooden splints in sulphur, paraffin, or some analogous substance and then dipping them in phosphorus paste, made up of phosphorus and chlorate of potash combined with glue. The common matches were dipped in a bundle, whereas the better class matches were fixed separately in frames so as to give a more equal distribution of the composition on the head. The phosphorus paste often contained a colouring agent such as red lead, Prussian blue, vermillion or sulphuret of antimony. The matches were then dried, cut (as the splints were kept in double lengths for dipping) and boxed. In the process of dipping, abundant white fumes were given off. Fumes were also present in the mixing stage and to a lesser degree in the drying room. The mixers and dippers were thus the most exposed to the risk of 'phossy jaw'. [2]

However, despite the horrific aspects of the disease with the resultant mutilation and deformity, the disease does not seem, from Dr Bristowe's extensive investigations in 1862, to have prevailed to any great extent amongst the match makers of the country. At that time there were 57 match making establishments in England (see Table III) employing upwards of 2,500 hands. The size of the concerns varied considerably; the largest factory employing approximately five hundred hands whereas the smallest were family businesses with perhaps the addition of a few extra labourers.

1 *J.S.A.* 1853 March 18th, pp200-201.

2 Dr Bristowe (1862), pp166-169 and p173. Arlidge (1892), pp456-457.

TABLE III: Distribution of Match Making Establishments in England in 1862

Town	Number of Establishments
London	33
Norwich	4
Bristol	4
Manchester	3
Newcastle	3
Nottingham	3
Liverpool	2
Birmingham	2
Leeds	2
Leicester	1

Source: Dr Bristowe's 1862 Report to the Medical Officer of the Privy Council

From the inquiry, he discovered only 59 cases of phosphorus poisoning within the preceding 25 years, of which 44 were amongst males and 15 amongst females.[1] It is quite probable that there were more cases than he identified since some factories had closed and were therefore not investigated, and, due to the slow onset of the disease, some employees had possibly moved on before the more horrific aspects became obvious. While the incidence appears as but a small percentage of the total number of match makers, twenty of the cases resulted in death; eighteen being directly attributable to 'phossy jaw' and many of the others were horribly disfigured after losing a lower or upper jaw.

The reason why a large proportion of the cases was found amongst males is due to the fact that they were usually employed in the dipping and mixing departments where the fumes were greatest. In fact over 60% of the cases (36) reported to Dr Bristowe were amongst dippers, mixers and grinders. The incidence of disease amongst females is interesting, because twelve of the fifteen cases

[1] Dr Bristowe (1862), pp181-182. Supplement pp194-204 gives full details of all the 59 cases.

reported occurred at the works of Dixon, Son & Evans in Manchester. Twelve cases amongst the males also came from these works which were one of the largest congreve manufactories in England, employing around 250 workers. In 1862, this firm had been in existence for twenty-five years and all the twenty-four cases of phosphorus poisoning had occurred within the first twenty years of production, being due partly to the unfavourable arrangements of the works. The rooms had been low and ill-ventilated, with all the operations being conducted in the same department, exposing all the workers, both male and female, to the pernicious fumes, hence the reason why the women fell victims of the disease as often as the men. The manufactory produced the lower grade bundle matches and the composition of the paste was one third phosphorus by weight. At one period they had also worked long hours but five years before Dr Bristowe's report, the company had taken steps to improve conditions and constructed well ventilated, large rooms. They had also stopped bundle dips and reduced the composition to one half strength, with the result that since the time of the improvements, no cases of poisoning had been reported.[1] These improvements appear to have been occasioned primarily by a concern for the health of the operatives.

Once the disease became apparent, there does appear to have been genuine concern by many employers for the plight of their workers and many firms enforced their own rules of hygiene. In 1854 in one factory,

> "the work-people (were) required to wash their hands night and morning in a solution of soda; the dippers (wore) sponges before their mouths, and an accumulation of fumes (was) prevented by numerous open windows, fanlights and ventilating shafts." [2]

The recommendations for preventative measures generally followed the lines of improved sanitary facilities or attention to personal cleanliness but, although undoubtedly

[1] Ibid. pp185-186. [2] Tomlinson (1854, Vol. II), p246.

of some benefit, they did not attack the source of the problem. Some suggestions were made as to the value of placing saucers full of turpentine near the dipping bowls and other areas where the phosphorus fumes were greatest.[1] The turpentine helped to neutralize the effects of the white phosphorus fumes. In one firm, it was even the practice for the dippers and their assistants to wear narrow mouthed cups or flasks containing turpentine on their chests, in the hope that it would prevent the oxidization of the phosphorus handled.[2] Dr Bristowe recommended the reduction in the manufacture of the cheaper range of bundle dips, as the paste covering these contained more phosphorus than the better class of match.[3]

The real answer however lay in the substitution of white phosphorus by some other, innocuous product. This became possible with the discovery of red or amorphous phosphorus in 1845 by the Austrian, A. Schrötter. This had none of the dangerous properties of white phosphorus. A method of producing red phosphorus on an industrial scale was patented in 1851 and the holders of the English patent, Messrs. Sturge, exhibited a sample of it at the Great Exhibition.[4] They sent specimens to most of the major match producers at home and abroad and it was felt that,

> "if the public will take an interest in the manufacture of amorphous matches, the time is not very distant when that form only will be tolerated; and thus the interests of humanity will be served by the extermination of a cruel disease and the introduction of a safer and better article of domestic use." [5]

[1] Dr Bristowe (1862), pp188-189. Phillips Bevan (1876), p136. Andres Rabagliati 'Workers in Phosphorus and Arsenic and their Diseases' *Great Industries of Great Britain* Vol. III, p235.

[2] Dr Bristowe (1862), p190.

[3] Ibid. p189.

[4] *J.S.A.* 1853 March 18th, p201. Tomlinson (1854, Vol. I) cxxxviii. Hunter (4th edition 1969), p382.

[5] *J.S.A.* 1853 March 18th, p201.

Although some manufacturers, like Dixon & Evans in Manchester and Mr Dowler of Birmingham, experimented with the use of amorphous phosphorus, they were not successful in making a match acceptable to the general public.[1] The matches were dearer because the quantity of red phosphorus which had to be used was far greater than the amount of white phosphorus required for the congreve matches. Difficulties were encountered in the mixing of red phosphorus with other ingredients, the greatest being that of mixing it with chlorate of potash, which was necessary in order to make it ignite by friction. The resulting compound was so explosive it was difficult to manipulate. It ignited noisily with a tendency to splutter which was inconvenient to the user. Dr Bristowe also reported that workmen were reluctant to mix it, as it was so unpredictable and dangerous to handle.[2]

The firm of Bryant and May however adopted another mode of using amorphous phosphorus which was more successful. The principle of the safety match had been invented in 1844 by a Swede,[3] and Bryant and May developed a method in which they covered the head of the match with a mixture containing chlorate of potash but no phosphorus, and then had a layer of composition with amorphous phosphorus but no chlorate on the outside of the match box. Although this avoided the problem of spontaneous ignition and the liability to 'phossy jaw', there were disadvantages with this process too. Firstly, the matches would only ignite on the prepared surface and by careless ignition the phosphorus paste on the box was often exhausted before all the matches had been used. It was also maintained that the phosphorus compound had a tendency to become moist and to deteriorate in efficiency and hence, with the Bryant and May amorphous match also being more expensive, the old match held its ground.[4]

1 Ibid; Dr Bristowe (1862), p190.

2 *J.S.A.* 1853 March 18th, p201. Dr Bristowe (1862), p191.

3 Hunter (4th edition 1969) p382.

4 Dr Bristowe (1862), p191.

By the time of Dr Bristowe's report it appears that the technical difficulties with amorphous phosphorus had been overcome, but that the price of the resulting product hindered its overall introduction. Two large London producers confirmed that they had,

> "succeeded perfectly in replacing the ordinary phosphorus by the amorphous kind, in the composition in which the matches are dipped, and that the real difficulty in the way of success is solely one of expense." [1]

White phosphorus matches were far cheaper to produce and whilst the public continued to demand them, some manufacturers were willing to make them despite the hazards. Hence, producers who attempted to use only amorphous phosphorus found it difficult to compete. The public might have claimed, initially, to have been unaware of the dangers that the cheaper matches presented to the match makers, (although the Society of Arts had tried to draw attention to the hazards in the 1850's) but by 1890 they could not claim ignorance. In the 1890's, the national newspapers had taken up the match maker's cause and had tried to arouse public sympathy for them by advertising their distress. The Salvation Army too, did its best to publicise their fate. One of their officers, Colonel Barker, took newsmen and M.P.'s around workshops where match makers still used white phosphorus. The climax of the tour was when he switched off the lights to show how the victims' jaws and blouses glowed with a greenish, fluorescent light.[2]

By 1890 many continental countries had compelled their match manufacturers to eliminate the use of white phosphorus and to use red phosphorus paste only on the side of the box,[3]

[1] Ibid. p192.

[2] *J.S.A.* 1854 June 9th, p496; *B.M.J.* 1892 January 30th, p238 (Report from Star newspaper); 1898 May 21st, pp1346-1347. Hunter (4th edition 1969) p380.

[3] Finland was the first to abolish the use of white phosphorus in 1872. Denmark followed in 1874.

but Britain had no such rules, and cases of 'phossy jaw' still occurred.[1] Under the powers of the Factory Acts, the Home Secretary issued Special Rules for Lucifer Match works in 1891 but thsse were solely concerned with sanitary details. In May 1891, Booth set up his model factory in the east end of London, producing his 'Lights in Darkest England' matches, which used only red phosphorus. But, like earlier attempts, his matches could not compete with the price of the white phosphorus 'strike anywhere' matches and despite his appeals to the public to buy on humanitarian grounds, his factory was forced to close within a couple of years.[2] The Government initiated its own inquiries in 1893 and found that since the Special Rules had been enforced, only two cases of 'phossy jaw' had occurred. They believed, however, that the danger still existed and that some changes in the Special Rules would be beneficial, mainly on the lines of better ventilation and periodical examinations. They condemned the practice observed in some factories whereby workers were employed in galleries over the departments where the fumes arose.[3] Along with arsenic and lead poisoning, phosphorus poisoning became a notifiable disease from 1st January 1896, although there was still no total ban on the use of white phosphorus.

The end of the century saw the discovery by French Government chemists of the harmless substance, phosphorus sesquisulphide, which proved a much more satisfactory substitute for white phosphorus than amorphous phosphorus had been. From about 1900, it began to take its place in the production of 'strike anywhere' matches. The final stages in the substitution process (which are described by Hunter) are interesting because they involved the co-operation and joint efforts of several countries. In 1906, a convention was held in Berne on the subject to which all the major

[1] Interestingly amongst workers at the Bryant and May factory which was held up to be a model factory by Dr Bristowe in 1862. *B.M.J.* 1892 January 30th, p238; 1894 January 6th, p33; 1898 May 21st, pp1346-1347.

[2] Hunter (4th edition 1969), pp380-381.

[3] 1893 Report bythe Chemical Works Committee of Inquiry into Lucifer Match Works (C 7236).

European countries sent representatives. They agreed to forbid the manufacture and importation of white phosphorus. In England, the use of white phosphorus in matches was finally prohibited by law in 1910.[1]

1.f. Zinc

In the 19th century the main use of zinc was in combination with copper to form brass. Although some zinc compounds can cause skin ulcers and irritation of the eyes and lungs, the major hazard of zinc is associated with the fumes of zinc oxide. This can cause an intermittent fever, which in the last century was referred to as 'brassfounder's ague'. Thackrah recognized that brassfounders exposed to the inhalation of volatized metal were affected in their respiration but he did not identify zinc as the cause. He also observed that coppersmiths using brass solder were liable to suffer from the fumes and in this instance, he did suggest that the spelter fumes might be to blame.[2]

The fever struck the worker on initially starting in the trade of brassfounding and whenever he returned to work after a day or two's absence. Nowadays, this syndrome is known as metal fume fever, and it is recognized that many metals can bring on this illness, with zinc, copper and magnesium being the commonest causes, although iron, antimony, manganese, silver, tin and several others have also been discovered to have the ability to produce this effect.[3] Towards the end of the 19th century, some doctors argued that copper fumes caused metal fume fever, but they saw the question as being one of alternatives - whether it was copper or

1 Hunter (4th edition 1969), pp381-382.

2 Thackrah (2nd enlarged edition 1832), pp101-102.

3 Hunter (4th edition 1969), p421.

zinc which caused the fever rather than the possibility of them both being equally responsible.

The attacks of fever were short in duration, not usually lasting longer than twenty-four hours. Thus patients were not generally prevented from going to work and rarely appeared before a doctor for treatment. It was seen as an inconvenience rather than an illness and the extent of the problem was not realized for some time. One of the first to investigate 'brassfounder's ague' thoroughly was Dr Greenhow, who became aware of the problem when he travelled through Birmingham in 1858, investigating the incidence of pulmonary disease for the Medical Officer of the Privy Council.[1] After this discovery, he decided to look further into the subject and so travelled to Wolverhampton, Sheffield and Leeds.[2] Earlier references had been made to the sickness, mainly in France, and the identification of zinc oxide as the cause has been attributed to Blandet in 1845 [3] although the Medical Times in the same year carried a report on the observations of a M. Becqueil on the effects of zinc fumes in copper foundries which again directed attention to zinc oxide.[4] The symptoms of the illness, as found by Dr Greenhow, were the following, almost all the brassfounders telling an identical story. They began with a,

> "sense of malaise and weariness or as one termed it nervousness; a feeling of constriction or tightness of the chest, and, in some rare cases, nausea commencing during the afternoon of a day employed in casting, followed towards evening, or at latest when getting into bed, by shivering, sometimes succeeded by an indistinct hot stage, but invariably by a very definite stage of profuse sweating. The sooner the latter follows the

1 Brassfounders also suffered from respiratory diseases from the dust generated in brassfounding.

2 E.H. Greenhow 'On Brass-Founders' Ague' *Medico Chirurgical Transactions* 1862, Vol. 45 (2nd Series, Vol.27), pp177-187.

3 Ibid. p178.

4 *The Medical Times* 1845 April 19th, p41.

> setting in of the cold stage, the shorter and milder is the attack, and the less likely is the caster to be incapacitated for work on the following day. Headache and vomiting frequently, but by no means always, accompany the attack, which, at the worst, is ephemeral, and rarely, if ever, prevents the caster from pursuing his occupation; but the attacks are, in some cases, of frequent occurrence, and men engaged in this employment are seldom long-lived, though the ailment which evidently shortens their days is chronic bronchitis; or, as they term it, asthma. Persons who have but lately adopted the calling, or who only work at it occasionally, and regular casters, who have been absent from work for a few days, are reported to be more liable to suffer from this disease than those who work at it continually."

It was also generally agreed to be worse when the weather was foggy and the fumes hung around the casting shop.[1]

In making brass, the copper was first placed in the crucible and when molten, the zinc was added. The reaction was intense, with some of the zinc being deflagrated, forming a dense cloud of white smoke which filled the atmosphere of the casting shop. The smoke was mainly composed of zinc oxide fumes and was soon diffused everywhere. In ill-ventilated workshops, it tended to linger. The density depended on the amount of zinc used which in turn depended on what the brass was destined to be used for. More white smoke resulted from mixing brass than in remelting brass ingots, hence the casters were more liable to suffer from the fever. Some of the casters did attempt to protect themselves by placing a handkerchief over the mouth while casting, also,

> "the men themselves have a very strong belief in the prophylactic and curative influence of milk, which many of them habitually drink for this purpose, and they assert that the occasional use of emetics has a tendency to prevent the disease."

[1] Greenhow (1862), pp181-182; Also reported in *Chemical News* 1862 October 11th, p192.

The illness was unknown among certain operatives such as makers of galvanized iron, who worked over molten zinc at temperatures not high enough to cause deflagration or oxidization of the metal.[1]

Following Greenhow's investigations, others took up the subject[2] with Edgar Hogben in 1887 putting forward the theory that copper fumes were the cause rather than zinc oxide. The following year the interest in the subject was maintained with a further inquiry being made by Robert Simon. He concluded that both zinc and copper fumes might be at fault for causing the fever but that the more chronic ailments found amongst brassfounders were the result of copper.[3]

The recommended remedies were better ventilation and draught extractors to remove the fumes quickly and these formed the basis for the proposed rules put forward by the Home Secretary in 1894, when he gave notice of his intention to schedule brass casting and mixing as an unhealthy industry.

> "The rules proposed by the Home Secretary aim principally at cleanliness both of person and workshops, ventilation, provision of respirators while actually casting, and prohibition of eating where casting or mixing is carried on." 4

Before the rules were made binding, a committee was set up to see if they would cover the needs of the industry. It consisted of representatives of the Factory Inspectorate, manufacturers and workers. The workers' representative

1 Greenhow (1862), pp186-187.

2 Mainly from doctors in the Midlands area, e.g. *B.M.J.* 1886 March 27th, p592; 1888 March 3rd, p471; May 5th, p964.

3 Edgar Hogben 'Brass-Workers' Disease' *Birmingham Medical Review* 1887 Vol. 21, May, pp195-201; Robert Simon 'Remarks on Brass-workers' Diseases' *B.M.J.* 1888 April 28th, pp887-888.

4 *B.M.J.* 1894 November 17th, pp1133-1134.

was the secretary of the Amalgamated Society of Brassworkers. The medical side was covered by Robert Simon, physician at the Birmingham General Hospital and most of the investigations were carried out in the Birmingham area. As zinc oxide fumes did not have the extreme poisoning effect of other metals, it was not considered a serious problem by the majority of employers. For safety measures to be adopted, a large scale Government intervention in the form of Special Rules would be needed.

2. DUST DISEASES

Dust was, and is, a common occurrence in many industrial processes. The larger particles were easily observable as the 1884 report on the effect of heavy sizing of cotton weaving shows:

> "The greatest accumulations of dust were seen on the floor under the looms, but it was visible enough on every surface that could retain it, and its diffusion through the atmosphere was made evident by the rapidity with which sufficient was deposited on a mirror held four feet from the ground to leave a distinct mark when touched by the finger. This time varied from four to eight minutes." [1]

But a greater problem was the small particles of dust, invisible to the human eye. These often presented a far greater health hazard than the observable dust, having a more penetrating and pernicious effect on the lungs. Many dust diseases were not immediately manifested after exposure, thereby adding to the complications of identifying the cause of an illness and implementing adequate preventative measures.

A problem encountered in the study of dust diseases is that of classification and terminology. The classification system is still changing today and 19th century doctors used various systems. Dr Richardson, for example, in his lectures to the Society of Arts, chose to arrange dust diseases as to the nature of the harm they produced, since specific groups of dust tended to attack different parts of the respiratory system. He thus categorized them as cutting dust, irritant, inorganic and poisonous, organic and poisonous, soluble saline, and obstructive and irritating.[2]

1 1884 Report on the Effects of Heavy Sizing in Cotton Weaving upon the Health of the Operatives. (C 3861), p5.

2 Dr B.W. Richardson 'Lecture II on Unhealthy Trades' *J.S.A.* 1876 January 14th, p129.

Another method was by the shape of the dust; whether angular particles or regular shapes. Arlidge looked at dusts under the headings of organic and inorganic, which is perhaps the most appropriate way of considering them and the one adopted here, since the organic or vegetable dusts are more likely to produce allergic reactions, such as hay fever and asthma or acute and chronic bronchitis, rather than permanent alterations in the lung structure which are associated with some of the inorganic dusts.

As to terminology, the word 'pneumonokoniosis' was first adopted by the German writer, Friedrich Albert Zenker in 1867.[1] Initially it was used to cover all lung diseases inspired by dust, but recently there has been a movement to exclude diseases caused by organic dusts, such as byssinosis (cotton and flax dust). Pneumoconiosis is thus left to describe the inorganic dust diseases where changes in the lung structure occur. Pneumoconiosis is divided into two categories, benign and fibrotic. Within the first group are the diseases of aluminosis, caused by the presence of aluminium-bearing dusts in the lungs especially that of alum, bauxite and clay; barytosis found amongst barium miners; berylliosis from beryllium; and stannosis, a disease of tin ore miners, caused by the presence of tin oxide dust in the lungs. Those which cause pulmonary fibrosis and are therefore more dangerous to health are silicosis and asbestosis.[2] It will be noted in the above grouping there is no mention of coal miners' pneumoconiosis and this, along with kaolin pneumoconiosis,

1 'Pneumonokoniosis' was later shortened to pneumoconiosis. F.A. Zenker 'Veber Staubinhalations Krankheiten der Luagen' 1867; for a translation of this article see A Meiklejohn 'The Origin of the term pneumonokoniosis' *B.J.I.M.* 1960 Vol. 17, pp155-160.

2 Asbestosis is a 20th century disease. The first case in Britain was observed in 1900 and described in 1907. The patient had worked for 14 years on a carding machine and was the sole survivor of the men who had worked in the card-room. All had died around the age of thirty, from lung diseases.

still lies within an undecided area between benign and fibrotic.

Thus, even with today's advanced knowledge and the assistance of x-ray plates to identify the stages of the disease, there is still confusion over terms and causes, so it is hardly surprising to find an even greater confusion in the 19th century. The numerous dust diseases went under a wide variety of names,[1] and it is clear that they were generally identified with individual industries or occupations, rather than by type. Hence, in the following discussion of organic and inorganic dusts, the various industries involved have been treated separately.

2.a. <u>Organic Dusts</u>

In manufacturing industry the main sector where organic dusts are found is in textiles. The lung disease, byssinosis, is now commonly associated with the cotton industry but although this name was used by German writers in the 1870's and by Sir Thomas Oliver in 1908,[2] it was not generally used to describe lung diseases among textile workers until the Report of the 1932 Departmental Committee on Compensation for Cardroom Workers. At this stage, it was really only associated with cotton workers, only later being discovered to be similar to the lung disease which affected flax workers, and to a lesser extent hemp and jute workers.[3] However, despite the relatively recent use of the term byssinosis, the fact that operatives in cotton and flax mills suffered from lung diseases as a result of their labours, has been recognised for well over a hundred years.

[1] Some of which were given on page 33. There were also regional variations in the names.

[2] Sir Thomas Oliver *The Diseases of Occupation* (1908), pp250-251.

[3] For the history of the term 'byssinosis' see: Aly Massoud 'The origin of the term byssinosis' *B.J.I.M.* 1964 Vol. 21, p162.

Cotton

Today there are four separate lung diseases recognised in the cotton trade; mill-fever, byssinosis, weaver's cough and an acute respiratory illness which sometimes affects those handling dusty, low-grade, stained cotton. No specific cause, as yet, has been found for the first three, although a specific bacterium has been held responsible for the outbreak of the fourth acute illness.[1]

Mill-fever is generally suffered by all workers when they first begin life in the mill and are first exposed to the cotton dust. After a few days they normally develop a tolerance to the irritation and are no longer troubled by the fever, except perhaps after a period of absence from work. The disease known as weaver's cough can vary from a dry cough, through to a severe attack of asthma. It is found primarily amongst the workers in the cotton-weaving sheds, where the dust from the size used is held responsible for its development. This is due either to the vegetable allergens it contains, such as the kernal of tamarind seed, or because it has been mildewed and thus contains mould allergens. The most serious respiratory disorder, however, is byssinosis. This is brought on by long exposure to cotton dust, often after ten or more years. Three stages of the disease are identified; first an initial 'Monday fever' or tightness of chest; second, a more permanent attack of bronchitis and asthma; and third, a disabling stage. At this point, the mill worker is often unfitted to continue working in the cotton industry and is forced to leave, suffering from chronic bronchitis and emphysema.[2]

[1] Hunter (4th edition 1969), pp1060n.

[2] Ibid. pp1064-1066. From the 1932 Report of the Departmental Committee on dust in cardrooms in the cotton industry.

19th century writers on the health of cotton operatives spoke in more general terms about respiratory disorders, giving them names like, 'card grinders' asthma', 'strippers' asthma', 'cotton card-room asthma', and 'spinners' phthisis'. Arlidge identified mill-fever in 1889, but only in relation to flax workers. He said that in the flax mills it was, "regarded by the operatives as a sort of seasoning to the occupation". The symptoms were a slight cough and sneezing attacks, "ushered in by chills, nausea and vomiting, quickly followed by headache, thirst, and heat of skin."[1]

Ramazzini made no reference to cotton workers in his treatise which is not surprising, since the cotton industry was then in its infancy. In the late 18th century the cotton industry grew rapidly and in part this accounted for the diseases of the cotton industry being seen as a phenomena of the factory system.

In the first decades of the 19th century, the textile industries formed part of the political and moral arena for arguments as to the evils or merits of a factory system of labour. Radicals and social reformers, such as Kay and Gaskell, used the cotton industry to illustrate physical deterioration and exploitation. Others, like Noble, refuted these claims and maintained that conditions for cotton workers had never been better and pointed to examples of improvements to health despite the factory system, or rather, because of it. These factors have to be borne in mind when trying to extract a truthful picture from the early literature on the health of the cotton operatives.[2]

1 *B.M.J.* 1889 March 30th, pp704-705.

2 Examples of the literature in question are: James Phillips Kay *The moral and physical condition of the working classes employed in the cotton manufacture in Manchester* (1832); Daniel Noble *Influence of manufactures upon health and life* (1843); P. Gaskell *Artisans and Machinery* (1836); Andrew Ure *The Philosophy of Manufacture* (1835).

Tasks where operatives were exposed to particular danger from dust inhalation were in the initial processes of sorting and cleaning the fibre. The first process involved oepning and sorting the bales when they arrived at the mill, and by necessity a certain amount of dust was involved. The fibres were then opened and cleaned by a machine called a 'willow' or instead, if the cotton was of a fine quality, it was beaten or batted with hazel twigs by hand. This job was usually performed by women, who held a rod in each hand and beat the cotton violently, thus opening the fibres without injuring the staple. Such a process naturally created much dust. Some of the coarser cottons were then passed through a scrutcher or blowing and lapping machine, and the final preparatory process was carding. Here the fibres were separated and freed of any remaining impurities before spinning and weaving took place.[1] Carding, too, was a dusty occupation, especially when the machines became clogged and had to be stripped by hand or when the teeth of the cards had to be reground.[2] This, of necessity, had to be done dry or the wires would have rusted.[3] After these initial processes only a minimal amount of dust was raised in spinning[4] and weaving, except when the cloth had been heavily sized, in which case weaving became a hazardous occupation. This problem was increased in the second half of the 19th century.

Despite the differences of opinion over the effects of working in cotton mills on the operatives' general health, the hazards of the card-room were usually acknowledged. In 1826, Robert Cowen of Carlisle, received the Gold Vulcan Medal from the Society of Arts for an improved method of carrying off the dust produced in grinding cotton cards.

[1] Tomlinson (1854 Vol. I), pp451-456.

[2] The dust from the card teeth is inorganic dust rather than organic, more like that met with in the grinding trades which is discussed on pages 141-148.

[3] *T.S.A.* 1826, Vol. 44, p134.

[4] One of the health hazards in the spinning rooms causing bronchial troubles was the high temperature.

He had first looked into the problem in 1817, but his initial attempts had met with little success, for the scheme had not included a fan, and the current of air from the grinding machine had not been sufficient to carry off the dust. Once a fan was included into his apparatus, it proved to be more effective.[1]

In 1822, the French writer Patissier, carried out research into cotton spinners which led him to believe that the fine cotton dust excited the bronchi and caused coughs and a perpetual irritation of the lungs, which forced many to change employment before phthisis developed,[2] but Thackrah, ten years later found no specific, serious illness affecting the cotton industry. He stated that in no department was any great amount of dust to be found, although in the card-rooms two disorders frequently complained of were headaches and gastric disorders, especially amongst those new to the work.[3] Occasionally operatives also suffered from common catarrh and coughs. Thackrah does, however, make reference to the work of Dr Kay, who distinguished a form of 'spinners' phthisis'. He said it was an inflammation of the bronchial membrane which in time could lead to consumption and was found particularly amongst workers in coarse cotton or those in badly ventilated and ill-conducted mills.[4]

The biggest problem for the early doctors in identifying cotton dust as being harmful to the lungs was the fact that it was some time after the exposure that the disabling effects became noticeable. An indication that illness from dust could be manifested reasonably quickly is indicated by a Scottish mill at Deanston near Doune, Perthshire, where a book recording the absences from the mill between 1829 and 1832, due to sickness, was still in existence in

[1] *T.S.A.* 1826 Vol. 44, pp132-137.

[2] Gaskell (1836), p222.

[3] Probably an indication of the disease described earlier as mill fever.

[4] Thackrah (2nd enlarged edition 1832), pp144-148.

1945 when it was examined by T. Ferguson.[1] At the beginning of the 1830's, there were believed to be about seven hundred workers at the mill. Between 1829 and 1832, 2632 cases of absenteeism due to sickness were recorded. Of these, about 700 cases were of more than three days' duration. The most frequent causes of absenteeism were:

> "influenza and upper respiratory catarrhs (544), headache (475), sepsis (142), accidents (140), dyspepsia (87), diarrhoea and dysentry (79), rheumatism (73), and eye conditions (52)."

Although it would be wrong to read too much into these figures, it is interesting to note that more than a fifth of the absenteeism was due to lung disorders and that the second most frequent cause of complaint was headaches. No doubt the noise of the machinery in a confined space was partly responsible for such a large figure, but possibly some were the result of mill-fever. The Children's Employment Commission of 1833 visited the Deanston Mills and from their report it appears that in 1831, 46 operatives (39 women and 7 men) were absent for more than three days at a time with catarrh and 41 (38 women and 3 men) with headaches. The total days lost through these illnesses were 274 and 244 respectively, giving an average duration for both illnesses of six days at a time. In 1832, the cases of catarrh were 54 (43 women and 11 men) and for headaches, 41 (36 women and 5 men) but for the former, the number of days lost was as many as 456 and the latter, 265.[2] The reason for the dramatic increase appears to have been an attack of influenza. A report from the mill in May 1833 stated,

> "that in consequence of a severe visitation of the disease called influenza, now prevalent in the country, the sickness amongst the workpeople at Deanston from that cause alone, during the last two weeks, was excessive, whereby the greater number of the workpeople have suffered more or less: that

1 T Ferguson 'Early Scottish Essays in Industrial Health' *B.J.I.M.* 1945 Vol.5, pp182-183. Attempts to trace this book have proved abortive and it seems likely that it was destroyed, along with other material, when the mill was renovated in 1948. The book did not, however, indicate the length of time operatives had been employed at the mill.

2 1833 Employment of Children in Factories: Factory Inquiry Commission Supplementary Report (C 167), pp80-81.

> above a hundred people are still absent and many present are still only convalescent, and many are tending towards the disease; that from this cause much of the machinery has been stopt, and the general system of the work much deranged." 1

Presumably the attacks of influenza made them more prone to other illnesses.

Deanston was, in fact, a well conducted mill and the Commission complimented the management on their system of dust expelling fans and recommended their use elsewhere.[2] The proprietor, Mr Smith, showed more interest in the medical welfare of his operatives than many millowners, employing a medical man, Mr John Fraser, surgeon from Doune, to inspect the workpeople from time to time. For the ten years 1823 to 1832, there were only thirty-four deaths at the mill of which twenty-three had been from consumption and two others from asthma and inflammation of the chest. The occupations and ages of those who died can be seen in Table IV which indicates that more than half of them had died aged twenty and under, and that their predominate occupations had been in the dusty departments of carding, spinning and weaving.[3]

1840 saw another report from a French doctor, Dr Villermé, who gave a detailed description of what he termed 'cotton consumption'. This was most noticeable in the batting and carding rooms:

> "The cough is the first symptom of a slow formidable disease of the chest, which is always relieved on abandoning the work, and altogether cured at its commencement, if the employment be not resumed. The disease, in the process of its development, assumes all the characteristics of consumption, and the medical men, resident in the manufacturing districts, call it 'cotton-consumption', (phthisie cotonneuse) and some 'cotton inflammation of the lungs'." 4

1 Ibid. p80.

2 1833 Employment of Children in Factories: Factory Inquiry Commission Second Report (C 519), p37.

3 Ibid. p38
Mr Fraser had been in charge for the four years prior to the report and before that the surgeon Macansh had held the officer for four and a half years.

4 Quoted by Noble (1843), p27.

TABLE IV: A List of Deaths of Workers from Consumption or Similar Illnesses at the Deanston Cotton Mills, Perthshire 1823 - 1832

Occupation	Age	Cause of Death
Spinner	12	Consumption
Carder	12	"
Carder	13	Inflammation of the chest
Unknown	16	Consumption
Throstle Spinner	16	"
Throstle Spinner	16	"
Weaver	18	"
Weaver	18	"
Weaver	18	"
Employed in Picking Room	18	" "
Iron Turner	18	"
Throstle Spinner	19	"
Spinner	19	"
Weaver	20	"
Spinner	20	"
Clerk	23	"
Dresser	25	"
Iron Turner	26	"
Throstle Spinner	28	"
Warper	30	"
Waste Picker	40	"
Weaver	40	"
Cash Keeper	41	"
Foreman of Cloth Department	50	"
Warper	60	Asthma

Source: 1833 Employment of Children in Factories: Factory Inquiry Commissioners. Second Report (519), p38.

Despite intermittant reports on asthmatical affections,[1] the first British observer to describe, in detail, the respiratory disease of cotton workers was Dr Greenhow in his 1860 and 1861 reports to the Medical Officer of the Privy Council on lung diseases.[2] In 1860 he visited the cotton town of Preston and in 1861, Blackburn. The most prevalent disorders seem to have been bronchitis and phthisis, with most of the local medical men commenting that those who suffered were the card-room workers:

> "If a lad be employed in one of these rooms from the age of 14 for 12 or 14 years, he rarely survives the age of 36 or 38 years. First of all he suffers from dyspnoea, and subsequently from cough and haemoptysis, which terminate in phthisis." 3

Greenhow showed how the card grinders and strippers were more exposed to cotton fibres than other workers in the card-room, the reason being that in many mills the carding machines were enclosed but by the nature of their work, the strippers and grinders had to work with the machinery open.[4]

Greenhow's work was furthered by Jesse Leach in 1863. Leach illustrated the extra hazards caused by the poor quality cottons, such as the East Indian or Surat cotton. With these short fibred cottons, there was a 25% loss on the cotton staple during the manufacturing process. This created more dust in comparison with the better quality, long stape American cotton and it both affected the respiratory system and caused skin irritation.

1 *The Medical Times* 1843 January 21st, p261; February 4th, p295.

2 Greenhow (1860), pp102-194; (1861), pp138-186.

3 Greenhow (1861), p175.

4 Ibid. pp176-177.

"The respiration is affected from the dust irritating the respiratory passages of the mixers, and coughing and sneezing are the frequent consequences, which disengage from the bronchial membrance a quantity of slaty-coloured expectoration, which, when placed under the microscope, is seen to consist of very fine short fibres of cotton in air-bubbles and mucous. The sneezing is occasioned by the same material irritating the olfactory nerves during nasal breathing. The arms and hands of mixers are not unfrequently affected with a cutaneous rash much resembling nettle rash." [1]

This subject was taken up by the Factory Inspectors and Alexander Redgrave, after studying the mills near Blackburn, was able to confirm Leach's findings.[2]

Another problem of the Surat cotton was the use of size. In the 1860's the use of Surat cotton had increased due to the cotton famine caused by the American Civil War. Not only did this inferior short fibre cause more dust in processing but it also required larger amounts of size. Size had always created dust but until 1851 it had consisted of a mixture of flour and tallow. From that date, however, china clay was added because,

"some manufacturers who used inferior flour found that they could reduce the brown colour of the cotton thus produced by the admixture of a certain quantity of china clay; and they further found that the china clay so far reduced the glutinous quality of the flour, that the sized warps would weave easily with a less amount of tallow in the size." [3]

The Russian war of 1854 increased the price of tallow thus encouraging the further use of china clay and after the American war in 1862, the subsequent cotton famine necessitated the use of short staple Surat cotton so that the demand grew for the use of larger quantities of size.

[1] Jesse Leach 'Surat Cotton, as it Bodily affects Operatives in Cotton Mills' *The Lancet* 1863 December 5th, pp648-649.

[2] Report of the Inspector of Factories for the Half Year ending 31st October 1863 (3309) Alexander Redgrave's Report, pp62-64.

[3] Andres Rabagliatti 'Cotton and Silk Workers and their Diseases' *Great Industries of Great Britain* Vol. III, p27.

The problem of oversizing attracted attention, not specifically because of the deleterious effects of the dust involved (although this was mentioned in passing) but due to the practice of injecting steam into the weaving sheds to keep the atmosphere artificially damp. This was required since the oversized thread needed to be softened for weaving. Another reason for the interest in the question of oversizing was the ethical issue for the size gave the cloth a fictitious weight and appearance.

With the large addition of size, it was found necessary to add salts, called in the trade 'antiseptics'[1], to prevent the fibres glueing together. In addition to flour, size thus contained up to one third of china clay, plus fatty substances, 'antiseptics' and sometimes a portion of animal glue or resin. The less tallow and flour in the mixture, the more likely it was that clay dust would be raised in the weaving process.[2]

Dr Greenhow, in 1860 and 1861, had pointed to the problems of oversizing and its effects on lungs, eyes and voice with a tendency to cause nose bleeds. Later, representations from the weavers, themselves, were made to the Government and in 1872 Dr George Buchanan was appointed to report on the weaving sheds of Todmorden. He mainly commented on the effects of the warm moisture and the tendency towards rheumatism and pulmonary complaints, but could not find any specific disease resulting from the practice.[3]

1 Arlidge lists these sales as chloride of zinc, magnesium and calcium, with a certain proportion of sulphate of magnesia. *B.M.J.* 1889 March 30th, p703.

2 Rabagliatti (Cotton), p27. Although china clay is a silicous dust, i.e. organic, it is considered here because of its relation to the textile industry. For a further discussion of china clay dust, see page 154, where it is spoken of in relation to the pottery industry.

3 1884 Effects of Heavy Sizing in Cotton Weaving Upon the Health of the Operatives. Report (C 3861), p3.

No effective measures resulted from the enquiry and the weavers made further representations. In 1882, Mr Birtwhistle, chairman of the N.E. Lancashire Weavers Association, presented a memorial to the Home Secretary in which he stated that despite the fact that the conditions of the cotton famine no longer existed and that it was only necessary to have 20% size for manufacturing purposes, additions of anything from 50% to 200% were to be found in some premises.[1]

The pressure put on the Government by the weavers led to the establishment of another inquiry, this time under the direction of J.H. Bridges and Edward Osborn.[2] They made their report in 1884 and, unlike Dr Buchanan who had found the use of 50 to 90% size, they found the percentage was then between 100 and 150%. Moreover, instead of a third of the size consisting of china clay and two-thirds flour, the ratios were either equal or more clay than flour. Efforts had, however, gone into keeping down the level of loss of size in weaving but for profit motives rather than health reasons. By the addition of various salts and by keeping the warp fibres moist with steam, they were able to maintain the weight of size. Despite the fact that Bridges and Osborn recognized the mischievous consequences to health of the introduction of steam to the weaving shed, they made no complaints about the dangerous nature of china clay.

The weavers were not satisfied with the situation and after further protests, the 1889 Cotton Cloth Factory Act was passed which attempted to regulate the practice of clay sizing and improve the sanitary conditions of weaving. It did this by trying to regulate the temperatures and humidity of the atmosphere in the weaving sheds, where such

1 *B.M.J.* 1882 June 24th, p952.

2 1884 Effects of Heavy Sizing Report (C 3861).

humidity was produced artificially.[1] But, without the control of clay dust as well, the problem of size continued and J. Tatham, in 1902, wrote:

> "The size contains, in addition to flour or farina, a very large proportion of china clay, which finds its way into the air passages and there produces its well-known mischief." 2

During the period 1780-1900, the problem of dust in the cotton industry had not really been solved, or, for that matter, really appreciated. Part of the reason for the lack of interest stems from the fact that no one specific disease could be identified with the industry, only a general tendency towards bronchitis and emphysema. In 1902 it was still being said, in some quarters, that,

> "although the manufacture of cotton goods is or has been carried on under conditions to some extent injurious to health, yet there is no definite disease which can be traced to these conditions." 3

Initially, the fact that the cotton industry was at the centre of the arguments over the evils and benefits of the factory system, was not conducive to producing an accurate picture of conditions. The French writers appear to have been inadvance in recognizing some form of disease associated with cotton but Greenhow also pointed the way in the 1860's. By the end of the century many mills were well ventilated and the size of the machinery meant that little over-crowding occurred. Some processes had also been made less dusty, e.g. scutching and carding where machinery was enclosed and by the 1890's automatic or self-stripping carding machines were available which reduced the need to employ card strippers. Improvements were made in

1 1889 Cotton Cloth Act 52 & 53 Vict. c62. Arlidge (1892), p358.

2 J. Tatham in T. Oliver (ed) *Dangerous Trades* (1902), p147.

3 J. Wheatley in T. Oliver (ed) (1902), p702.

the cards which meant a decrease in the frequency of regrinding the combs[1] but how extensively these kind of changes were adopted is hard to estimate as are the reasons for their introduction. The deleterious effects of the china clay dust in cotton sizing had only come to light as a secondary issue to the protests against the effects of heavy sizing, the main issue being the artificially maintained humidity within the weaving sheds. This made working conditions uncomfortable and the weavers, being better organised than many other trades, were able to exert pressure on the Government to take action. But even after inquiry, the potential danger was not really recognised as to its true nature. Thus by 1900 there had been some recognition that cotton dust could have a deleterious effect on health and some research had begun to sort out the confusion of symptoms and causes but the main developments in dust diseases within the cotton industry were in the 20th century, with the distinction of byssinosis and mill-fever and other disorders, and the discovery of their similarity with the diseases of flaxworkers.

Flax

In comparison to the diseases of cotton workers, those of hemp and flax workers seem to have aroused more interest. Ramazzini observed:

> "Those who card flax and hemp so that it can be spun and given to the weavers to make the fabric, find it very irksome. For a foul and poisonous dust flies out from these materials, enters the mouth, then the throat and lungs, makes the workmen cough incessantly, and by degrees brings on asthmatic troubles." 2

1 *B.M.J.* 1889 March 30th, p702.

2 Ramazzini (1964 translation), p258.

Thackrah practised in Leeds, the centre of the English linen industry, and understandably gave an extensive account of the health of the flax workers in his book.[1]

Flax, in its production, went through many stages and like cotton, it was the initial processes of sorting and cleaning which created the biggest hazard in the form of dust. Flax is the filamentous portion of a particular stalk and before it could be processed, it had to be separated from the woody part. The two sections were bound together with a kind of gum or resinous sap, and this needed to be dissolved, a process known as steeping or retting. This was either accomplished by mere exposure to rain and dew, immersion in a running stream or by purpose-built pits filled with water, in which the steeping process could be controlled and also shortened. However conducted, obnoxious vapours were emitted, which were often complained of, although did not necessarily cause ill health. The nuisance was greater with the latter two forms of retting.[2]

The flax was then broken and scutched, a task either performed by machine or hand.[3] This finished the job of separating the flax from the wood and after scutching it was divided into lengths ready for the mill. Here it was cleaned in a process known as heckling. It was this department which produced the largest quantities of dust. The heckle was a form of comb with iron or steel teeth, one or two inches long. There were different grades of heckle; the first used being coarse and the last finely

1 Thackrah (2nd enlarged edition 1832), pp70-84. It is probably his observations amongst flax workers which led to his interest in occupational medicine generally.

2 Dr Ballard '2nd Report of the Inquiry as to Effluvium Nuisances arising in connection with various manufactures and other branches of industry' *7th Annual Report to the Medical Officer of the Local Government Board* 1877, pp84-92.

3 In Ireland it was practically all done by hand.

toothed. When the task was carried out by hand, the heckler threw a bundle of flax onto the teeth of the heckle and pulled it through, thus splitting and separating the fibres into parallel order. As can be imagined, this action inspired much dust to be raised. It was said that,

> "one hundred pounds of well cleaned flax is reckoned to yield from forty-five to sixty pounds of line, the rest being tow, bony particles and dust." 1

The exact amount of flax in comparison to tow and dust extracted, depended very much on the skill of the heckler; an unskilful heckler being known to produce more tow than flax. In some flax mills the process was improved by being conducted by machinery, however, Thackrah observed that in other mills, the practice was to employ children in the task, as they seemed to bear up to the occupation better. When they reached the age of twelve or thirteen, they were either dismissed or moved to another department. No serious disease of the lungs was manifest in them at this age, whereas the ages of eighteen to thirty were known to be susceptible to consumption. Thackrah rightly felt that it probably did weaken the lungs but he was unable to trace any of the children who had lef t the flax mills after early employment to follow other trades and so could not confirm this.[2]

After heckling had been completed, the flax was ready for spinning and weaving; operations in which little dust was raised. Thackrah said that the flax workers were,

> "subject to indigestion, morning vomiting, chronic inflammation of the bronchial membrane, inflammation of the lungs, and pulmonary consumption. The dust, largely inhaled in respiration, irritates the air-tubes, produces at length organic disease of its membrance, or of the lungs themselves, and often

1 Tomlinson (1854 Vol. I), p681.

2 Thackrah (2nd enlarged edition 1832), pp78-79.

> excites the development of tubercles in constitutions predisposed to consumption. There is little doubt that a considerable quantity is also swallowed with the salvia, and deranges in a greater of less degree, the functions of the stomach." 1

He noted a tendency for flax hecklers to die young.

> "Very few can bear it for 30 years, and not an instance could we find of any individual who had been 48 years either in this or any of the dusty rooms." 2

As with most of the industrially produced lung diseases, one of the best 19th century reports came from Dr Greenhow in his 1860 report to the Medical Officer of the Privy Council[3].

1 Thackrah (1st edition 1831), pp40-41. Also includes some case histories, two of which are: "G.P., a heckler, aged 39, has been in the employ, with some intermission, for 25 years. His general health is not remarkably impaired. Percussion elicits a natural sound at the upper parts of the chest on both sides; but are unnaturally solid at the base of each. Respiration is heard by the stethoscope over the upper lobes; but is very deficient, and generally, inaudible over the lower. He breathes short; indeed respiration seems to be performed with the upper lobes only of the lungs. On examination with the jar of water, he exhales 5½ pints. S.J., aged 33, is a back minder, i.e. a person placed at the back of the roving machines. She has been 15 years in the flax mills. She was healthy when she entered; but soon was attacked with cough and vomiting, which have increased and continue. The cough, she says, comes on in paroxysms, like the whooping cough. The matter she expectorates, is frothy, and sometimes purulent. Her respiration is habitually oppressed, but occasionally so much worse, especially in winter, that it is with difficulty she can walk from the mill to her lodgings, a quarter of a mile distant. She is tall, stoops much, and is of a very sickly appearance. Her digestive organs are impaired. She complains of a great pain across the base of the chest, with occasional, but great, swelling at the pit of the stomach. Chest sounds well on percussion. Puerile respiration is heard over the major part; and on the right anterior bases, a subcrepitating rale. On the left lateral part, mucous, sonorus, and, occasionally, sibilant rale. She exhales 4½ pints.

2 Ibid. p44.

3 Greenhow (1861), pp145-151.

He visited Pateley Bridge in Yorkshire, where he noted a large increase in the number of deaths from respiratory disease since the introduction of linen manufacture to the area. Twenty-seven hecklers were examined, of whom twenty-three were habitually asthmatical. The older men were observed to be short of breath and round shouldered, with a laborious wheezing respiration.

> "It was stated that operatives are more affected by the dust at the beginning than at the close of the week and that they always suffer more on resuming the employment after an interval of cessation."

This observation was interesting, for although not defined as such, it provides evidence of 'Monday fever' and mill-fever.

Greenhow found that most of the flax mill owners were aware of the problems of dust and many had tried to introduce respirators in an effort to prevent its inhalation. Some employees were also interested. In 1855, following an announcement of an interest in industrial pathology, the Society of Arts received a letter from John Smart, a flax dresser at Dundee, asking for any information on methods to ameliorate his working conditions from the great evil of dust. The Dundee factories were different from other flax mills as they were engaged in making sail cloths and sacks which used a coarse flax or jute which was spun dry. Although this avoided the evils of the injection of steam, far more dust was produced.[1] In a later issue of the Society's journal, a remedy was suggested by Dr Elliott of Carlisle; a faceguard made of copper wire, covered with wire gauze mesh and silk. He dispatched one to John Smart who tried it to his advantage.[2] Other writers also advocated the use

1 *J.S.A.* 1855 January 5th, p111. Arlidge (1892), p372. In Scotland flax dust was referred to as 'stour'. Smart claimed it had such a baneful effect on health "that a man when he ought to be at his best, if left to his own exertions, either meets a premature grave, or sinks into the unenviable condition of a pauper."

2 *J.S.A.* 1855 February 16th, pp228-229.

of respiratators,[1] but as an answer to the problem, it was not very satisfactory, as their successful use depended to a large extent upon the individual's attention to their fitting and adjustment. Many workers would not wear them because of this and also because they were awkward and cumbersome to wear.

Much interest in flax workers' diseases, not unnaturally, came from Ireland, especially from Belfast, the centre of the Irish linen industry. The most prolific writer on the subject was Dr C.D. Purdon,[2] who began to study the topic in the 1870's. At the time, despite inprovements in mill construction, the number of cases of respiratory illnesses in Belfast was increasing. This was probably due to the fact that the area had previously supported a fairly large silk industry but this had recently suffered contraction as a result of competition and many silk producers had turned over to the production of linen. Despite the improvements made in the flax mills, with better ventilation and sanitary measures, the silk industry had been less pernicious to health.[3]

Purdon was not the first to look at the health of the Belfast flaxworkers as A.G. Malcolm had made a statistical survey of them in 1856. He had studied the returns from six dispensaries in the Belfast area between 1852 and 1855 and found that 35,039 people had attended. Of these, 2,503 were flax mill workers. (394 males and 2,109 females). No less than 18.7% of the mill workers were suffering from chest diseases, compared with 6% of the total number attending. There were sixty-five hecklers in the list, of whom

1 Dr Purdon talked of the use of the Baker Respirator *B.M.J.* 1876 August 26th, p272. For references to the Baker's Respirator, see *B.M.J.* 1872 September 21st, p334.

2 C.D. Purdon *The Mortality of Flax Mill and Factory Workers as compared with other classes of the community* (1873); C.D. Purdon *Longevity of Flax Mill and Factory Operatives* (1875); C.D. Purdon *Sanitary State of Belfast* (1877).

3 *B.M.J.* 1878 August 17th, p242.

twenty-one had pulmonary affections, mainly in the form of bronchitis. Malcolm made the important observation that it was the smallest particles of dust which were the most dangerous.[1]

In 1876, Dr Purdon spoke at the British Medical Association's annual meeting, held that year in Sheffield. His paper was entitled 'On the Injurious Effects produced on the lungs by Flax Dust' and as well as describing the symptoms, he exhibited a selection of photographs, illustrating the changes that took place in a flax worker as the disease progressed.[2] His work was used as the basis for many future reports. It was said that mill owners became so concerned that they were willing to help Purdon in his researches and that apparently beneficial results were arrived at.[3]

The symptoms Purdon described with such clarity were the initial onset of a dry throat and inflammation which gradually crept down to the lungs, accompanied by morning and evening spasms of coughing. The chest became tight and coughing came in spasms until the stomach was emptied, with sometimes blood being emitted:

> "The worker when smitten by a paroxysm, in his distress clutches anything near him that may give his racked frame support. His features become livid, and a cold clammy sweat bedews his face; indeed so familiar are the mill hands with these symptoms, that whenever an operative is seen suddenly clutching at the table, his comrades talk of him as being 'pouncey'." 4

1 J.A. Smiley 'Background to Byssinosis in Ulter' *B.J.I.M.* 1961 Vol. 18, p4.

2 *B.M.J.* 1876 August 26th, p272.

3 Smiley (1961), p4.

4 Based on Purdon (1877) quoted in W. Gordon Hogg 'Flax Workers and their Diseases' *Great Industries of Great Britain* Vol.II, p45.

At this stage, many left the flax mills but the effects of 'pounce' were already irreversible and many died of consumption. Those who remained in the mill often hastened the course of the disease.

Richardson, at about the same time, investigated the allied trade of hemp dressing and found from 112lbs of hemp, there was a loss of 4lbs in production. In addition to the normal dust found in Russian and Polish hemp, he discovered that the Neopolitan hemp had a peculiar, odorus substance which brought on an attack rather like hay fever. Arlidge (as well as identifying mill-fever as a separate illness) made a thorough examination of flax dust, describing it as,

> "a very fine, soft and palpable powder, far more granular than fibrous in constitution and containing thirteen parts of silica in one hundred." [1]

Attempts were made to try and remedy the situation both by enclosing machinery and by better ventilation. The Government issued its own report in 1894 on the health of flax mill workers, in which E.H. Osborn, using the reports of local medical observers, drew conclusions very similar to Dr Greenhow's. These were that bronchial catarrh accompanied by asthma were frequently caused by breathing the dusty atmosphere of flax mills and that flax hecklers died young, and suffered from chronic diseases of the lungs.[2] Part of the high phthisis rate he blamed on the operatives themselves, for not taking precautions; other causes identified were working in heated and steamy rooms, and the imperfect methods of arresting the dust. One report he received said that:

> 'Hackling[3] is the most deadly process...The hacklers all

[1] *J.S.A.* 1876 January 14th, p131; *B.M.J.* 1889 March 30th, pp704-705; Arlidge (1892), p371.

[2] Smiley (1961), p5.

[3] Hackling = heckling.

> die young and all suffer from chronic diseases of the lungs caused by the flax dust or 'pounce' as it is locally named. Many of these men succumb to cirrhosis of the liver and to disease of the kidneys but this is partly due to the amount of raw alcohol which they consume. The first thing a hackler does each morning is to drink a glass of raw whisky to clear out his bronchial tubes otherwise he is unable to breathe. After a day off, the men often told me that their breathing is worse." [1]

In the same year, the Government scheduled the flax mills as a dangerous trade and set about to institute regulations to control conditions.

It can thus be seen that knowledge of dust diseases amongst flax workers appears to have been more advanced than for similar diseases amongst cotton workers. One explanation is the fact that flax dust seems to have been more pernicious and to have acted more quickly than cotton fibres. Perhaps it was also due to the interests of Thackrah in occupational medicine and his residence in Leeds, the main linen producing area of England, as well as the writings of Purdon in Belfast which helped to publicise the fate of the flax workers. The contemporary evidence however, merely demonstrates the awareness of respiratory disorders, for although references were made by some writers to conditions being worse in the morning and at the beginning of the week, it is only ex post facto, with the benefits of 20th century medical knowledge that we can deduce from the reports evidence of the various stages of byssinosis and mill-fever. Until Arlidge's writings at the end of the century, there had been no distinction between the various illnesses suffered by textile workers. Such a distinction was necessary before any adequate remedies could be investigated although, even today, byssinosis remains a considerable problem. The precautions resorted to were respirators, which were inadequate, and better ventilation. This included enclosing machinery which undoubtedly did help, as

[1] Smiley (1961), p5.

did the changeover in some mills from hand processes to mechanization. As for the problem of dust from size in the cotton mills, as one writer commentated when speaking of remedies:

> "I have no suggestion to make but the obvious one of a little more honesty." 1

Silk

Other sectors of the textile industries gave off organic dusts of both vegetable and animal origin but not to the same extent as the cotton and flax trades. Of silk, Dr Greenhow wrote, "neither dust nor flue is given off in the process of manufacture."[2] The same however, could not be said of the manufacture of silk waste, which was accompanied by the production of large quantities of dust in the dressing process. This occurred after the gum had been boiled off and the silk was sent to be cleaned. In silk waste production the carding machines were placed horizontally which made it difficult to enclose them and hence a fine dust was suspended in the air throughout the workshop:

> "The breathing of this is a source of chest troubles, which from small beginnings, increase to a chronic asthmatic condition, with symptoms of bronchial irritation and expectoration." 3

The numbers involved in the trade were relatively small and the industry does not appear to have attracted any special interest or pathological studies.

[1] Rabagliatti (Cotton), p29.

[2] Greenhow (1861), p171.

[3] *B.M.J.* 1889 March 23rd, p643; Rabagliatti (Cotton), pp28-29.

Wool and Shoddy

Wool manufacture was also accompanied by a small quantity of dust. Here again, any dust produced was in the initial processes of sorting and cleaning. A particular hazard known as 'Woolsorters' Disease' was associated with this, but although caused by spores in the dust raised when the bales were opened, it was really an infectious disease and thus will be included in a later discussion. When the wool reached the spinning stage, it was lubricated with oil to facilitate the process, and this helped to prevent the generation of dust.[1]

Shoddy was the manufacture of cloth from discarded woollen rags and when Dr Greenhow wrote on the industry in 1860, he described a 'shoddy fever' characterised by headaches, sickness, dryness of mouth, difficult breathing, cough and expectoration. By the time Arlidge looked at the industry in 1892, the disease had disappeared, due to the fact that woollen rag grinding was almost universally carried out in enclosed machines.[2]

Throughout the 19th century other occupations were referred to in relation to the generation of organic dusts, such as malting, paper making, hair brush making and sorting wool and rags,[3] but although in some cases, the quantity of dust involved may have been substantial, the ill effects were simple respiratory disorders of an asthmatical nature, or bronchitis. Often the exposure was not continuous, so the effects of the dust were not as pernicious as they might have been. Most of these trades only employed a few people and so did not generate much interest. The only two trades, other than textiles, in which organic dusts were seen in any way as a problem, were the tobacco trade and flour milling.

[1] Arlidge (1892), p404. [2] Ibid. p207.

[3] See generally, Arlidge (1892) and Thackrah (2nd enlarged edition 1832); also *B.M.J.* 1889 March 30th, pp704-705.

Tobacco Trade

The obnoxious effects of tobacco dust had been written about even earlier than Ramazzini, for in his treatise, he refers to the works of Simon Paulli, Richard Norton, Theophile Bonnet and others. Ramazzini wrote:

> "Those who make tobacco, breathe in freely those bad odours and the flying particles of dust which when fine are correspondingly sharp, so that they prick and dry up the delicate coats of the lungs and traches."

As preventative measures, besides covering the mouth and nose whilst grinding, he also suggested frequent ventures into the fresh air, washing the face in cold water and rinsing the throat with a mixture of vinegar and water. He also suggested drinking this mixture to wash away the particles.[1]

Thackrah was aware that the fine dust of tobacco was more deleterious in snuff making than in cigar making. In the latter process, dust came from the broken leaves when they were rolled, but in the manufacture of snuff, tobacco leaves were finely cut up and mixed with lime water and salt, and then heated two or three times. During the drying period, the mixture was frequently turned over in order to hasten the process, and it was this action which raised the dust. The disabling effects of this dust were more apparent in the younger workers who were not accustomed to the process,

> "they become faint and vomit, until, by use they are rendered tolerant of the poisonous matters they inhale."

The dust also appears to have irritated the eyes. The effects were made worse by a large number of ill-ventilated and small workshops.[2]

1 Ramazzini (1964 translation), pp141-147. [2] Thackrah (2nd enlarged edition 1832), pp56-57.

2 *J.S.A.* 1876 January 14th, p133. *B.M.J.* 1889 March 30th, p704.

Flour Milling

The miller's trade had long been associated with dust and many references are found to the 'dusty miller' and millers being pale and sickly-looking. Ramazzini refers to them as being continually whitened by the,

> "floating particles of flour; the grain is ground into the finest powder and the flying particles fill the mill house, so that, willy nilly, the mouth, nostrils, eyes and ears, in fact every part of the body is besprinkled with flour. I have known many to become asthmatic from this cause and finally to lapse into dropsy." 1

Flour dust was seen as being an obstructive, as well as an irritating dust. The irritative effect of the particles was comparatively minor but when they passed into the bronchial tracts, they were responsible for the development of emphysema. They were considered obstructive because most of the dust was composed of starchy particles which clogged the bronchial mucous membrane, rather than causing inflammation:

> "The symptoms attendant on this condition are those of suffocative breathing and spasmodic cough. They constitute the disease commonly called 'miller's asthma'."

Another name given to the disease was 'miller's creeping pneumonia', as each attack had a progressively worse effect on the individual's health. Another source of dust was from the stones themselves. This only made up a small percentage of the total dust formed, but it was a particularly pernicious component.[2]

[1] Ramazzini (1964 translation), p231; Thackrah (1st edition 1831), pp37-38.

[2] *B.M.J.* 1868 February 29th, p203; 1889 March 30th, p704. *J.S.A.* 1876 January 14th, p134.

The average life of a miller in 1884 was said to be 43, and at that time, due to the acknowledged ill-effects their labour had on their health, they were rarely accepted as members of Friendly Societies.[1] Remedial measures were suggested by many people. Thackrah felt the dust might, "be removed, or greatly diminished by a current of air under the floor."[2] Another, interesting, suggestion was the use of the Richardson feather respirator. This was promoted by Dr Richardson in his series of lectures to the Society of Arts in 1876. It consisted of a face mask, with a filter tube placed below to catch the inspired air. The filter was terminated by a protruding group of feathers, through which the air was drawn.[3] It received good reports that year at the British Medical Association's annual meeting, where Dr Farquharson, gave demonstrations of its filtering properties,[4] but two years later to a query about suitable respirators for flour mill workers, the following letter was received:

> "Sir - In answer to the query in your last week's impression as to which respirator answers best for mill-workers, I may say that Richardson's feather respirator answers admirably, but men object to wear it on account of its comical appearance.
> Yours obediently, THOS. BRITTIN. M.D."[5]

Attempts were made to install extractor fans but as with many industries, improvements came with a change in production methods. In the case of flour mills, this was the introduction of roller grinding. This was an enclosed process, with the added advantage that it was virtually automatic,

1 Arlidge (1892), p385; T. Oliver (1902), p505.

2 Thackrah (1st edition, 1831), p38.

3 *J.S.A.* 1876 April 14th, pp492-493.

4 *B.M.J.* 1876 August 26th, p272.

5 *B.M.J.* 1878 October 26th, p653.

requiring no interference except for taking samples from time to time for testing. The level of dust was thus reduced as was the exposure to it.[1] But although roller milling had been introduced at large merchant and port mills by 1900, country mills retained stones with the associated health hazards.

Organic dusts clearly had deleterious effects on the health of operatives exposed to them but contemporary recognition of occupationally induced illness was no more than of a tendency towards respiratory disorders such as bronchitis and asthma. Only in those industries such as flax, where the harmful effects were more obvious, did they receive any real attention. Preventative measures introduced were in general better ventilation and the enclosing of machinery. Respirators and improved standards of cleanliness were recommended but the most effective measures came about through reductions in dust levels as the result of changes in production techniques.

2.b. Inorganic Dusts

Inorganic dusts presented far greater health risks to the industrial worker than organic dusts. Their effect was usually more dramatic and pernicious, and consequently, attracted increasing attention throughout the period under consideration, in both the medical world and amongst the public at large. The main processes and sectors in which inorganic dusts were found were the grinding trades, stone quarrying and masonry, the manufacture of china and earthenware, coal mining, metalliferous mining and to a lesser extent in iron and steel foundries.

[1] Arlidge (1892), pp383-384.

Grinding Trades

Amongst the grinding trades, the first to attract attention was that of needle pointing. One of the earliest writers on the subject was James Johnstone, who in 1796, wrote an account[1] of a 'Species of Phthisis Pulmonalis, peculiar to persons employed in pointing needles in Needle Manufacture', observing that,

> "persons employed in pointing the needle by dry grinding them, are constantly very soon affected with pulmonary complaints, such as cough, purulent or bloody expectoration; and being so affected, they gradually waste in flesh and strength, and hardly ever attain the age of forty years."

At the time, this was obviously a well-known fact, as he continued by saying,

> "As the business is known to be constantly attended with much fatal effects, the manufacturers find it not very easy to engage persons to work at it." [2]

The principal region of needle manufacture was centred on a small area of the Worcestshire/Warwickshire border, around the towns of Redditch, Alcester and Studley. Hathersage, in Derbyshire, also had a small-scale needle industry and whilst Sheffield could claim a few needle pointers amongst its labour force, their numbers were always insignificant compared with the grinders in the cutlery and allied trades.

Johnstone identified the source of the danger as being the small particles of iron and steel given off whilst grinding. As the object being ground was small, it only demanded a small grindstone and so, unlike the cutlery trades

[1] Not published until 1799.

[2] James Johnstone 'Species of Phthisis Pulmonalis, peculiar to persons employed in pointing needles in needle manufacture' *Memoirs of the Medical Society of London* 1799 Vol. 5, p90.

where the grinder generally sat astride the grindstone, the needle pointer was seated in front of it. This brought him in very close contact with his work, for in pointing, he would take approximately fifty to a hundred wires, spread them between the palms of his hand, and, leaning forward, would hold them against the revolving stone, whilst turning them skilfully on their axis in order to make an even point. This process was carried out dry, and the friction created caused the needles to become red hot, so that,

> "while the needles are held on the stones, the steel dust flies from the points in a stream of white-hot sparks as brilliant as those from any fireworks." 1

The grinder was exposed to the full force of this dust cloud. Dust was also raised when the stones were prepared. This was not a daily task but depended on the nature of the work. The stones could last from two weeks to three months. Whilst preparing the stones, some men did see fit to adopt some limited means of protection, usually by holding a handkerchief over the mouth.[2]

Johnstone had said that needle pointers were unlikely to attain the age of forty. Later writers often gave a much lower figure of between thirty and thirty-five. Dr Holland, writing about the needle grinders of Hathersage in 1843, observed that:

> "The new hands are young men from seventeen to twenty years of age, rough and uncultivated from the plough, and in those manufactories where ventilation is not secured, they are dead before the age of thirty, perhaps after two or three years of suffering." 3

The Lancet in 1854, confirmed this opinion and wrote:

> "The average age of the Sheffield workmen is thirty-five years, the average age of the 'dry grinders' of needles very much under this figure." 4

1 W.T. Heming *The Needle Region and its Resources* (1877), p20.

2 Greenhow (1860), p117. 3 G. Calvert Holland *Diseases of the lungs from mechanical causes* (1843), p69.

4 *The Lancet* 1854 December 30th, pp553-554.

The number of needle grinders at Hathersage was small, being seven in 1822, fourteen in 1832 and twenty-three in 1842.[1] Some only remained in the trade a few years and their eventual fate is unknown but Dr Holland gathered details on the deaths of twelve pointers who had died between 1822 and 1843 (Table V). Of this number, nine had died from what was called the 'grinders' disease', their period of suffering ranging from just over a month, to thirty-six months, with the majority suffering from seven to eighteen months before death.

Several ideas on preventative measures were put forward. Johnstone had felt that one of the factors promoting the wasting effect of the disease was the continual loss of salvia in wetting the fingers in order to touch the red hot needles. He therefore suggested that bowls of water should be placed around the workshops. As a protection against dust, he recommended a 'crape hood' or 'gauze helmet'.[2] The Society of Arts offered a premium for suggestions of methods to alleviate the evils of dry grinding and several awards were made, mainly for ventilating systems but also for a magnetic guard, suggested by Abraham in 1822.[3] At Hathersage a regulation was enforced, limiting the hours of labour of pointers to six hours a day[4] and S.R.H. Jones (1980) in his researches into the needle making firm of John English & Co., found that in 1830 they had made a number of unsuccessful experiments with pointing equipment to try and reduce the level of dust created.[5]

1 Holland (1843), p70.

2 Johnstone (1799), p92.

3 These ideas are discussed more fully in the section on the Sheffield Grinders, 3.1. pages 306-345.

4 Holland (1843), p69.

5 S.R.H. Jones John English & Co., Feckenham: A Study of Enterprise in the West Midlands Needle Industry in the Eighteenth and Nineteenth Centuries PhD Thesis (London) 1980, p209.

TABLE V: Details of the Deaths of Twelve Hathersage Needle Grinders 1822-1843

Cause of Death	Age took up trade	Age at Death
Grinders' Disease	14	27
"	14	28
"	14	32
"	17	28
"	17	30
"	18	36
"	18	42
"	20	37
"	21	26
Other causes	15	20
"	15	20
"	26	42

Source: Dr Holland *Diseases of the Lungs from Mechanical Causes* (1843), p71.

The firm of Morrall, Archer and Morrall at Washford Mill, Studley, attempted to introduce respirators for their needle pointers, but the workmen refused to use them:

> "The pointers' impression evidently being, if he made use of any contrivance which would lengthen his life it would at the same time tend to reduce the amount of wages he could earn." [1]

They saw any attempts at improvements as a threat to their priviledged financial position, as in the 1840's they were reported to be earning as much as £2 to £6 a week.[2] Their wages included "danger money". If the dangers were reduced, it would become a buyer's rather than a seller's labour market and wage rates would tend to fall.

[1] M.T. Morrall *History and Description of Needle Making* (1854), p14.

[2] Ibid. p24.

The grinders' attitude was much the same when attempts were made to introduce extractor systems to the grindstones to draw off the dust. The main promotor for a better system of ventilation in the grinding shops was Dr Holland, who, in his work of 1843, described a system of extractor fans installed by Samuel Cocker & Co., at their factory at Hathersage. This system had cost the proprietor nearly two hundred pounds to install.[1]

Technological substitution met with opposition from operatives in the grinding trades for in this trade it carried implications of job loss and deskilling. Pointers and manufacturers were in conflict in 1844 after the introduction of a mechanical pointing machine at the factory of John Chambers, and the machine was eventually broken up. Two years later, a further dispute broke out when the manufacturers attempted to introduce extractor fans by the pointing wheels. The conflict was extended in September 1846, a period of fairly prosperous trade, when the pointers went on strike for an increase in wages. The manufacturers answered by a lock-out and by laying-off other needle workers as they ran out of points. Internal disputes broke out and eventually the pointers were forced to accept the terms of the manufacturers.[2] One of the proprietors, A. Morrall, went to Sheffield to inspect the fans which had been installed there and the pointers, with reluctance, began to accept their use. By the 1850's the majority of manufacturers had introduced them into their works and it was reported that a marked improvement had taken place in the health of the pointers.[3] A further improvement resulted with the introduction of a mechanical pointing machine in the 1870's. As well as keeping the dust away from the pointer, it also increased output and so rapidly displaced the manual pointer.[4]

[1] Holland (1843), p73.
[2] Jones Thesis (1980), pp49-50.
[3] Morrall (1854), p25.
[4] Heming (1877), p21.

Despite these improvements however the Medical Officer of Health for the Stratford-upon-Avon combined sanitary district could still report a high incidence of phthisis amongst the needle pointers in 1890.

> "He thought that the needle manufacturers in the district had done all they could to render their factories healthy but so long as the mechanics did not realize the value of efficient ventilation, so long he feared phthisis would dwell among them." 1

There were still several small factories which had not taken advantage of the life preserver appliances[2] but even where dust extractors were installed, it was impossible to remove all the dust. Arlidge made a microscopic examination of dust taken from a needle mill in Redditch. He looked at both the dust on the grinders' bench and that which had been removed by the extractors into the 'dust house'. In both he found angular particles of silica and jagged particles of steel, but the dust on the grinders' bench was mainly silica, whereas that of the 'dust house' contained more steel. Dr Page did a similar study and found that the sample from the 'dust house' was made up of 96.15% steel in comparison with the bench dust which was 94.8% silica.[3] Much attention had been given to the iron and steel particles which, being more jagged, looked more harmful than the stone dust, but Arlidge was unsure as to which was the more pernicious. Later discoveries have shown that the inhalation of iron and iron oxide dust does not cause a fibrotic reaction in the lungs and that the disease which should be assigned to the needle and cutlery grinders is sidero-silicosis, in which it is the free silica dust, coming from the sandstone grinding wheels which causes fibrosis. The iron dust, in comparison, is relatively

1 *B.M.J.* 1890 May 3rd, p1052.

2 *B.M.J.* 1889 April 6th, p768.

3 Arlidge (1892) pp350-351.

inert. With this knowledge, it is easier to see why the dust extractor fans were only marginally useful. Moreover, particles of only 0.5mm to 7µm were harmful and these are not visible to the human eye. Mechanization and the removal of the pointer to the position of observer was far more effective in reducing the level of 'pointers' rot' and it is questionable whether these changes were made for economic or welfare reasons. In the 20th century, another important step in eradicating grinders' disease was the substitution of sandstone wheels by artificial abrasives.[1]

The position of the Sheffield grinder was in many respects like that of the needle pointer, with the one exception that many of the objects were ground wet. This helped to suppress the level of dust. Although cutlery grinders, especially fork grinders were considered to have a hazardous occupation, the occupation of needle pointing was considered more dangerous.[2] Even Dr Holland, who was well acquainted with all the grinding trades of Sheffield, commented of needle pointers,

> "we had frequently heard of the pernicious tendency of this particular occupation, and though prepared to believe much, from elaborate investigation into similar pursuits, we candidly admit that the physical evils produced by it exceed all that imagination had pictured."[3]

As the Sheffield trades form part of a later discussion, only a short comment on their health hazards will be made here. The problem appears to have become greatly increased in the 19th century, with the move away from the small units operated by water power to the large steam powered factories.

[1] Hunter (4th edition, 1969), p986 and p1051. Stellman and Daum (1973), p181. Information on particle size supplied by the Department of Environmental and Occupational Health, The University of Aston in Birmingham.

[2] *The Lancet* 1854 December 30th, pp553-554.

[3] Holland (1843), p69.

The first published paper on the Sheffield grinders appeared in 1819, when Dr Arnold Knight addressed the Medical and Surgical Society of Sheffield. Later investigators were Drs Holland, Hughes, Favell and Hall, and overall the trade received much publicity. The grinders themselves, were not as obstructive towards change as had been the case in Redditch, and there was far less resistance to the introduction of extractor fans, although the incidence of respiratory disorders remained fairly high. As with the pointers, the main improvements came in the 20th century, with the substitution of artificial abrasives for the sandstone wheels.[1]

Stone Quarrying and Masonry

Although most stone workers suffered considerably from respiratory disorders, the incidence and severity of disease was directly related to the type of stone being worked. For instance, the granite quarrymen of Aberdeen, although showing signs of chronic bronchitis, did not exhibit the severe lesions of other stone workers.[2] The same immunity was not found amongst the stone masons of the Craigleith sandstone quarries in Edinburgh. The first to draw attention to their plight was Dr Alison in 1824,[3] who believed that no mason, regularly employed, at

1 For Sheffield Trades see pages 306-345.

2 Arlidge (1892), p303, although Dr Beveridge of Aberdeen in 1876, reported that the occurrence of phthisis amongst the granite masons had become more prevalent in the last fifteen years. He attributed the past healthiness to working in part-open sheds. As there had been no change in production techniques, he put the increased frequency of the disease down to the migration of masons away from Aberdeen, (especially attracted by high wages in America) and their replacement by town youths who were at an age which predisposed them to such illnesses. *B.M.J.* 1876 October 14th, pp489-490.

3 Arlidge (1892), p304. Thomas B. Peacock 'On French Millstone-Makers' Phthisis' *The British and Foreign Medico-Chirurgical Review or Quarterly Journal of Practical Medicine and Surgery* 1860 Vol.XXV, p215.

these quarries could escape from phthisical symptoms before the age of fifty. Around Edinburgh, it became known as 'stone masons' lung' and was a common phenomenon to all quarry workers. An Edinburgh physician of the Chest Dispensary, Dr R.W. Philip, observed many stone masons who came for relief, and he maintained that the average age of those seeking treatment was thirty-five. The disease generally ran the form of very chronic bronchitis, initially starting with recurrent attacks which soon became persistent.[1] It was not just the large sandstone quarries, like Craigleith, which attracted attention, as references can also be found to lung diseases in some of the smaller, rural quarries.[2]

The degree of injury depended to a great extent on the type of stone quarried. Generally, the sedimentary rocks were more harmful than the primary rocks. This was because the former were composed of siliceous and readily detachable particles which were easily inhaled, whereas the primary rocks were better fused together.[3] The Craigleith quarries were sandstone, which was a sedimentary, siliceous rock, consisting of 75 to 95% free silica and made up of quartz grains and other minerals, held together by a cement varying in composition. Granite came in several forms, the true granite having a silica composition of 65 to 75% and basic granite from 45 to 55%.[4]

1 Arlidge (1892), p304.

2 T. Ogier Ward (1841), p87. "Chronic bronchitis and phthisis are very prevalent among the quarrymen of Grinshill, so that few live to the age of sixty. The grinding of barytes also is a powerful exciting cause of this complaint among those employed." However, despite such early remarks, no real investigation seems to have been carried out until Dr Wheatley, County Medical Officer of Shropshire, made a careful observation of all the men working there in 1910, after a report from a local doctor of the presence of much chest illness in the Grinshill area. G. Whitwell 'Grinshill' *The Shropshire Magazine* 1952 March, pp11-12.

3 Arlidge (1892), p302.

4 Hunter (4th edition 1969), pp973-975.

Dr Alison was not the first to remark on lung disorders amongst stone workers. Ramazzini had included a section on stone cutters and observed,

> "when they hew and cut marble underground or chisel it to make statues and other objects, they often breathe in the rough, sharp, jagged splinters that glance off; hence they are usually troubled with a cough, and some of them contract asthmatic affection and become consumptive." 1

Thackrah, on the other hand, did not mention quarrymen at all and for masons, merely remarked that they often developed lung diseases through inhaling sand and dust.[2]

In 1860, Dr Peacock drew attention to what he termed 'French millstone makers' phthisis', which he claimed until then had remained unnoticed. The stone worked on was French Burr, a type of hard flint suitable for grinding wheat. It was imported, generally in the form of small blocks, from the Paris basin area of France and subsequently made into millstones. The blocks were cut into angular shapes and cemented together with plaster of paris; and then the circumference was bound with iron bands. The grinding surfaces were then dressed ready for milling. The rough work was done with a steel chisel and the surface finished off with a bill and thrift. Due to the hardness of the stone, each blow of the chisel resulted in a flash of light and cloud of dust. Many of the stone and iron particles thrown off became embedded in the hand and face of the workmen and it was possible to tell how long a man had been at the trade by the number of bluish spots, studding the back of his hands.

1 Ramazzini (1964 translation), p249. Ramazzini also refers to the work of Diermerbroeck, who dissected the lungs of several stone cutters who had died of asthma, and found them to be full of sand. Dr Peacock in his 1860 article, has reference to several 18th century writers on the subject; Wepfer, 1727, on the frequency of consumption in the workmen of Waldshut, who were excavating and cutting millstones, and the French writer Le Blanc, 1775, on diseases prevalent amongst cutters of grit and freestone.

2 Thackrah (2nd enlarged edition 1832), p85.

Dr Peacock made a detailed investigation of the French millstone makers in London. One master told him,

> "that those who are apprenticed to the trade, or take to it early in life, never live beyond forty years; and one of the foremen said they seldom do more than live out their time." [1]

From the numbers applying to the local hospital, Peacock was convinced that the occupation was one conducive to pulmonary complaints and although some workshops were small and ill-ventilated[2] and the work involved little muscular activity, both factors which would help induce respiratory diseases, these causes were not sufficient to explain the whole situation. He contended that the inhalation of gritty particles of silicous stone was therefore mostly to blame.[3] Throughout the 1860's, both he and Dr Greenhow made pathological studies of stone masons' lungs which helped to confirm this.[4]

As preventative measures, Peacock advocated the prohibition of young men from the trade as they were more likely to succumb to consumptive type complaints; that men should be encouraged to dress appropriately for the conditions and to be temperant in habits; and that the workshops should be well ventilated and where possible, the men should work in an upright position instead of stooping over the stones. He also felt that the men should be made to wear respirators, if not all the time, at least when particularly dusty aspects of the job were being carried out,[5] although

1 Peacock (1860), pp214-224.

2 He found one workshop to be in a cellar which although open above, was very damp.

3 Peacock (1860), p219.

4 Dr Peacock 'Millstone Makers Phthisis' *Transactions of the Pathological Society of London* 1861, Vol. XII, p36. Dr Greenhow 'Some Workers Pulmonary Diseases' *Transactions of the Pathological Society of London* 1866, Vol.XVII, p24. Dr Greenhow 'Millstone Makers Phthisis' *B.M.J.* 1865 November 4th, p485.

5 Peacock (1860), p223.

as with other trades, the men were reluctant to do so.[1] The Factory Inspector, Alexander Redgrave, advocated the compulsory use of respirators for millstone cutters in 1875.[2] As with millers, a reduction in the incidence of lung diseases was seen with the changeover to roller milling.

Of the other stone quarrying activities, the slate industry was one which caused concern. Mr Evans, the Metalliferous Mines Inspector for Wales, gave a melancholy report on the trade in 1875. In his subdistrict, during that year, the average age at death of all males was 49.33 years. For those not employed in the slate quarries it was 67.12 years; for the slate workers, 37.78 years. Mr Evans laid much of the blame on the insanitary state of their houses, as typhoid and fever were rampant,[3] but a local doctor, Dr Robert Roberts, observed that many of the slate workers were suffering from chest complaints. He gave an address to the North Wales Medical Association on 'Slate Quarrying as a dust inhaling occupation'. He felt that although the areas where the quarry men resided, being both wet and cold, were conducive to respiratory disorders, their work was also to blame for the high incidence of such disease. He distinguished between the quarries of Caernarvonshire, where the quarry men were fairly robust, and the less healthy quarry men of Ffestiniog. The former generally worked in the open, whereas in Ffestiniog, the slate was obtained from underground and dressed on the surface. The Ffestiniog slate was much softer in composition and consequently needed different methods of working. In his

[1] *B.M.J.* 1868 January 25th, p80. A Portland Stone Cutter, 42, regular at the trade and then suffering with respiratory disorders, said that, 'he knew, in fact, that the dust had produced his disease; and confessed that he should have worn a respirator, if his mates had not ridiculed another man who had used one during work-hours.'

[2] Reports of the Inspectors of Factories for the Half Year ending 31st October 1875 (C 1434) Alexander Redgrave's Report, p20.

[3] Phillips Bevan (1876), p169.

investigations, he found that the slate dressers were in a worse condition than the slate miners. Some reasons for this difference he assigned to the smallness of the machine rooms and the fact that boys were apprenticed to the trade of dressing at twelve or fourteen, whereas the pitmen were not taken on until they had reached maturity. Under the microscope, the dust appeared angular and serrated and he was surprised at how little the quarry men complained, accepting it as a condition of life.[1]

In 1893 the Government made a report into the dangers to life and health of all quarrying activity.[2] In it, Dr Ogle made an investigation of the mortality of quarry men in England and Wales, both from disease and accidental causes. He found that a quarry man's life was shortened to a remarkable degree by phthisis and other diseases of the respiratory organs, all of which could be attributed to the dust inhaled.[3] The Committee recommended special rules but under the existing laws, these could not be applied in quarries where no machinery, women, young persons or children were employed, as one of these conditions needed to apply before it was considered a 'factory' or 'workshop'. If a quarry was considered to be a 'factory' or 'workshop', then the existing laws on dust prevention and adequate ventilation could be enforced. The Committee therefore recommended the need for further legislation to bring quarries under the existing acts which was partly provided by the Quarries Act of 1894.

1 Arlidge (1892), p301.

2 1893 Report on the Conditions under which the Quarrying of Stone, Limestone, Slate, and Clay is conducted, with the object of diminshing any proved Dangers to the Life and Health of the workpeople engaged therein. By the Quarry Committee of Inquiry, (C 7237).

3 Ibid. p.v.

China and Earthenware

In the manufacture of earthenware and china, the disease referred to popularly as 'potters' asthma' and 'potters' rot' was prevalent amongst certain branches of workmen. Several authors, namely Meiklejohn (1946 and 1963),[1] Posner (1973 and 1974)[2] and Evans and Jones (1974),[3] have written on the occurrence of silicosis amongst potters, particularly in the North Staffordshire area, and on the measures taken which eventually led to its control and decline. There were several dusts met with in the pottery industry and the effects of one of them, lead, have already been considered in the discussion on toxic metals. Of the remaining dusts, the most pernicious and that responsible for inducing what is now known to be silicosis, was the fine powdered dust of calcined flint. Other irritant dusts were those of potters' clay and the various agents used in colouring and decorating the ware.

Calcined flint was added to the clay body in order to give it a fine white quality. The credit for introducing this ingredient to the clay mixture has usually been attributed to Thomas Astbury of Shelton in 1720 but Copeland, in his work on the Cheddleton Flint Mill, records that a John Dwight of Fulham introduced this substance to get a white body in 1698[4] and L. Weatherill records the existence of a partnership to produce flintware before 1720.[5]

1 Meiklejohn (1946), pp516-525. A. Meiklejohn 'The Successful Prevention of Silicosis among China Biscuit Workers in the North Staffordshire Potteries' *B.J.I.M.* 1963 Vol. 20, pp255-263.

2 E. Posner 'John Thomas Arlidge (1822-99) and the Potteries' *B.J.I.M.* 1973 Vol. 30, pp266-270. E. Posner 'Eighteenth-Century Health and Social Service in the Pottery Industry of North Staffordshire' *Medical History* 1974 Vol. 18, pp138-145.

3 Evans & Jones (1974), pp1-15.

4 Robert Copeland *A Short History of Pottery Raw Materials and the Cheddleton Flint Mill* (1972), p5.

5 Lorna Weatherill *The Pottery Trade and North Staffordshire 1660-1760* (1971), p23. She also states that although Dwight was aware of the significance of adding powdered flint to the clay body, he never actually used the method himself.

The flints were first calcined and then crushed and powdered in the dry state, either by hand with a pestle and mortar or by using stamping mills. This system produced excessive amounts of fine dust, resulting in a great deal of suffering for the millmen.[1] The harmful effects were soon realized as is shown in the oft-quoted patent taken out by Thomas Benson in 1726 for improved methods of grinding flint. He remarked:

> "that any person ever so healthful or strong working in that business cannot probably survive above two years, occasioned by the dust sucked into his body by the air he breathes." 2

Benson advocated grinding and crushing in the wet state in order to minimize the level of dust produced. His system involved first sprinkling the flints with water and then crushing them by the means of edge runners, operated by water power. A further set of edge runners reduced the flint to a fine powder. His initial patent stated that the edge runners should be of iron but this contaminated the whitening effect of the flint, so that a second patent, taken out in 1732, changed the edge runners to stone.[3] Benson's methods were further improved by James Brindley, who enlarged the size of the grinding pans and changed the type of stone used to grind the flints.[4] Wet grinding did not totally remove all the dangers and the modern method is to grind in enclosed cylinders, a practice which was introduced by J.R. Asling in 1890's, however, some dry grinding continued and Meiklejohn remarks on having observed the practice himself in the 1930's.[5]

1 Which was probably exacerbated (if reports are correct) by the fact that in the early days, the process was carried out in cellars and small, enclosed rooms in order to keep the ingredient a secret.

2 Copeland (1972), p7.

3 Ibid. p6; Weatherill (1971), p24.

4 Copeland (1972), p8.

5 Ibid. p17; Meiklejohn (1946), p521. He gives no indication of the scale of dry grinding in the 1930's but it was presumably small.

Exposure to flint dust was not limited to the millmen. Potters, placers, sifters, scourers and polishers were also subjected to its harmful effects, but these were problems of the 19th rather than the 18th century due, chiefly to the introduction of bone china at the end of the 18th century.

In making the new white ware of the early 18th century the recipe for the earthenware body was approximately:

Ball Clay	25 parts by weight
China Clay	25 parts by weight
Flint	35 parts by weight
Stone	15 parts by weight 1

The quantities might vary slightly with the quality of good being produced. At the beginning of the 18th century, this flintware was salt glazed but by the end of the century, this had been superceded by lead glazing which produced the extremely popular creamware also known as Queensware.[2] Despite the fact that potters worked with the clay body in a moist state, some of the clay could inadvertently be scattered on the floor, where it would become dry and powdery. With the constant running backwards and forwards at the potbanks, it was not allowed to settle but became airborne in the workshop. Much dust was also created in putting a smooth edge on such items as plates and saucers, which was done after part-drying.[3] The risks however, were not as great as for the millmen, where the dust consisted purely of powdered flint.

[1] R.W. Gay & R.L. Smyth *The British Pottery Industry* (1974), p20.

[2] Geoffry Godden *British Pottery: An Illustrated Guide* (1974), pp71-72, p140.

[3] *B.M.J.* 1889 April 6th, p766.

The real dangers from flint for the potters came with the introduction of bone china by Josiah Spode in about 1796.[1] The body for bone china consisted of:

Bone Ash	52 parts by weight
Cornish Stone	24 parts by weight
China Clay	24 parts by weight [2]

which was not in itself particularly harmful. But whereas earthenware could be supported by sand in the saggars for the first biscuit firing, bone china, being fired to a temperature of 1250°C in the biscuit, required more support, otherwise it sagged at the edges and became generally distorted.[3] The best means of support was found to be powdered flint which did not fuse at the high firing temperatures, nor did it contaminate the ware and so it was used freely as a packing agent. The packers and placers of the saggars were thus exposed to the risk of lung diseases from breathing in flint dust, as were the sifters who recovered the flint after firing by sieving it to remove any pieces of broken ware. After this initial biscuit firing, some flint adhered to the china but it was easily removed through a process known as scouring. This job was carried out by women and was particularly harmful. The flint was removed partly by dusting and brushing, and partly by rubbing the china with sandpaper. The fineness of the dust depended on the quality of ware being produced, with the higher quality goods producing a much finer sort of dust. The women tended not to stay in the trade very long and those who continued soon became asthmatical. After the china had been decorated and glazed, any blemishes were removed by polishers, who frequently used a mixture of powdered flint and water as an abrasive agent.[4]

[1] Copeland (1972) Appendix I.

[2] Gay & Smyth (1974), p20.

[3] Ibid. p21.

[4] Greenhow (1860), pp105-110.

The first precise references to the dangers experienced by those employed in china biscuit processes was in the Report of the Children's Employment Commission of 1843. Dr Scriven made the medical enquiries for the Commission and it is clear from the evidence given, that the scourers themselves were well aware of the dangers they worked in. This is shown in the following comments of two scourers:

> "This occupation is very unhealthy, it stuffs a person up very much in the stomach, not many scourers live very long; it takes some off sooner than others; none of us are ill now, except that we all feel overloaded upon the chest; sometimes we cough very much, especially in the morning when we first begin."
>
> "I complain of being stuffed up in my chest; I cannot lie down at night; my throat is always sore; and I have constant cough, with difficulty of breathing. Have never had medical advice; 'tis no use while I am at work here. The flint dust is very bad." [1]

The second quote, again shows the workers' acceptance of the inevitability of their fate, as has been observed with other industrial diseases, and also indicates that the hazards of flint dust were common knowledge to those in the trade.

Dr Greenhow, in his celebrated 1860 report, made a study of the districts of Stoke-on-Trent and Wolstanton, where more than third of the males over twenty and about one fifth of the women, were employed in the manufacture of china and earthenware. Within the district there was found to be an above average number of deaths from pulmonary causes. It was not just the dust which caused the respiratory problems but also the excessive heat and poor ventilation in certain parts of the pot bank, together with the exhausting nature of some of the work. Many of the manufactories consisted of a series of small, haphazardly built workshops, ill-designed for the jobs performed in them. The general environment, with the vast number of

[1] Quoted in Elliott (1970).

kilns in fire causing heavy atmospheric pollution, was also conducive to bronchial troubles. However, by far the greatest suffering was seen amongst the china scourers, which could be put down to the excessive quantity of flint in the atmosphere in which they worked. Greenhow found that few attempts had been made to prevent the dispersal of flint dust and when he inquired into the possibilities of scouring the ware wet, the was told that it could not be done.

> "Those who relinquish the employment in time are said occasionally to regain in health. Probably this branch of the manufacture might be rendered much less injurious to the health of the workers if some arrangement could be adopted for withdrawing the dust from the atmosphere, or, perhaps, the use of some kind of protection for the mouth, such as a respirator, might serve to exclude the dust from the air passages." 1

As with other harmful processes, there was no immediate reaction to either of the reports but the Children's Employment Commission of 1862 recounted some of the statements made by Scriven and Greenhow and a further investigation was carried out which confirmed their findings, although the investigator, Mr Longe, did add that:

> "many young women are tempted to sacrifice their health for the high wages which the employment affords." 2

Following this, the manufacture of china and earthenware was brought under the supervision of the Factory Inspectorate with the passing of the 1864 Factories Act Extension Act.[3]

1 Greenhow (1860), p111.

2 Quoted in Meiklejohn (1963 Silicosis), p259.

3 1864 Factories Act Extension Act 27 & 28 Vict. c48.

One of the witnesses to the 1862 Commission had been Dr John Thomas Arlidge, who had been appointed consulting physician to the North Staffordshire Infirmary in that year. In 1863 he was also appointed as the certifying surgeon for the districts of Stoke, Fenton and Longton.[1] From that time, he devoted himself to the study of potters' diseases. His first work on the subject was a paper in 1864, on the mortality of the Parish of Stoke-on-Trent, the statistics being based on the year ending 31st March, 1863. The Parish of Stoke-on-Trent included the districts of Hanley, Shelton, Stoke, Fenton and Longton which, together, formed the major areas of the manufacture of earthenware and china. In all there were 2,107 deaths, of which 913 were of people over the age of ten. Of this number, 163 had died from disease of the lung (17.86%), 216 from consumption or phthisis (23.65%), 72 from zymotic diseases (7.88%) and 462 from other causes (50.61%), hence 379 deaths had resulted from respiratory disorders (41.51%). Of the 913 deaths, 497 had been in males and 416 in females. Of the 379 dying from respiratory disorders, 210 were men, being 42.25% of the total male deaths and 169 were females, being 40.62% of all female deaths. Unfortunately, there were few indications of the occupations of the deceased and of the males over twenty, only 138 were known to be potters, but of this number, 37 had died from diseases of the lung and 42 from consumption or phthisis.[2]

Arlidge also spoke widely on the subject of potters' diseases and was one of the speakers at the British Medical Association's annual conference in Sheffield in 1876 which concentrated on industrial diseases. He was also active locally, where, for example, he gave a lecture to the Wedgwood Institute in Burslem in 1877.[3] The culmination

1 For a biography of Dr Arlidge see Posner (1973) or Vivien Herbert 'John Thomas Arlidge 1822-1899 with special reference to his life in the Potteries.' MA Thesis (Keele), 1975.

2 J T Arlidge *On the Mortality of the Parish of Stoke-on-Trent with References to its causes and the ratio of deaths among children and potters* (1864), pp9-10, p16 and p19.

3 *B.M.J.* 1876 August 26th, p271; October 14th, pp488-489. J T Arlidge *Diseases of Potters: their causes and prevention - two lectures* (1887).

of his work was when he presented the Milroy Lectures to the Royal College of Physicians in 1889, which were entitled, 'Occupations and Trade in Relation to Public Health.'.[1] The lectures were well received and, as a result, he was encouraged to write them up in the form of a book which was published in 1892. Although he met with opposition both from amongst his colleagues and the pottery manufacturers,[2] there is no doubt that he did much to publicize the plight of the potters, providing useful investigations into their distress. There is also evidence that his lectures had some influence on pottery manufacturers and that his ideas were not always opposed.[3]

In 1864, Dr Charles Parsons, house surgeon and colleague of Arlidge's at the North Staffordshire Infirmary, presented a thesis to the University of Edinburgh on a 'Form of Bronchitis (simulating phthisis) which is peculiar to certain branches of the Pottery Trade', for which he was awarded the degree of MD with gold medal. Although Parsons claimed he was the first to identify the disease,[4] which was

1 *B.M.J.* 1889 April 6th, p766. 2 Posner (1973), p268.

3 Annual Report of H.M. Chief Inspectors Year Ending October 31st 1892 (C 6978), p116; contains a letter from J. Cheadle, the Hon. Treasurer & Accountant of the Coalport Company, Shropshire, on the setting up of a Coffee House at the works. He says, *"Shortly after my advent here in 1889, I conceived the idea that a refreshment room with a free library attached and facilities for reading daily papers, various games, such as draughts & c., would prove a very desirable place for the workpeople and neighbourhood; and having had the privileage of hearing and reading several lectures delivered by the eminent physician, Dr Arlidge, Newcastle-under-Lyme, on the vital question of factory employees, habits, & c.; I recognised the importance of cleanliness and regularity in taking meals by persons engaged on work similar to our own."*

4 C. Parsons On a Form of Bronchitis (simulating phthisis) which is peculiar to certain branches of the Pottery Trade MD Thesis (Edinburgh) 1864, p3 (copy on microfilm at Stoke-on-Trent, Hanley Library).
For biographical details on Parsons, see: A. Meiklejohn 'A House-Surgeon's Observations on Bronchitis in North Staffordshire Pottery Workers in 1864' *B.J.I.M.* 1957 Vol. 14, pp211-212.

untrue, the thesis was important for its detailed clinical and pathological descriptions. In 1875 Dr Farr, the compiler of Abstracts for the Registrar General, wrote that the manufacture of earthenware was one of the unhealthiest trades in the country and that above the age of thirty-five, mortality amongst potters was double the average of the country at large. His successor, Dr Ogle, again emphasized the problem in 1885, and agreed that the majority of potters' illnesses were respiratory.[1]

With the growing concern over the incidence of plumbism, as well as lung disorders in the pottery industry, a Departmental Committee on the Pottery Industry in general, was set up in 1892 to look into conditions with a view to diminishing the risks. Dr Arlidge and a Mr Spanton were responsible for the medical reports. They concluded that both potters' clay and flint dust were injurious although the latter was by far the more dangerous of the two. However, whereas practically all workers in the potteries were exposed to clay dust, only a few were subjected to flint dust.[2] Both bronchitis and asthma were prevalent in the area and the mortality returns for the Parish of Stoke-on-Trent, in 1890, showed that amongst potters over the age of fourteen, 42% had died from bronchitis, 8% from pneumonia and pleurisy and 21% from pulmonary consumption, showing little difference from the scanty statistics produced by Arlidge in 1863. Although the atmospheric pollution in the area was also conducive to bronchial trouble, the statistics for the male population over fourteen in the area who were not employed in the pottery trade, show that only 26% had died from chest disease (that is bronchitis or pneumonia) and 14% from pulmonary consumption.[3] The best preventative measures recommended were cleanliness in work,

[1] Meiklejohn (1963 Silicosis), pp259-260.

[2] 1893-1894 Conditions of Labour in the Potteries, Dept. Cttee. Report (C 7240), p4.

[3] Ibid.

especially in avoiding the scattering of clay particles; the frequent removal of waste fragments; sprinkling the floor with water to stop the dust from rising; and, keeping the temperature of the workshops at more reasonable levels. They also recommended the installation of fans to improve ventilation and the sweeping of rooms after work hours.[1]

Under the powers of the Factory Acts, Special Rules were drawn up for the pottery trades in 1898, which required that women and young persons employed in china scouring be included amongst the workpeople needing monthly medical examinations and possible suspension by the certifying surgeons. The period of examination was later extended to once a year. A problem arising from this ruling was that, if suspended, there were no provisions for compensation for lost earnings. This was not provided for until 1928.[2] Some manufacturers did pursue their own investigations into dust control and Doulton's of Burslem, came up with a system for china biscuit scouring involving revolving brushes under an exhaust hood. This won the support of the Factory Inspectorate and was illustrated in their annual report of 1899.[3] A decline in the incidence of silicosis in the 20th century occurred with the replacement of flint with alumina.[4]

[1] Ibid. p5

[2] Meiklejohn (1963 Silicosis), p260.

[3] Ibid.

[4] Hunter (4th edition 1969), p997. Meiklejohn (1963 Silicosis) pp260-263.

Coal Mining

The high employment figures for the coal industry in the 19th century probably account for the fact that lung disease amongst coal miners attracted considerable attention. The subject has also been discussed by more recent writers, with Andrew Meiklejohn, in 1951 and 1952, writing a series of articles in which he made a detailed survey of the medical literature which referred to the respiratory diseases of British coal miners for the period 1800 to 1952.[1] As a physician his interest in the subject was to judge the advances in knowledge from the early 19th century papers written on miners' lung diseases and to assess how accurate these clinical observations had been without the advanced techniques of modern pathology, physiology, biochemistry, chest radiology, dust sampling and dust analysis. George Rosen published 'The History of Miners' Diseases'[2] in 1943 in which he dealt generally with miners' illnesses and not just respiratory disorders. He was concerned with both colliers and metalliferous miners and their status in society, tracing their history from ancient times to the modern day, in a descriptive manner. In 1946 Treve Holman[3] looked at the historical relationship between rock extraction and silicosis, discussing both coal and metalliferous mining. He attempted to outline the progress in rock drilling in each of the three areas of drilling operations: drifting, underhand stoping and overhand stoping, and to show how the gravity of the resulting occupational disease was increased with the intensity of operations until the realization of the problem in the early 20th century, brought subsequent action - both a change in the design of equipment and the introduction of water spraying to suppress dust levels. He was concerned that despite knowledge of the dangerous aspects of drilling, at the time of writing (1946) not all mines were operating the safeguards.

[1] A Meiklejohn 'History of Lung Diseases of Coal Miners in Great Britain: Part I 1800-1875' *B.J.I.M.* 1951 Vol.8, pp127-137. 'Part II 1875-1920' *B.J.I.M.* 1952 Vol.9, pp93-98. 'Part III 1920-1952' *B.J.I.M.* 1952 Vol.9, pp208-220.

[2] George Rosen *The History of Miners' Diseases* (1943)

[3] Treve Holman 'Historical Relationship of Mining, Silicosis and Rock pp1-15.

Although the first clinical observations on miners' lung disease came in the early 19th century, earlier writers had commented on the liability of colliers to suffer from chest diseases. John Evelyn in 1661, wrote;

> "Newcastle Coale, as an expert Physician affirms, causeth consumptions, phthisicks, and the indisposition of the lungs, not only by the suffocating aboundances of smoake, but also by its virulency. For all subterrany fuell hath a kind of virulent or arsenical vapour rising from it, which, as it speedily destroys those who dig it in the mines, so does it by little and little, those who use it here above them." [1]

19th century medical literature on respiratory disorders of coal miners was not only abundant but was also extremely confusing. This is not really surprising considering the present day disagreement in the medical world as to what excactly constitutes coalminers' pneumoconiosis. The earliest writers talk of melanosis of the lungs; melanosis being an abnormal growth of black pigment. But these accounts have been dismissed as describing the natural darkening of the pigment of the lungs with ageing.[2]

The first published account of a black deposit in a coal miner's lung, came in 1831 from J.C. Gregory. He described an examination undertaken on the lungs of a fifty-nine year old collier from Dalkeith. The man had been a coal miner for ten or twelve years, prior to which he had been a soldier. For sixteen months he had been unable to work and he had spent the last three weeks of his life in hospital, where he died of progressive heart failure. From the examination, Gregory concluded that

1 J. Evelyn *Fumifigium* (Reprint 1772), p28; (Quoted by R.I. McCallum in 'Pneumoconiosis of Coal Miners in North East England with special reference to the Durham Coalfield' *B.J.I.M.* 1952, Vol. 19, p99).

2 Meiklejohn (1951, Part I), pp128-129; Hunter (4th edition 1969), p1033.

there were distinctive differences between melanosis and the black infiltration he had found in the collier's lungs. He also felt that although this was the first recorded case of the infiltration of the lungs with coal dust, it was probably not an unusual disease in coal mining areas and appealed to other practitioners in such districts, to look out for it.[1]

Following in his path, Dr William Marshall of Cambuslang near Glasgow, published three more accounts of the black infiltration in 1834. He gave the disease the name of spurious melanosis or phthisis melanotica. From reviewing post mortem examinations he had seen, he identified four stages in its development. He deduced that the black expectoration seen in some cases, was a sign of lung disintegration and that when that occurred, nothing could be done to alleviate the problem.[2] Several factors had been put forward as explanations for the cause of the disease, which varied from blasting underground with gunpowder, to the inhalation of lamp black or soot from the oil lamps used. Dr Marshall felt both were unsatisfactory explanations, as the miners he had examined had worked in pits where blasting was not carried out and although virtually all miners in his area used oil lamps, the disease appeared to be restricted to certain pits. He was, instead, in favour of the theory that it was caused by fine coal dust which, under normal conditions, was expelled by the lungs, but when they were diseased or the quantity inhaled was considerable, the dust caused pulmonary vesicles and irritation. This condition, he felt, was more likely to occur in mines where the coal was found in hard, dry seams, for then much pick work was necessary. In support of this argument, he gave

[1] Meiklejohn (1951 Part I), p130; *The Lancet* 1831 October 8th, pp38-39.

[2] Meiklejohn (1951 Part I), p130; *The Lancet* 1834 May 17th, pp21-274; September 20th, pp926-928.

the case of an iron moulder who used charcoal in dusting the moulds who had died from a similar disease.[1]

Marshall was criticized for his work[2] but other cases were forthcoming,[3] and in 1837, Dr Thomas Stratton published a "case of Anthracosis or Black Infiltration of the whole lungs",[4] which for the first time applied the term anthracosis to colliers' disease. At the same time, a classic study on the subject was published by Thomson of Edinburgh, in two articles in the Medical-Chircurigical Transactions of 1837 and 1838.[5] These were based on observations made by Thomson and his father since 1824. The climax of the inquiry was in 1833, when a questionnaire was sent to doctors practising in the colliery areas. There was a great diversity of opinion in the replies but Thomson and his father clearly distinguished between phthisis and tubercular phthisis in the reports, and recognized the difference between the nodulations in the stone workers' lungs, as opposed to the black accumulations in the men working at the coal face. They also examined men who had died in pit accidents and found that universally black lungs were compatible with men in good health and doing a full working day.

[1] *The Lancet* 1834 September 20th, pp926-928.

[2] *The Lancet* 1834 September 6th, pp838-839. Notably by Mathew Gibson, a surgeon from Glasgow. In his opinion, they were simple cases of everyday phthisis. All coalminers' lungs contained black matter whether health or not, as was seen in examining miners killed in accidents. He agreed that the black expectoration was a sign of the lungs breaking up, but did not agree it caused the disease. It was natural that as the lungs were destroyed by phthisis, that the coal dust attached to them should follow and be expectorated along with them.

[3] Meilkejohn (1951 Part I), pp131-132. From Dr G Hamilton of Falkirk, Dr Graham a lecturer in Chemistry at the Andersonian Institution, Glasgow who carried out analyses for Dr Hamilton on lung material, Dr Girdwood, a Carron practitioner and Dr William Gray of Glasgow.

[4] Reprinted by A. Meiklejohn under the title: 'The origin of the term Anthracosis' *B.J.I.M.* 1959 Vol.16, pp324-325.

[5] Meiklejohn (1951 Part I), pp132-134.

According to the 1842 Mines Report, two types of lung disease were identified with the dust in coal mines; the first being 'miners' asthma' and the second 'black spit'. All underground workers in collieries were subject to inhaling coal dust. In the young men it had little effect as it was easily expectorated on return to the surface, but after the age of twenty-five most began to suffer with breathlessness, and by forty, all were more or less suffering from chronic bronchitis or asthma.[1]

> "Most colliers at the age of thirty become asthmatic. There are few attain that age without having the respiratory apparatus disordered - I met with very few colliers above forty years of age who, if they had not a confirmed asthma, were not suffering from difficult breathing." 2

These reports, on asthmatic type complaints, came from all over the country; from the large coalfields of the North-East, Lancashire, South Wales and East Scotland, to the small mining districts in the Forest of Dean and North Somerset. The most vivid accounts, however, came from East Scotland, where Dr S Scott Alison of East Lothian sent a full history of the course of the disease:

> "Between the twentieth and the thirtieth year many colliers decline in bodily vigour and become more and more spare, the difficulty of breathing progresses, and they find themselves very desirous of some remission of their labour. This period is fruitful in acute disease, such as fever, inflammation of lungs and pleura, and many other ailments, the product of over-exertion, exposure to cold and wet, violence, insufficient clothing, intemperance and foul air. For the first few years chronic bronchitis is usually found alone and unaccompanied by

1 John Benson *British Coal Miners in the 19th Century* (1980), p45.

2 1842 Children's Employment Commission, First Report of the Commissioners (Mines) (380), p189.

> disease of the body of the lungs. The patient suffers more or less difficulty of breathing, which is much affected by changes of the weather and by variations in the weight of the atmosphere, he coughs frequently, and the expectoration is composed, for the most part, of white frothy and yellowish mucous fluid, occasionally continining blackish particles of carbon, the result of combustion of the lamp, and also of minute coal dust. At first, and indeed for several years, the patient, for the most part, does not suffer much in his general health, eating heartily, and retaining his muscular strength little impaired in consequence. The disease is rarely, if ever, entirely cured; and if the collier be not carried off by some other lesion in the mean time, this disease ultimately deprives him of life by a slow and lingering process. The difficulty of breathing increases and becomes more or less permanent, the expectoration becomes very abundant, effusion of water takes place in the chest, the feet swell and the urine is secreted in small quantity, the general health gradually breaks up, and the patient, after reaching premature old age, slips into the grave at a comparatively early period with perfect willingness on his part, and with no surprises on that of his family and friends." [1]

The disease was known as 'miners' asthma' and Cox, who looked after the medical welfare of a large colliery near Wigan, called it the 'scourge of the mine',[2] as although in itself it might not be the direct cause of death, it weakened the lungs to such an extent that attacks of bronchitis and pneumonia proved fatal.[3] In many, the asthmatic conditions led to the development of diseased hearts.[4]

The second disease, referred to as 'black spit', was reported to have more drastic consequences. Again, a vivid account was received from Dr S. Scott Alison:

[1] Ibid.

[2] William Cox 'Diseases of Colliers in South Lancashire' *B.M.J.* 1857 May 23rd, p491.

[3] P.E.H. Hair The Social History of British Coal Miners 1800-1845 D. Phil Thesis (Oxon) 1955, pp103-104.

[4] Cox (1857), p491.

> "Spurious melanosis, or the 'Black-spit' of colliers, is a disease of pretty frequent occurrence among the older colliers, and among those men who have been employed in cutting and blasting stone dykes in the collieries. The symptoms are emaciation of the whole body, constant shortness and quickness of breath, occasional stitches in the sides, quick pulses, usually upwards of one hundred in the minute, hacking cough by day and night, attended by a copious expectoration, for the most part perfectly black, and very much the same as thick blacking in colour and consistence, but occasionally yellowish and mucous, or white and frothy; respiration is cavernous in some parts and dull in others; a wheezing noise is heard in the bronchial passages, from the presence of an inordinate quantity of fluid; the muscles of respiration become very prominent, the neck is shortened, the chest being drawn up, the nostrils dilated, and the countenance is of an anxious aspect. The strength gradually wasting, the collier who has hitherto continued at his employment finds that he is unable to work six days in the week, and goes underground perhaps only two or three days in that time; in the course of time he finds an occasional half day's employment as much as he can manage, and when only a few weeks' or months' journey from the grave, ultimately takes a final leave of his labour. This disease is never cured, and if the unhappy victim of an unwholesome occupation is not hurried off by some more acute disease, or by violence, it invariably ends in the death of the sufferer. Several colliers have died of this disease under my care." 1

This fatal disease was not reported from all districts[2] and not from all the coal mines in the areas where it did occur. In 1851, Professor Bennett, in reviewing the situation in Scotland, found that whereas lung diseases were rife in some pits, they were absent from those of Newcastle, Paisley and Alloa. He also found that those engaged in stone work in the pits were particularly liable to the complaint.[3]

1 1842 Children's Employment Commission (Mines) (380), p196.

2 Ogier Ward (1841), p87; 'I have made many enquiries, but I cannot learn that bronchitis and spurious melanosis of other coal districts have ever been known in the Shropshire coalfields.' R. Wilson 'The Coalminers of Durham and Northumberland' *B.M.J.* 1863 September 19th, p330. Dr Wilson maintained that phthisis was not prevalent amongst the miners of the North of England, and that there was an absence of black phthisis or carbonaceous lung.

3 Ferguson (1948), p184.

Although the real significance of this observation was probably not appreciated at the time, it is indicative of the source of one of the dangers. Some historians, when discussing the coal industry, have simplified this 19th century literature, identifying 'miners' asthma' as present-day coal miners' pneumoconiosis and 'black spit' as silicosis.[1] However, as indicated earlier, in current medical literature, there appears to be no agreement as to what constitutes coalminers' pneumoconiosis. It would seem that true silicosis does not appear amongst coal miners, although coal dust may contain some free silica and thus coalminers' pneumoconiosis may be a subdivision of silicosis.[2] Currently two kinds of lung disease are recognized amongst colliers; simple and complicated pneumoconiosis. But as the simple form has no symptoms or physical signs, and is only apparent on an x-ray plate, its identification would have been impossible in the 19th century and the distinction between 'miners' asthma' and 'black spit' is indicative either of the progressional stages of the same disease or of complications by another, for example, pulmonary tuberculosis, which was widespread throughout the century but very hard to identify. The bacilli for tuberculosis was not discovered until 1882 and it was some years before it was generally recognized and preventative measures looked for.

After the initial interest of the 1830's, the excitement in the subject declined, so that W. Sanders reviewing the question in 1858, remarked how neglected the topic had become.[3] There are few, if any, statistics available on

1 Hair (Thesis 1955), p104; Hunter (4th edition 1969), pp982-983; Benson (1980), p45.

2 In the Workmans' Compensation Act, 1925, coal mining was not scheduled as a dangerous occupation and it was not until 1931 that workers at the coal face were allowed to apply to the Silicosis Medical Board for relief. The number of cases increased rapidly. Now 'coalminers' pneumoconiosis' is the commonest varient of silicosis.

3 W. Sanders 'Observations on some objects of interest in the Museum of the College of Surgeons in Edinburgh' *B.M.J.* 1858 August 14th, p676.

the extent of respiratory disorders amongst colliers. Greenhow in his 1861 report investigated the conditions of coal miners both in the Midlands at Wolverhampton, and in the South Wales area of Merthyr Tydfil and Abergavenny but unfortunately his statistics did not isolate the colliers as a class but spoke of the overall mortality rates for adult males from lung diseases. Wolverhampton, for instance, had many manufacturing concerns besides mining and in the South Wales area there was as much ironstone mining as coal mining and many were employed in the manufacture of iron. His general impression was that the problem was greater in South Wales compared with the Midlands, and he put this down to the poorer ventilation and foul gases met with in the mines in that area.[1] The variety of coal mined was also responsible for the difference; the harm depending on the silica content in the dust. Throughout the '60's, Greenhow continued to look at the problem of colliers' respiratory disorders by making various post mortem examinations on coal miners' lungs.[2]

In 1876, at the British Medical Association's annual meeting, a paper was to have been read on 'colliers' black spit' but it was cancelled as the writer could not obtain enough information. He was of the opinion that because of the great improvements in ventilation systems, the primary purpose of which was to prevent explosions, the disease was now comparatively rare.[3] Arlidge, in 1892 wrote:

> "There is a widespread belief at the present day that the serious lesions of the lungs associated with the calling of coal getters, belong to past history, or at the most, are very uncommon; and no doubt can

[1] Greenhow (1861), pp154-166.

[2] Greenhow 'Coal Miners' Black Lung' *Transactions of the Pathological Society of London* 1865, Vol. XVI, p60. Greenhow 'Colliers' Lung' *Transactions of the Pathological Society of London* 1866 Vol. XVII, p34. Greenhow 'Coal Miners' Lung' *B.M.J.* 1869 April 10th, pp331-332.

[3] Meiklejohn (1951 Part I), p136; See also the section on explosions in coal mines on pages 187-188.

> exist that, compared with the past, they are becoming rarer; thanks to the introduction of efficient ventilation, of shortened hours of labour and of increased attention given to hygiene of mines." 1

Arlidge was aware that lung diseases were still prevalent but the majority of commentators appear to have felt that the problem had been solved. Unfortunately events were to show that this was far from true and pneumoconiosis amongst coal miners is one of the most notable industrial health problems of today.

Metalliferous Mining

The metalliferous mines of copper, tin, lead and iron, presented different problems and types of dust than the collieries.[2] Whereas coal was found in seams, in fairly regular patterns, the veins of ores ran irregularly and were either reached by horizontal adits, driven into the hillside, or more frequently, by shafts sunk vertically. To obtain the mineral, the miner thus had to follow the erratic course of the ore. This often made ventilation impracticable. Metalliferous mines did have one, important advantage over coal mines, however, as they did not generate the poisonous, explosive gases found in the latter.

The copper and tin mines of Cornwall were very deep and consequently lacked ventilation, making them extremely hot and close. In the 1830's, John Forbes, a local doctor, made a detailed survey of the medical topography of the Landsend area of Cornwall and included a special study of the health of the miners. He gave the following description

1 Arlidge (1892), p265.

2 Although ironstone was often mined together with coal, as it overlayed the coal seams.

of the conditions in the mines:

> "All the various labours of the miner tends to impregnate the air with minute earthy particles, and this impregnation is rendered much greater than it could otherwise be, by the great stagnation of the air in the extremities of the galleries, where these labours are chiefly performed. The kind and quantity of dust varies according to the nature of the rock and vein, the degree of humidity, and also according to the process by which the rock and ore are broken up. The constant presence of dust is sufficiently obvious to anyone who visits the interior of a mine in a state of activity. I cannot say, however, that I was ever sensible of its presence from any immediate effects in the organs of respiration. Its prevalence is abundantly obvious in the smutty ochry complexions and dresses of the miner, or of the visitor of mines, in the dusty floors of such galleries as are perfectly dry, and in the layers of soft mud and turbid puddles that cover the bottom of all those which contain much humidity. A still more striking proof of the prevalence of this dust....is the fact, confirmed to me by the testimony of many labouring miners, of the sputa being tinged by it for many hours after the miner leaves the mine, and of this tinge being varied in colour accord- to the nature of the rocks and vein worked." 1

In 1821 he made a personal examination of the miners at one of the local mines, as to their age, length of service and present and past health.[2] The following tables (VI, VII, VIII) have been drawn up from this data. One problem in examining Forbes' figures is, that it is unclear whether the observations are his own or whether the statements came from the miners themselves. If the latter were true, they may well have underestimated any illnesses. Of those reporting to be in good health, half had seen under

[1] John Forbes 'Sketch of the Medical Topography of the Hundred of Penwith comprising the District of the Landsend in Cornwall' *The Transactions of the Provincial, Medical and Surgical Association* 1834 Vol. II, p87.

[2] John Forbes 'Part Two of the Medical Topography of the Hundred of Penwith.' *The Transactions of the Provincial, Medical and Surgical Association* 1836 Vol. IV, pp217-219.

TABLE VI: Table to Show the State of Health of a Group of Cornish Miners in Relation to Age in 1821

Present age	Good health	Affected with dyspnoea[1]	Affected with pains in chest	Affected with pain of stomach or bowels	Lumbago	Pain of shoulder	Palpitation	Scrofula	Fits	Total in age group
		State of Health								
10-14	1	-[2]	-	-	-	-	-	-	-	1
15-19	13	1[2]	3	-	-	-	-	-	-	17
20-24	11	-	4	2	-	1	-	-	1	19
25-29	17	6	3	1	1	-	1	-	-	29
30-34	8	4	2	1	1	1	-	-	-	17
35-39	6	2	-	4	-	-	-	1	-	13
40-44	5	4	-	1	-	-	-	-	-	10
45-49	1	4	1	1	-	-	-	-	-	7
50-54	-	4[3]	1	-	-	-	-	-	-	5
55-59	-	1	-	-	-	-	-	-	-	1
60-64	-	1	-	-	-	-	-	-	-	1
Total	62	27	14	10	2	2	1	1	1	120

Ref. 1. *Some cases are past historys and the miners are not troubled with them at present. Dyspnoea means difficulty in breathing.*

2. *This case was stated to have dyspnoea before he went underground but the complaint had been aggravated since taking such work.*

3. *One of these cases had suffered with dyspnoea for two years but he had not worked for a period of twenty years.*

Source: Data from J. Forbes 'Medical Topography of the Hundred of Penwith' *Transactions of the Provincial, Medical and Surgical Association* 1836 Vol. IV, pp217-219.

TABLE VII: Table to Show the State of Health of Cornish Miners in Relation to their Length of Service in 1821

Length of service	State of health: Good health	Affected with dyspnoea	Affected with pains in chest	Affected with pain of stomach or bowel	Lumbago	Pain of shoulder	Palpi-tation	Scrofula	Fits	Total
Under 5 yrs	11	1 [1]	2	2	-	-	-	-	-	16
5- 9 "	20	3	5	1	1	-	-	-	1	31
10-14 "	12	4	4	-	-	2	1	-	-	23
15-19 "	6	3	-	2	1	-	-	-	-	12
20-24 "	8	4	1	2	-	-	-	1	-	16
25-29 "	3	4	-	2	-	-	-	-	-	9
30-34 "	2	3	1	1	-	-	-	-	-	7
35-39 "	-	2	-	-	-	-	-	-	-	2
40-44 "	-	1	1	-	-	-	-	-	-	2
45-49 "	-	1	-	-	-	-	-	-	-	1
50-54 "	-	1	-	-	-	-	-	-	-	1
Total	62	27	14	10	2	2	1	1	1	120

Ref. 1. *This miner was 25 but only been working underground for a year. Dyspnoea was present before going underground.*

Source: Data from J. Forbes 'Medical Topography of the Hundred of Penwith' *Transactions of the Provincial, Medical and Surgical Association* 1836 Vol. IV, pp217-219.

TABLE VIII: Table to Show the State of Health of a Group of Cornish Miners in 1821 in Relation to the Age at which they Commenced Work

	State of Health									
Age of commencing work	Good health	Affected with dyspnoea	Affected with pain in chest	Affected with pain of stomach or bowel	Lumbago	Pain of shoulder	Palpi-tation	Scrofula	Fits	Total
Under 10	-	2	-	1	-	-	-	-	-	3
10-14	22	7	6	2	1	1	-	-	-	39
15-19	32	14	7	7	1	-	1	1	1	64
20-24	7	3	1	-	-	1	-	-	-	12
25-29	1	1	-	-	-	-	-	-	-	2
Total	62	27	14	10	2	2	1	1	1	120

Source: J. Forbes 'Medical Topography of the Hundred of Penwith' *Transactions of the Provincial Medical and Surgical Association* 1836 Vol.IV, pp217-219.

ten year's service in the mines and after ten years, the majority of miners seem to have suffered from some form of ill-health, but since the effects of mining will also have depended on the age of commencing work, it is hard to draw conclusions. True, the three miners who had started work before the age of ten were all reported to be suffering from some form of ill health, but in the next group, by far the majority enjoyed good health. Of the three who began work under the age of ten, two had started at the age of nine, one then having reached thirty-six years of age and suffering occasional gastrodynia,[1] but otherwise being healthy and the other was then twenty-nine and had been affected by dyspnoea (difficulty of breathing) for the last four years. The third miner was reported to have started at the age of five and was at the time of examination fifty, having suffered with slight dyspnoea for the previous eight years.

[1] Gastrodynia = stomach complaint

Taking the group as a whole, 34.17% of them were suffering from either chest pains or difficulty in breathing and of those aged thirty and upwards, the percentage increased to 44.45%. From the comments of other medical authorities in the area,[1] it was generally agreed that miners suffered from chest affections more severely than others in the region. Whether these respiratory disorders could be attributed to the problem of dust inhalation is not clear and many possible causes were indicated. Despite Forbes' descriptions of the dust laden galleries, none of the writers, at the time, seem to have felt this was the main cause, partly for the reason that although chest disease was more prevalent amongst miners they would,

> "hardly say they are subject to any peculiar disease of the chest and which we do not witness in others." 2

Factors which were suggested with frequency, were the foul and impure air in the galleries where they worked.[3] More than one report remarked on the fact that it was often so bad that a candle held perpendicularly went out and that the only way to obtain light, was to hold two candles together horizontally.[4] The other major contributory factor was said to be the exertion needed to ascend to the surface after a working shift.[5] This was done by climbing perpendicular ladders. This was quite a feat considering the depth of some of the mines. The lowest gallery at Dolcoath

1 Forbes (1836) The Report ends with replies to a circular sent by the author to people, both in the medical world and of local importance in the mining area.

2 Forbes (1836), p225; Dr Wise, Helston.

3 Ibid. p227 Dr. Montgomery, Penzance; p.230, Mr Moyle, Helston & Mr Moyle, Penzance; p231 Mr Vincent, Camborne; p233 Messrs. Gurney & Vivian, Marazion; pp235-236 Rev. George Treweeke, Rector of Ilogan.

4 Ibid. p230 Mr. Moyle, Penzance; p231 Mr. Vincent, Camborne; p240 Mr Doble, St Agnes, case history I.

5 Ibid. pp223-227 Dr Wise, Helston; pp233-234 Messrs Gurney & Vivian, Maraxion; p238 Mr Doble, St Agnes.

copper mine was 1,386 feet in 1819 and at Huel Abraham in 1822 1,446 feet.[1] The situation was made worse by the rapid speed at which they ascended. This increased the speed of circulation and caused breathlessness, moreover the shock to the system on reaching the cold air at the surface, after the hot, clammy temperatures of the mines was thus exaggerated:

> "The circulation having such a sudden check, the whole of the viscera of the thorax and abdomen are gorged with blood; and the daily repetition of this process produces chronic disease of the affected parts; and this, we believe, is what is termed 'miners' consumption'." [2]

Although the miners' disease was called consumption, it was rather a form of chronic bronchitis. None of the writers in Dr Forbes' account, had been able to carry out pathological examinations as the miners opposed it.

Dr Greenhow found that copper and tin mining were less pernicious activities than lead mining but that they must have had some adverse effects on health as the incidence of respiratory disorders was far higher amongst the male population in Redruth than the female, and this could only be accounted for by occupation.[3] As with both earlier and later reports,[4] he lay the blame on the great heat and poor ventilation in the galleries and changes in temperature on ascending.[5] Although tin and copper miners suffered from chest complaints, the symptoms were not acute but rather long drawn-out, death often occurring some time after working had ceased.

[1] Forbes (1834), p96.

[2] Forbes (1836) pp233-234 Messrs. Gurney & Vivian, Marazion.

[3] Greenhow (1860), pp129-133.

[4] John Forbes (1834 & 1836); Royal Cornwall Polytechnic Society 1847; Robert Blee, Royal Cornwall Institute Paper 1871; *B.M.J.* 1897 September 2nd, p269; Charles Batham 'The Diseases of Cornish Miners' *B.M.J.* 1871 September 2nd, pp253-255.

[5] By 1871, in about a dozen of the more important mines, the ladders had been superceded by machinery for ascent.

> "For the most part they become more or less asthmatical about the age of forty, and but comparatively few are met with between the ages of forty and fifty years, whose health has not been unequivocally impaired by their occupation, still they often survive for many years after discontinuing work."

In 1865, Dr Peacock was able to carry out a post mortem examination on a Cornish tin and copper miner's lung.[1] Despite being the only post mortem he performed, the case was probably fairly typical as to history and age of Cornish miners. The miner had been 55 at death, having worked in copper and tin mines for about 38 years. He first went underground at the age of 13 or 14, and had been compelled to give up work two years before his death. On the whole, he had been ailing for the last five years with pains in the chest, difficulty of breathing, coughs and expectoration. The lung was found to contain a brownish fluid and to be deep blue or black at the edges. It was also solidified and contained no tubercles. On analysis, the dark material was found to be carbon, and no siliceous particles could be discovered. From the examination Dr Peacock drew the following conclusions; that if the miners were not predisposed to consumption, they developed chronic bronchitis and emphysema, and lived to about middle age, at which point the lungs became consolidated and broke down; if, on the other hand, they were susceptible to consumption, they died at an earlier age of true tubercular phthisis. He put the chief cause down to the impure air underground and the change in temperature from the heated galleries to the open air, and he felt the risks were aggravated by starting work underground at an early age. As to the question of dust, he wrote:

> "It has been thought that the miners are injured by the inhalation of gritty particles, like the French millstone makers or builders, but such does not seem to be the case with the Cornish miners."

1 Dr Peacock 'Cornish Miner's Lung' *Transactions of the Pathological Society of London* 1865 Vol. XVI, p57.

Amongst lead miners, the commonest disorder was 'miners' complaint' or 'miners' asthma' which was considered to be the result of the foul air in the mines, the gaseous vapours left after explosions, the cold and damp on leaving the mines, aggravated by insanitary conditions at home. A common case history of a lead miner was as follows: At first he was set to work at the crushing, washing and sorting plant. This was generally carried on in the open air and was thus fairly healthy. At about the age of 18, he would enter the mine itself.

> "After a few years, more or less, he begins to be short of breath, but this does not hinder his work, but still he is 'touched in his wind'. On leaving work he coughs up a quantity of bluish-black sputa. As years pass by, the difficulty of breathing increases, and there often occur acute attacks of bronchitis. These pass off, but the miner is left with increasing shortness of breath, getting up more slate-coloured expectoration, and with progressive debility. His appetite fails, and he frequently vomits his breakfast on his way to work after a paroxysm of coughing. At 40 or 45 he is a wheezing old man, with a more or less barrel-shaped chest, coughing and expectorating, incapable of much exertion, with more or less blueness of the lips, and other signs of defective aeration of the blood; and before 50 he is usually forced to give up work as worn out old miner. This state of things lasts for a time, varying in different cases from a year up to twenty, with some improvement in the summer, but with frequent subacute attacks of bronchitis being superadded to the old mischief, in the autumn, winter and spring; and one of these attacks generally ends the scene, or the miner falls prey to increasing exhaustion." 1

In some miners the picture was further complicated by attacks of catarrhal pneumonia and pleurisy.

C.J. Hunt in 1970, made a study of lead miners of the Northern Pennines and confirmed the hazardous nature of their occupation, showing that the average life expectancy of an adult lead miner was less than that of a worker in almost any other trade in Britain. The average age at death between the years 1837 and 1841 of adult miners over 19, was

1 Robinson (1893), p417.

45 at Alston, 48 at Allendale, and 47 at Teesdale. By far the greater number died of respiratory disorders. The situation had not improved thirty years later, as in the ten years prior to 1864, the average age at death at Allenhead was 44.[1]

The investigations of the Government into lead mining areas in 1842 and 1864, both revealed that the men accepted their poor health as inevitable and were often unwilling to admit to suffering from any illness at all. They generally talked of their symptoms in terms of shortage of breath and 'black-spit'. Although both the largest lead mining concerns in the Pennine area had established medical services for their employees, the reports show that employers, too, were unwilling to acknowledge a link between occupation and ill-health and preferred to blame bad diets, poor houses, intemperance and stupidity amongst the miners themselves, for any problems.[2] Hence, despite the fact that there was a considerable incidence of respiratory diseases amongst lead miners, there was no knowledge of the cause of the problem, both the Government reports being written before there was any awareness of the hazards of stone dust. It appears, therefore, that both miners and employers tried to dismiss the problem by refusing to acknowledge its existence. Failing to understand the danger of stone dust, no attempts were made to reduce the levels of dust created in drilling or blasting the rock, nor were simple precautions such as the provision of masks taken.

It is difficult to draw any conclusions on the incidence of respiratory disorders amongst ironstone miners, as ironstone was, more often than not, mined alongside coal, and miners often transferred from one type of mine to another. The iron seam generally overlayed the coal seam, and to obtain it the coal was first holed and then the layer of

[1] C.J. Hunt *The Lead Miners of the Northern Pennines* (1970), pp208-213.
[2] Ibid. p211.

ironstone was broken down by explosives. Due to the fact that iron ore was a dense metal, it required larger and more frequent use of explosives than in coal mining, which added to the problems of ventilation.[1] The dust caused problems and Dr Greenhow reported on the high incidence of respiratory disorders amongst the ironstone miners of Wolverhampton and Methyr Tydfil.[2]

Generally, the problem of respiratory diseases amongst metalliferous miners proved beyond the scope of the 19th century medical observers, and where no explanation could be found, the fault was laid at the feet of the miners themselves. There was little improvement throughout the century, as although the foul air, rapid ascent, etc. all aggravated the problem, the root cause, stone dust, was not understood, so no steps were taken to suppress it. Dr Ogle in 1892, showed that the mortality from phthisis and lung diseases amongst the Cornish miners was still comparatively high.[3] Holman, in his study of drilling operations, discovered that the first use of water to suppress the formation of dust was in driving the St Gothard Tunnel in 1879. This inspired Hesse and Harting to carry out some investigative examinations from which they drew up the following proposals: 1. The obligatory introduction of wet boring; 2. The institution of adequate ventilation; 3. The introduction of cages for the transportation of miners up and down the shafts; 4. The furnishing of working clothes, including shoes, for the men; 5. The institution of a dressing-room within the shaft building, heated in winter, where the miners could change their clothes on leaving and entering the pit. In Britain, no serious notice was taken of dust hazards until the 20th century, and the first use of water to reduce the level of dust was around the turn of the century. When Holman wrote in 1947 wet boring was still not obligatory or universally accepted.[4]

[1] Arlidge (1892), p282.

[2] Greenhow (1861), pp154-166.

[3] Holman (1947), p8.

[4] Ibid. pp9-10.

3. GASES AND VAPOURS[1]

There are three main ways in which gases can prove harmful to human beings. Firstly, they can react as a simple asphyxiant. The gas in itself can be inert in its effect on the body but simply by replacing the amount of oxygen breathed in, can cause lack of oxygen in the blood and hence suffocation. Secondly, the gas can act as a chemical asphyxiant, interfering with the tissues of respiration or setting up a chemical reaction in the blood and causing damage to other organs in the body. Other gases are referred to as irritating gases, as they set up immediate irritation in the respiratory tract. The area affected is dependent on the solubility of the gas in water. The less soluble, the more likely it is to attack the upper regions of the respiratory tract, and the more soluble, the more likely the damage is to be found in the lungs themselves.[2]

In the 19th century, one industry in which gases were frequently met was the coal industry, the common names for the gases being firedamp (carburetted hydrogen) and choke-damp (carbon monoxide). However, neither Arlidge, in his article in the British Medical Journal of 1878 or his book of 1892, nor Dr Richardson in his lectures to the Society of Arts in 1876, list coal miners as being amongst those workers liable to be harmed by gases.[3] The concern with

[1] Confusion is sometimes caused by the terms gases and vapour, and although they are sometimes used interchangeably, there are in fact differences. The term gas is usually applied to a completely elastic fluid which does not become a liquid or solid at normal temperatures, whereas vapour is used for the gaseous form of a normally liquid or solid substance. The gaseous form of solids are also referred to as fumes and the dangers resulting from these have mostly been dealt with under the section entitled toxic metals. For copper fumes see pages 54-56, phosphorus fumes pages 97-106 and zinc fumes pages 106-110.

[2] Hunter (4th edition 1969), p649, p655 and pp667-668; Stellman & Daum (1973), pp157-166.

[3] *B.M.J.* 1878 August 17th, p243; *J.S.A.* 1876 January 21st, pp146-149; Arlidge (1892), pp471-529 on noxious vapours.

gases in coal mining was rather with the explosive properties of firedamp and the tragic accidents which followed, than with any sickness ensuing from inhaling them. After an explosion of firedamp, carbon monoxide was present and many miners, who survived the initial explosion, died from carbon monoxide poisoning. Efforts were directed towards obtaining better means of ventilation to disperse the gases and on various forms of safety lamp to lessen the risk of explosion.[1] Cox in his article of 1857 on Lancashire miners, however, does record noxious gases as being a cause of bronchial trouble in miners. Those he identified as being present in the Lancashire pits were carbide of hydrogen, carbonic acid, sulphurous acid and occasionally free hydrogen.[2]

Firedamp was also a problem to tunnel diggers. David Lampe (1963) in his book on the construction of the Thames Tunnel from 1824 to 1842, includes extracts from the journals of Brunel which make reference to a 'tunnel sickness',[3] caused by inflammable gases. Most complaints, apart from burns, seem to have been about the effect of gases on the eyes and in a general depressing of spirits. Many of the sufferers were treated at Guy's Hospital but several did not survive and it is evident from the extracts, that the company provided compensation for the widows and orphans. In order to lessen the sickness they had tried scattering chloride of lime on the tunnel floor.

Suffocating gases were a hazard to those descending wells, cesspits and sewers. It was recommended that a caged bird or guinea pig be lowered first to detect any accumulation of such gases, but this precaution was not always taken and cases of asphyxia occurred.[4] Workers

[1] Explosions are dealt with in more detail in the section on accidents, pages 268-288.

[2] Cox (1857), p425.

[3] David Lampe *The Tunnel* (1963), pp164-165 and pp180-181.

[4] *B.M.J.* 1887 April 2nd, p743; *J.S.A.* 1876 January 21st, p147.

around limekilns or others in the vicinity were often overcome by a mixture of sulphur fumes and carbon monoxide which could prove fatal.[1] An example of such is a report in the Salopian Journal of 1822, originating from the Cornwall Gazette. This case also illustrates the lack of precautions taken, even after one fatality had occurred.

> "A man having occasion to light the limekiln, went down from the kiln head, as is usual in such occasions, to make a hole, or what is termed a chimney, with a rod of iron, when he was suffocated by the gas arising from the culm. A second man went down to his assistance, who instantly shared a similar fate. A third followed and also lost his life. A fourth man had still the courage to descend to the assistances of his unfortunate companions; he took the precaution, however, to tie a rope round his middle, but was no sooner down that he dropped as the others had done. He was immediately drawn up senseless, and after a considerable time restored to life. The three men who had descended the fatal kiln were after much difficulty drawn up quite dead. It is lamentable circumstance that each of the sufferers has left a wife to deplore his untimely fate; and the children of the three families amount to twenty."[2]

The question of noxious vapours in general was studied extensively in 1876, 1877 and 1878 by Dr Ballard in three reports to the Local Government Board.[3] His concern was more with the environmental aspects of effluvium nuisances from various manufactories and branches of industry than on the diseases contracted by working people, and was involved with much wider issues than health and safety at work. However, the reports are helpful in identifying many of the gases involved and Arlidge drew heavily on them when writing about noxious vapours in 1892.[4] The general conclusions

[1] *W.J.* 1865 March 25th; 1868 September 6th.

[2] *The Salopian Journal* 1822 June 12th.

[3] Dr Ballard 'On the effluvium nuisances arising in connexion with various manufacturing and other branches of industry' 3 reports:
6th Annual Report to the Local Government Board 1876-1877;
7th Annual Report to the Local Government Board 1877-1878, pp84-138;
8th Annual Report to the Local Government Board 1878-1879, pp42-320.

[4] Arlidge (1892), pp471-529.

of Ballard appear to have been that although many vapours were offensive to the sense of smell and thus might irritate the stomach, there were no long-sustained ill effects and that it was more a case of inconvenience than illness.

Although there was little discussion of the effects on health of the gases generally found in mines, the effects of the vapours from explosives used underground did cause concern. This was especially true of the explosive roburite, used at the Park Lane Pits in Lancashire, in the late 1880's.[1] Roburite was a mixture of di-nitrobenzene, chloronitrobenzene and ammonium nitrate, and both those handling the cartridges and those present in the areas after the explosion had occurred, claimed that it had a pernicious effect on their health.[2] It was decided to conduct a series of experiments to try and establish whether there were any hazardous effects in using the explosive. The colliers at the Park Lane Pit, who had complained of being poisoned by the vapours, chose Dr Mouncey as their representative and the Garswood Coal and Iron Company appointed Dr N Hannah, the local Medical Officer of Health, to be their spokesman. A third member, Professor Dixon of Manchester, was also appointed as analyst and the Roburite Company itself offered its co-operation. At the time roburite was in general use in forty of the local pits.[3]

The committee was appointed in February 1889 and made its report in June, after a series of experiments had been conducted in the Park Lane pits by Professor Dixon and further experiments carried out in the Roburite Works. They found that any nitro-benzene poisoning from handling the cartridges was usually the result of carelessness and when it was fired, the fumes emitted contained particles of coal and a yellow fatty solid which was free of nitrogen.

[1] *B.M.J.* 1889 February 9th, p315. [2] *B.M.J.* 1889 June 15th, p1371.

[3] *B.M.J.* 1889 February 9th, p315; February 16th, pp371-372; March 9th, pp542-543.

Occasionally nitro-benzene fumes were found but not when it had been fired in well-packed cavities. Some carbon monoxide was produced if fired in coal but not in clay, but it could be counteracted by good ventilation. Hence, in general, the Committee felt the use of roburite was not excessively harmful and with due care in handling cartridges and meticulous attention to ventilation, the ill effects could be kept to a minimum.[1] The Lancashire Branch of the National Association of Colliery Managers in their August and September meetings, continued to discuss the topic and although more interested in the level of flame produced in exploding roburite, also raised questions on the pernicious effects of the fumes. The majority opinion at the meetings seems to have been in favour of the findings of the earlier Committee.[2]

A major new branch of industry was the chemical industry, associated with which were many new, hazardous vapours.

> "The chief vapours which affect him (the workman) are sulphuretted hydrogen, which produces, after inhalation, diarrhoea, rapid pulse, and symptoms of low continued fever; chlorine, the effects of which are transient and less serious, viz. suffocation, cough and difficulties of breathing; nitric acid, the vapour of which gives rise to dryness of the throat and constipation; hydrochloric acid, which produces spasm of the mucous membrane of the nose, mouth and throat. Amongst the less known sources of mischief, according to Dr Richardson, is the vapour of anilines, which induces a peculiar neuraliga, and in marked cases, insensibility, with sometimes ulceration of the skin in the lower extremeties; also vapour of nitro-benzole, which tends to coma and apoplexy."[3]

Some vapours attacked the skin and will be discussed later, but of those inhaled, chlorine was particularly obnoxious

1 *B.M.J.* 1889 June 15th, p1371.

2 *National Association of Colliery Managers Transactions* 1889 Vol.I. Meeting of Lancashire Branch, August 10th 1889, pp167-172; August 31st 1889, pp176-187; September 14th 1889, pp189-195.

3 Phillips Bevan (1876), pp125-126.

for although Phillips Bevan (above) dismissed chlorine as being one of the less serious gases, the immediate effects were disabling. It produced a suffocating cough and difficulty in breathing, even when the workmen were only exposed to a small quantity of the gas.[1] One branch of industry in which workmen were exposed to chlorine gas, was the manufacture of bleaching powder.

The bleaching action of chlorine was first demonstrated by the French chemist Berthollet in 1785. Two years later, Berthollet showed his experiments to James Watt, who brought the idea back to Glasgow. Musson and Robinson (1969)[2] have discussed the numerous problems which occurred in the introduction of chlorine bleaching and the many experiments conducted to obtain improvements. Not least of the problems was the fact that both the fabric and the workmen suffered severely from the effects of the chlorine gas. Pajot des Charmes in 'The Art of Bleaching' (1799) spoke of his having to design a mask with a glass eye piece for bleaching operatives using chlorine bleach because of its suffocating and irritating qualities. To reduce the level of fumes, the practice was soon adopted of dissolving the chlorine in alkaline solutions (soda or potash). In 1798 Charles Tennant introduced the use of milk of lime which was cheaper than both soda and potash. He later patented the idea of using dry lime to absorb the chlorine.[3]

In the early manufacture of bleaching powder, chlorine was made from salt, manganese ore and sulphuric acid but later, chlorine was produced from the recovery of waste hydrochloric acid from soda works. There were two methods

[1] *J.S.A.* 1876 January 21st, p147; M. Wyman *A Practical Treatise on Ventilation* (1846), pp84-85.

[2] A.E. Musson and Eric Robinson *Science and Technology in the Industrial Revolution* (1969), pp251-237.

[3] Pajot des Charmes *The Art of Bleaching* translated by Nicholson (London) 1799; W.A. Campbell *The Chemical Industry* (1971), p63; Campbell also remarks that French workers were recommended to chew liquorice to alleviate the symptoms of chlorine gassing.

which were adopted; the Weldon and the Deacon processes. The Weldon process was evolved between 1866 and 1869 by Walter Weldon and allowed the successful recovery of the manganese used. The Deacon process was worked out by Henry Deacon between 1868 and 1870. This process produced chlorine from hydrochloric acid gas without the use of either manganese or trapping it in towers, but the resultant chlorine was diluted by nitrogen. The method of producing the chlorine dictated the chamber constructed to make the bleaching powder.[1]

Where Weldon chlorine was used, the floor of the chamber was first spread with four to six inches of lime. The chamber was then closed and chlorine gas injected. This was absorbed by the lime and after about four days, the gas was turned off and the excess chlorine extracted. When this had been completed, the doors of the chamber were opened but it was left a further two hours before the workmen were allowed to enter and pack the powder. When Deacon chlorine was used, the chamber consisted of a series of shelves on which the lime could be spread thinly.[2] By far the majority of English bleach in the late 19th century however, was produced by the Weldon process as the cost of erecting such plant was cheaper. Campbell (1971) put the cost of erecting a Weldon plant at £2,877 in 1873, and for a Deacon plant £8,000.[3]

The bleach packers had a hazardous occupation and received far higher wages than workers on other processes.[4] On entering the chamber, they shovelled the powder into a heap to mix it thoroughly and then raked it out into casks.

[1] Campbell (1971), pp43-44 and p67.

[2] 1893-94 The Conditions of Labour in Chemical Works Dept. Cttee. Report (C 7235), pp3-4.

[3] Campbell (1971), p67.

[4] Although Arlidge (1892), p465, maintained that as they were generally paid piece-rates, the evils of the work were aggravated as it encouraged the men to work longer in the chambers.

As soon as the powder was disturbed, chlorine gas was released and it was impossible for the packers to work without the aid of a respirator. The Departmental Committee which examined the trade in 1893, discovered the use of a respirator called a 'muzzle'. This consisted of thirty folds of flannel, dampened and tied tightly over the mouth but with the nostrils free above. The men, in order to work, were forced in inhale through the mouth and 'muzzle' and to exhale through the nose. Due to the thickness of the 'muzzle', a tremendous amount of energy was used in breathing. Some men took further precautions, protecting their legs with folds of thick brown paper and wearing goggles to safeguard their eyes from the irritating lime dust.[1] An interesting point in the Departmental Committee Report was that the packers, themselves, seldom complained about the gas, probably because they only worked short shifts and were highly paid, but those whose work brought them near to the chambers frequently reported that they were affected by the gases.[2]

The only satisfactory solution to the problem was the introduction of mechanical processes. A mechanical bleach chamber was invented by Hasenclever in 1888 and was introduced to Britain by the United Alkali Company. The 1893 Departmental Committee examined some of the mechanical devices and recommended that they be adopted more widely.[3]

The vapour of oil of turpentine also had a marked effect on persons exposed to it. It produced giddiness, disorders of the nervous system, intense headaches and anaemia.[4]

[1] 1893-94 Chemical Works. Dept. Cttee. Report (C 7235), pp3-4; Arlidge (1892), pp465-467; Onthe continent the bleach packers wore helmets supplied with air from bellows outside the chamber. Campbell (1971), p68.

[2] 1893-94 Chemical Works. Dept. Cttee. Report (C 7235), p4.

[3] Ibid; Campbell (1971), p68.

[4] *J.S.A.* 1876 January 21st, p148.

Dr Richardson in his lecture of 1876, claimed that a Frenchman, De Calvi, was the first to identify the vapour of turpentine as the cause of sickness in 1855, but in the British Journal of Industrial Medicine of 1953, there appears a reprint in full, of a book first published in 1825 in London, entitled 'The Painters and Varnishers Pocket Manual' in which is written:

> "Oil of Turpentine, burnt oils of several descriptions, and some other substances used in painting and varnishing give out fumes which, though not a poisonous nature, are apt to occasion a slight sickness at the stomach, accompanied with a headache, and a fainting sensation, to persons whose nerves are not strong; and these effects are frequently felt by young people before they become accustomed to the business." [1]

Hence, it is clear that the symptoms were known much earlier and it is interesting that the booklet was published for members of the painting profession rather than for the doctors. It is an attempt to make them aware of some of the hazards of their occupation. The Manual recommends that if a new employee was continually bothered by the vapours, it was best for him to leave the trade, for a person with weak nerves was likely to suffer ill health all his working life and there were no precautions which they could recommend to ease the problem. The same symptoms were seen in crewmen working cargoes of turpentine as well as painters and decorators on earthenware and china.[2]

Other instances of the ill effects of gases can be found[3] but most discussion of gases at this time, was part of the wider issue of noxious vapours and environmental

[1] Rosen (1953), p197.

[2] *B.M.J.* 1854 February 3rd, pp112-113; 1866 February 24th, p211; Arlidge (1892), p515.

[3] *B.M.J.* 1864 April 9th, p401, sulphurous acid vapour; 1879 November 15th, p783, ammonia in photography; *Chemical News* 1863 May 2nd, p216, effects of sulphuret of carbon; 1867 January 19th, p372, sulphuretted hydrogen in chemical works.

pollution from coal and other smoke. Much of the writing was very evocative, conjuring up descriptions on the destruction of the natural vegetation,[2] but paid little heed to any question of health and safety at work. Legislation was passed in 1863 (The Alkali Works Act) which attempted to control the polluting aspect of Alkali works by requiring the fumes of hydrochloric acid gas to be condensed by at least 95%.[2]

1 Examples of such are: Edward Davies 'Noxious Vapours from Alkali Works' *J.S.A.* 1876 December 8th, pp56-59; *Chemical News* 1870 July 15th, pp27-29; July 22nd, pp37-39.

2 1863 Alkali Works Act, 26 & 27 Vict. C 124.

4. INFECTIOUS DISEASES AND FEVERS

Early attention to industrial hygiene had been concerned with the spread of infectious diseases amongst factory workers and the risk of contagion amongst the local populace. The 1802 Health and Morals of Apprentices Bill had been promoted as a result of an outbreak of fever at a cotton mill at Radcliffe, near Manchester.[1] The incidence of pulmonary tuberculosis was also high in the 19th century and many trades which weakened the constitution, predisposed their workers to early death from this disease.

But certain infectious diseases are connected with particular branches of industry. Of these, those discovered and identified in the 19th century were Weil's disease and ankylostomiasis amongst miners, and anthrax, found amongst woolsorters and handlers of hides and skins. Weil's disease is a form of infectious jaundice and although Weil published an account of it in 1886, it was not until the 20th century that its incidence and wide geographical distribution were recognized. Ankylostomiasis, also known as hookworm or miners' anaemia, caused a skin eruption and later anaemia. It was caused by a small worm which, although identified in 1838, was not traced as being the cause of miners' anaemia until 1882. As the hookworm needs warm conditions in which to breed (between 60° and 75°F), it was frequently found in the mines of Southern Europe but in Britain it only appears to have occurred in some of the Cornish tin mines.[2] Anthrax, however, caused many deaths amongst woolsorters and for much of the century its cause remained a mystery, the deaths being attributed to an illness known as 'woolsorters' disease'.

[1] This outbreak was discussed on pages 21-22. Outbreaks of smallpox were frequent amongst sorters of rags in paper mills. *B.M.J.* 1866 October 6th, pp386-387.

[2] Hunter (4th edition 1969), pp736-738 & 749-755; *B.M.J.* 1882 June 17th, p914; 1887 March 12th, p583.

Anthrax

Anthrax is an infectious disease which is conveyed to man by certain species of animals, chiefly sheep, cattle and horses. It is caused by a bacillus, bacillus anthracis, which was first identified by Koch in 1876, although the disease was recognized in animals long before this. In animals it was commonly referred to as splenic fever. It was particularly prevalent in Russia, Asia Minor, Turkey, Peru, Persia and South America.

In man there are two types of anthrax which are generally described as the external and internal kind. In the former, the infection takes hold through a crack or cut in the skin and first develops into a boil or papule. The normal location is on the face, neck or arms. An inflamed area of pus then appears in the middle, which bursts to produce a black scab about half an inch in diameter. The infection is not as dangerous as the internal form of anthrax but can still be fatal. Internal anthrax, on the other hand, is caused by breathing in spores of the bacillus and it is extremely difficult to diagnose. There are symptoms of acute pneumonia or gastro-enteritis with fever, pains in the chest and rapid respiration. The onset is usually sudden and death may occur within three days.[1]

Those at risk are any who deal with contaminated animals, whether bones, hide, hair or bristles. If an animal, which has died from anthrax, is buried immediately without opening the carcase or removing the skin there is no risk as the anthrax bacillus soon dies, but once the blood of an infected animal is brought in contact with air, the bacilli form resistant spores which are able to remain alive for several years, hence when the hides, fleeces, etc. are removed, any blood on them will contain spores. Occupations which are prone to the disease are such trades as farming, butchering,

[1] Brown (1977), p48.

tanning, brushmaking and, most notorious, woolsorting.[1] In the 19th century, it was first identified amongst the woolsorters of Bradford and as the cause was unrecognized, it became known as woolsorters' disease.

The most dangerous wools were those brought from areas in the world where anthrax was rife. The most harmful of all was Van Mohair, from the Lake Van area of Turkey but other sources of infection were Persian wool, alpaca, camel hair, mohair locks, Cape hair and low quality Siberian and South American horse manes and tails.[2] Many of the bales contained 'fallen fleeces' from diseased animals and were generally offensive to handle. On arrival at the mill, the bales were first broken open and sorted into the various qualities. This was an extremely dusty occupation and was accompanied by the risk of lung disorders common to all the dusty trades but with the additional danger of anthrax.

The manufacture of alpaca and mohair was not introduced to Bradford until about 1837 and it was therefore after this date that cases of the disease were noticed. At first, other than the general risks of lung diseases such as bronchitis from the dust, the occasional, sudden deaths passed with little comment but when, in some instances, several men working together in the same room died mysteriously, within a short space of time, there was alarm.[3] Often the victims were at work one day, went home feeling ill and had died by the next day.[4] The cause of death was recorded as blood poisoning or heart failure and later sometimes the term woolsorters' disease appeared on the death certificate.[5]

[1] Hunter (4th edition, 1969), p721.

[2] Report of the Chief Inspector of Factories and Workshops Year Ending 31st October 1880 (C 2825) Alexander Redgrave's Report, p30.

[3] Alexander Hay *Industrial Curiosities* (1891), p70.

[4] Report of the Chief Inspector of Factories and Workshops Year Ending 31st October 1880 (C 2825), Alexander Redgrave's Report, p32.

[5] *B.M.J.* 1880 July 17th, p114. Registrar General for 1877 recorded one death from alpaca and three from woolsorters' disease.

At times, post mortem examinations were conducted but no real explanation for the disease could be found or any preventative action suggested which would lessen its frequency;[1] although it was felt that there must be some connection with the wool they sorted. An observer commented on the incidence of the disease in the Bradford area in 1880:

> "It has now prevailed and been recognized in this neighbourhood about forty years, and not withstanding all that has been done to prevent it, by ventilation, the use of respirators, and other means, it still continues, as severe and frequent as it ever was, overclouding the life of the sorter with a mysterious shadow, and threatening him daily with death." 2

Although the highest incidence of the disease was to be found in Bradford, cases also occurred in other parts of the country[3] and woolsorting was not the first anthrax-linked occupation to receive Government attention. This was first directed to the Adelphi Horsehair Factory in Glasgow, where, in March 1878, three mysterious deaths had suddenly occurred amongst the young female workers and where four other employees had exhibited symptoms of anthrax in a less acute form. Another girl died in the April and the local Medical Officer of Health, James Russell, made a full investigation which he reported to the Local Government Board.[4] In it he made reference to the possible connection with the disease anthrax as known in animals and the similarity of the symptoms in certain cases.

1 *J.S.A.* 1880 June 11th, p645. Dr Bell, in 1880 considered that scarcely a month passed without some death within the Bradford area occurring from this disease.

2 *J.S.A.* 1880 June 11th, p645.

3 Cases also occurred in Leicester. *B.M.J.* 1880 July 10th, p54; December 18th, p992.

4 James Russell 'Sickness and Health of workers in the Adelphi Horsehair Factory - Glasgow: March - April 1878' *8th Annual Report of the Medical Officer to the Local Government Board* 1878, p321n.

In the same year, Dr J H Bell of Bradford gave a talk to the annual meeting of the British Medical Association on 'Woolstaplers' Disease'.[1] He also noted the resemblance to splenic fever and his own views were that the disease was connected with the decomposition of animal matter within the imported bales. Deaths continued to occur and in 1880, after the death of a woolsorter aged thirty-five, the medical man in attendance certified that the death was due to neglect on the part of the patient's employers because they had not had their wool properly disinfected. The coroner's jury did not uphold this charge against the employer but the case stimulated further interest.[2] In consequence, the Government held its own inquiries under Dr Spear of the Local Government Board and, under the direction of Professor Greenfield, the Brown Institution conducted a series of experiments into the true nature of the disease and any connections with anthrax.[3] At the same time, Pasteur was looking at the problem in France where the disease was called 'charbon'.[4] Dr Bell also continued his researches on the subject in Bradford.[5] As a result of all these investigations, it was found that there was a connection between anthrax in animals and woolsorters' disease in man. Cattle on a farm at Harden near Bradford, suddenly died of splenic fever after drinking water from the washings of a local hair factory where several of the workers had suffered with woolsorters' disease. It was also found that there were anthracis bacilli in the blood of those who had died of the disease and if a sample was inoculated in a guinea pig or mouse, it produced death by anthrax.[6]

[1] *B.M.J.* 1878 August 31st, p319. [2] *B.M.J.* 1880 September 4th, p397.

[3] *B.M.J.* 1880 October 23rd, p656; September 4th, pp397-398; July 24th, pp139-140; 1881 January 1st, pp3-5; January 15th, pp81-82. Report of Professor Brown on Anthrax or Woolsorters' Disease 1881 Veterinary Dept. Privy Council (C 3022).

[4] *B.M.J.* 1880 September 4th, p398.

[5] J H Bell 'On Anthrax and Anthracaemia in Woolsorters, Heifers and Sheep' *B.M.J.* 1880 October 23rd, pp656-657; *J.S.A.* 1880 June 11th, p645.

[6] *B.M.J.* 1880 December 18th, p992; 1881 January 1st, p4.

By 1880 employers and workers in the woolsorting industry in Bradford felt that steps should be taken to try and combat the disease. A meeting was arranged to which Captain May, the Superintending Factory Inspector for Yorkshire, and Mr Beaumont, the Factory Inspector for Bradford, were invited, although it was not within the influences of the Factory Department to enforce regulations as the processes of woolsorting and hairsorting in Bradford were not carried out by either women or children and only a handful of young males were employed. A committee was then set up which drew up a series of regulations which it was felt would reduce the incidence of the disease. The committee recommended that the local sanitary authority in Bradford should enforce these regulations in all factories in the Bradford area which handled noxious wools. The sanitary authority agreed to the recommendations and issued notices of them to all factories concerned. These regulations called for the steeping of bales before opening and then washing the wool or hair in hot, soapy water to a temperature of between 100 and 120 degrees. After that, it was to pass through rollers and be partly dried and then be sorted whilst still damp. Other precautions included improved ventilation, the limewashing of walls and daily sweeping of the floors in the sorting rooms, and a ruling that no food should be taken into or consumed where the bales were opened and sorted.[1]

As in other cases where industrial disease was strongly localized, the local medical society, the Bradford Medico-Chirurgical Society, took an interest in the subject and set up its own committee in 1880. It included both J H Bell and H Butterfield, the local Medical Officer of Health.[2]

1 Report of the Chief Inspector of Factories and Workshops Year Ending 31st October 1880 (C 2825) Alexander Redgrave's Report, pp36-37. This appears to be an early example of a local authority issuing regulations in an attempt to control an industrial disease. For full details of the regulations see Appendix III.

2 *B.M.J.* 1880 August 14th, p279. Other local medical societies which took an interest in industrial health problems were those at Sheffield, see pages 311-312 and London, see page 51.

Within the first year the Committee met upwards of eighteen times and amassed considerable information but issued no report since opinion was divided. One of the members, E T Tibbits, seems often to have been in disagreement with the others.[1] On one point, however, the committee was unanimous:

> "To communicate to employers of woolsorters and other workers in wool, the necessity of some decisive effort to prevent infected material from entering their premises at all; such a rule, for example, as requiring their agents, abroad and at home, to exclude all fallen and suspected fleeces from the bales of wool, whether that be of foreign, colonial, or home growth. Such a rule would at least strike at the root of the mischief so far as woolsorters and woolworkers are concerned, and be the best measure of prevention which can be suggested in the meantime." [2]

Although the rules were generally adopted, deaths still occurred. Mitchell Bros., the largest manufacturer of mohair in Bradford, despite enforcing the rules experienced the death of a worker in July 1884, followed a week later by another death, this time one of their wool carders.[3] Cases occurred in other wool factories amongst workers who were not sorters. By the time the wool had reached the carder in Mitchell Bros. factory it had been steeped for two hours in hot water at a temperature of 130°F, washed in soap and water, sorted in a damp state and then washed a further two times.[4] If after such treatment wool could still on occasions contain harmful bacilli, it is hard to assess whether the Bradford Regulations could have markedly affected the incidence of the disease. Some firms neglected to introduce the preventative measures but employees took action to get them adopted. In one factory the sorters went on strike because the owners would not have the wool washed or steamed

[1] *B.M.J.* 1880 October 16th, p643; 1881 June 18th, p982; June 25th, p1014.

[2] *B.M.J.* 1881 June 25th, p1014. [3] *B.M.J.* 1884 July 5th, p27; July 12th, p76.

[4] *B.M.J.* 1881 June 11th, pp927-928; 1883 June 23rd, pp1224-1225.

before sorting. At another, when the practice of steaming was stopped at a period of peak activity, the sorters refused to sort the wool and were replaced by twenty new men, three of whom were shortly killed by 'woolsorters' disease'.[1]

Interest was also aroused in the leather and hide trades of London where, unlike Bradford, the cases were predominantly of the external type of anthrax. Between 1872 and 1882 St Guy's Hospital treated seventeen cases of anthrax of which four ended in death. Of these seventeen, fourteen were employed as tanners or wharf labourers handling hides. One of the main problems seems to have been a lack of knowledge amongst the workers as to the nature of the disease, some blaming the scabs and deaths on the arsenic used in the trade.[2]

> "Since so great an amount of ignorance to the nature of the disease prevails, as we have shown, both among employers and employed, we would suggest to the Privy Council the advisability of circulating printed notices among the leather warehouses, not only of Bermondsey, but throughout the country, calling attention to the risk of acquiring malignant pustule in the trade, detailing its symptoms, and recommending early application to a medical practitioner." [3]

It would appear that some notice was taken of this recommendation for within a year one of the largest firms of hide brokers had issued its workforce with a description of the disease and instructions of what action to take if they found themselves suffering from the symptoms.[4]

Dr Spear looked at the health of the London hide and skin trade workers for the Local Government Board in 1882,[5] and in

1 Hay (1891), p73.

2 *B.M.J.* 1883 March 10th, pp459-460; March 17th, p527.

3 *B.M.J.* 1883 March 17th, pp527-528.

4 *B.M.J.* 1884 May 31st, p1053.

5 *B.M.J.* 1884 May 31st, p1052.

1895 Dr Hamer made a similar report for the London Council. He had information of 118 cases which had occurred within the preceding twenty-one years. Of these, twenty-six had proved fatal.[1] It was not as easy to issue rules on precautionary measures in hide handling and tanning as it had been in the woolsorting trades, since disinfection and steaming of the hides destroyed some of their qualities. The most which could be done was a general increase in the awareness of the risks involved and quick action whenever any of the symptoms arose. Again, the industry was outside the scope of the Factory Acts.[2]

Anthrax was made a notifiable disease under the Factory Department from 1st January 1896.[3] This was announced in 1895, the same year as the Home Office appointed another Committee to inquire into woolsorting, bone and hair factories, brushmaking, the work of furriers and tanners and any other employments in which anthrax occurred.[4] The report was issued in 1897, almost coinciding with the death of another workman from anthrax. The committee believed that the only effective method of prevention was to adopt Dr Bell's recommendations of disinfecting and steaming the bales before sorting.[5] Cases of neglect still occurred. An inquest at Bradford in 1899 found that bales had not been disinfected or opened and sorted under a down draught. In another case, the fans had not been emptied as often as necessary and had become clogged with dust.[6] Cleaning fans was a risky operation and it was generally advised that it should be carried out twice a week and that the operator should be free from cuts and wear a respirator. The Coroner at another inquest recommended that before the floors were swept, they should first be sprinkled with carbolic acid.[7]

[1] *B.M.J.* 1894 August 18th, p380.

[2] Ibid.

[3] *B.M.J.* 1895 July 6th, p37.

[4] *B.M.J.* 1895 November 30th, p1372.

[5] *B.M.J.* 1897 July 24th, pp231-232.

[6] *B.M.J.* 1897 September 4th, pp614-615; 1899 February 25th, p494.

[7] *B.M.J.* 1897 May 29th, p1370.

It would thus seem that much effort was put into making people aware of the problem of anthrax and to take preventative action but by the end of the 19th century it was still believed that the disease was only contracted by handling dirty or offensive wools. In the early 20th century F W Eurich, a physician to the Bradford Royal Infirmary, made investigations which enabled him to cultivate anthrax bacilli from wool and he showed that the strong adherence of blood and serum to the wool allowed them to persist both in clean fleeces and in wool which had been washed and scoured, besides that which looked offensive.[1] The disease was eventually controlled by the provision of adequate exhaust ventilation and the setting up of a Government Wool Disinfecting Station at Liverpool Docks in 1918. Here the bales were carried automatically into an enclosed bale opener and then passed through a series of enclosed disinfecting troughs. This process, known as the Duckering process, helped to reduce the exposure of the worker to anthrax bacilli. Workers were provided with protective overalls and gloves but unfortunately some of the men did not wear the gloves and cases of cutaneous anthrax did occur. The risk of mortality was reduced however when it was found that the anthrax bacilli was sensitive to antibiotics. Safe immunisation against anthrax is also now available.[2]

[1] Hunter (4th edition, 1969), pp722-723.

[2] Ibid. pp729-733; Brown (1977), p48.

5. SKIN DISEASES AND OCCUPATIONAL CANCER

Most of the occupational diseases reported today involve skin disorders, for although the skin has remarkable protective properties, it can be injured by the materials used in industrial processes. As skin disorders are easily observable, it is not surprising that reference is found to them in 19th century journals,[1] although bearing this in mind, the frequency of reports is not perhaps as great as might be expected. Possible explanations include a higher incidence of other occupational diseases, or the possibility that skin disorders were so minor and commonplace that little significance was attached to them, or that the disorder was not directly associated with occupation. Some doctors, at least, were aware of possible connections between occupation and skin diseases for in 1854 the journal of the Society of Arts contained a letter from a doctor attendant at the Hospital for Diseases of the Skin.[2] He was concerned that in an earlier discussion on occupational diseases within the Society, no reference had been made to skin ailments. Table IX shows the number of patients seeking relief from him at the hospital on three days in 1854. From this, it can be seen that a wide variety of occupations were represented although certain common sources of irritation can be identified, namely, flour, sugar, lime and soda. Nevertheless skin ailments, especially amongst miners, had been noticed several hundred years before the period in question,[3] although it was not until 1776 that any attempt was made to try and classify the various lesions observed by type, and the first person systematically to describe and identify occupational skin complaints was Robert Willan in 1798.[4]

1 E.g. *B.M.J.* 1870 February 5th, p132; 1881 October 15th, p627; 1898 September 3rd, p648; *J.S.A.* 1854 June 23rd, pp543-545.

2 *J.S.A.* 1854 June 23rd, pp543-545.

3 Such as Celsus *De Re Medicina* in the 1st century AD and Agricola *De Re Metallica* 1556.

4 Hunter (4th edition, 1969) pp767-768. Von Plenck had attempted to classify skin ailments in *Doctrina de Morbis Cutanei* (1776) and Robert Willan identified occupational cancer in *Description and Treatment of Cutaneous Disease* (1798).

TABLE IX: Persons applying for relief at the hospital for diseases of the skin on May 31st, June 2nd and June 7th, 1854.

Trade	Age	Number of years in present employ	Disease	Duration of Disease	Parts Affected
Grocer	18	2½	Eczema[1]	11 mths	Hands and arms
Baker & Confectioner	20	9	Psoriasis[2]	2 yrs	Entire body commencing with hands
Plasterer	48	20	Impetigo[3] & Eczema	10 yrs on and off	Arms and chest
Baker	19	2	Eczema & Lichen[4]	9 mths	Both hands and wrists
Brass filer	17	4	Eczema	2 yrs	Hands, Arms, Face
Baker	23	12	Eczema	1½ yrs	Entire Body
Washerwoman (using soda)	42	12	Psoriasis, Eczema & Impetigo	6 yrs	Arms, Hands, Legs.
"	30	7	Eczema	5 mths	Arms and Hands
"	60	20	Psoriasis & Eczema	8 yrs on and off	Hands and Arms
Potboy (from sugar in beer)	45	5	Impetigo & Eczema	2¼ yrs	Hands and Wrists
Washerwoman	55	8	Impetigo & Furunculi[5]	1 mth	Hands, Arms, Chest
Whitesmith	19	4	Psoriasis Palmaris	2 yrs	Palms of Hands
Plasterer	40	24	Eczema	1 yr	Hands and Body
Galvanised Iron Worker	31	1	Psoriasis Palmaris	1 yr	Palms of Hands
Glass & China Washer using soda	46	2	Severe Eczema & Impetigo	1 yr	Hands, Arms, Face & Body commencing in Hands.

continued

TABLE IX: Continued

Trade	Age	Number of years in present employ	Disease	Duration of Disease	Parts Affected
Shoemaker	25	10	Psoriasis Palmaris	1½ yrs	Palms of Hands
Bricklayer	44	20	Impetigo, Furunculi & Anthrax 5	2 mths	Hands, Arms & Shoulder
Dyer	56	20	Eczema	6 mths	Hands, Arms
Dyer	43	22	Impetigo & Eczema	20 yrs on and off	Hands and Arms but sometimes whole body
Grocers porter (now on railway)	23	6	Impetigo	6 yrs	Hands, Arms, Face
Schoolboy (using soap lees)	11	-	Eczema	1 mth	Hands, Arms, Face and Head
Bricklayer's labourer	21	2	Lichen	1 yr	Entire Body
Boy (using turpentine and palm oil)	7	-	Eczema	2 wks	Entire Body
Slopmaker with lime dressed calico	22	2	Psoriasis	1 yr	Hands, Arms, Body
Typefounder	40	20	Impetigo & Furunculi	2 mths	Hands

Source: *J.S.A.* 1854 June 23rd, p544.

References:

1. **Eczema = watery vesicles or spots with rawness and redness of the skin.**
2. **Psoriasis = red scaly spots and patches.**
3. **Impetigo = mattery pustules, with much inflammation and swelling.**
4. **Lichen = dry raised pimples.**
5. **Furunculi & Anthrax = boils and abscesses which may become carbuncular.**

Skin ailments can vary from anything from mere hardening of the skin, through itching, burning or rashes, to more serious pustules, warts, ulcers and malignant growths. The usual area of infection, as illustrated in Table IX, is any exposed skin, especially the hands, face or neck, but other areas of the body can be contaminated and where fitters, engineers and the like, work in oil clad overalls, injuries can be found on the legs and thighs. Although some irritating agents cause very characteristic lesions, such as chrome compounds and salts, the majority have many symptoms in common which makes both diagnosis and treatment more difficult.

The causes can usually be traced to the mishandling of materials, to careless practices or to a lack of cleanliness. There are four main categories of agents which can cause skin troubles. These are physical factors, plant products, living organisms and chemical substances.[1] In the case of chemicals, two different types of reaction can be observed. Some chemicals cause direct damage to the skin by penetration of the outer layer, the epidermis, attacking the lower skin layer, the dermis. These are known as primary irritants and cause the same reaction in all who handle them at the time of exposure. It was this type of reaction which was noticed in the 19th century as being an occupational hazard, as the cause was more easily identifiable. Other chemical agents, however, have a sensitizing effect, which is referred to as contact dermatitis. The substance is not initially irritating but repeated exposure may change the composition of the skin's protein, thus making it allergic to the chemical, building up an immune memory which can last for years after the original exposure even after the chemical is no longer present. This kind of dermatitis is particularly difficult to treat.

[1] Hunter (4th edition, 1969), p769.

[2] Stellman & Daum (1973), p54-61 .

There are numerous physical factors which can give rise to disorders of the skin. A general hardening of the skin or formation of callosities due to the pressure of holding the tools of the trade can occur in many occupations. Arlidge commented on the hardening seen in the palms of japanners and the general flattening of the hand which was a result of the practice of rubbing the finished articles with the palm of the hand covered in rotten-stone, in order to give it a smooth surface.[1] The result of pressure and friction on the skin was observed by the Children's Employment Commissioners in their 1842 report on mines, where they noted that the practice of pushing the corves with the head rendered many children denuded of hair even if they had taken the precaution of wearing a padded cap.

> "The hair is very often worn off bald, and the part is swollen so that sometimes it is like a bulb filled with spongy matter, so very bad after they have done their day's work, that they cannot bear it touching." [2]

Another result of undue pressure is the swelling of a bursa.[3] Thackrah mentions the case of housemaid's knee and the British Medical Journal gives occasional reports of operations to try and relieve this complaint as, although not serious, it was quite painful.[4] In miners, other areas of the body where swellings were observed were the hips and knees.[5]

Extreme variations in temperature can also cause skin disorders. The Children's Employment Commissioners reported that:

1 Arlidge (1892), p518.

2 1842 Children's Employment Commission. First Report of the Commissioners (Mines), pp186-187.

3 Bursa = a natural space containing a little fluid situated in fibrous tissue at a point where there is constant pressure or friction. For example, the elbow, knee or shoulder joint.

4 Thackrah (2nd enlarged edition, 1832), p50; *B.M.J.* 1858 August 14th, p677.

5 Arlidge (1892), p551.

"Sometimes, when amongst the salt water, the heat brings out boils about the size of a hen's egg upon him (the miner) about his legs and thighs, and under his arms sometimes. A vast (number) of the boys, men and all, have these boils at times. These boils, perhaps, last a fortnight before they get ripe, and then they burst. A great white thing follows and is called a 'tanner'." [1]

Many plants, fruits, wood dusts and resins produce irritating substances to the skin. Those affected are horticulturists, gardeners, field labourers, fruit pickers and hop pickers, although the only reference to plant disorders of the skin in the 19th century was amongst those who handled quinine. Arlidge stated that this had first been observed in 1852. Those powdering the quinine suffered a mild irritation but more serious was quinine eczema which came on suddenly:

"seizing on the exposed parts of the skin, causing redness, swelling, itching, and burning smarting pain. From these parts the eruption spreads widely over the body, and by its partiality to the genital organs, is a cause of great annoyance. It is truly vesicular, and at times a patch of vesicles will run together and produce a superficial ulcer; on which a crust may form; but no elevation of temperature occurs."

It appears that although it reacted favourable to treatment, after some improvements, it often recurred in a more severe form.[2]

Living agents causing skin diseases include mites, fungii and bacteria. Dermatitis caused by mites, was recognised in the 19th century amongst workers in flour and sugar. The fermenting grain used by starch makers caused an eruption of the skin[3] and bakers and millers were also reported, frequently, to suffer from the handling of grain and bran.

[1] 1842 Children's Employment Commission (Mines) (380), p187.

[2] Arlidge (1892), p395.

[3] Thackrah (2nd enlarged edition, 1832), p53.

The irritation set up was known as 'Bakers' Itch' and was usually put down to neglect in washing.[1] Amongst sugar workers the complaint was known as 'Grocers' Itch'.[2] Arlidge reported on the mould and fungii in hay as causing a measle-like eruption on the skin,[3] and it has already been shown how anthrax bacilli caused malignant pustules on the skin of woolsorters, tanners, and others handling the fleeces or hairs of infected animals.[4] Few other examples of skin disorders caused by living organisms can be found in 19th century sources. The British Medical Journal for 1881 gives a report of an unusual case of a sheep shearer who, after his work, developed red spots on his hands which swelled up becoming hot, sore and confluent so that his hands appeared to be twice their normal size. This condition continued for about a week, with the infection spreading to any part of his body which he touched with his hands. Then the eruption subsided and died away.[5] One is forced to conclude that it was only the unusually severe case which was considered worth reporting, the more commonplace rashes caused by mites and insects being considered insignificant and causing little obstruction to employment.

As the use of chemicals in industrial processes increased, the number of cases of skin complaints caused by chemicals grew, particularly those which had a primary irritant effect. One source of danger was the many acids in use. Sulphuric acid was reported by Thackrah to cause corrosion of the fingers in felt hat makers and wire drawers.[6] Other acids recorded by Arlidge as harmful were fluoric acid, as used by etchers on glass and china, and nitric acid when used by jewellers to

[1] *J.S.A.* 1854 June 23rd, p543; *B.M.J.* 1878 August 17th, p244; Thackrah (2nd enlarged edition, 1832), p199; Arlidge (1892), p386.

[2] Thackrah (2nd enlarged edition, 1832), p121; *B.M.J.* 1878 August 17th, p244.

[3] Arlidge (1892), p388.

[4] For discussion on anthrax see pages 195-203.

[5] *B.M.J.* 1881 October 15th, p627.

[6] Thackrah (2nd enlarged edition, 1832), p54 & p122.

brighten their products.[1] The vapours from carbolic acid were observed to turn the skin brown, continued exposure causing it to peel. Chlorine gas, produced in the manufacture of bleaching powder, had the immediate result of causing a papular eruption on all exposed parts of the body. In an attempt to counteract this, the men were in the habit of applying grease to their exposed skin before entering the chambers.[2] Another vapour said to be harmful was naphtha.[3]

Skin reactions could be caused by hazardous dusts. Anything containing lime dust presented a danger as it set up an immediate irritation. This was noted amongst bricklayers, lime workers and cement mixers.[4] Boys grinding mother-of-pearl were apt to get eczema[5] and dusts produced during brass polishing, bronzing or in processes using arsenic caused skin eruptions.[6] One group of substances which caused particularly characteristic lesions were chrome compounds. The lesions were first noticed in connection with chromate of potash but the same was true for compounds of chromic acid with soda and lime. They primarily attacked the membrane in the nose, causing ulceration which led to perforation and complete destruction of the nasal septum.[7] It also caused the characteristic 'chrome holes' on any exposed skin,[8] identified by their great depth and stubborness to react to treatment:

1 Arlidge (1892), p196 & p520.

2 *B.M.J.* 1885 May 9th, pp946-947; Arlidge (1892), p467 & p520.

3 *B.M.J.* 1878 August 17th, p244; Arlidge (1892), p221.

4 Thackrah (2nd enlarged edition, 1832), p55; Arlidge (1892), p328.

5 1862 Children's Employment Commission (3414), p146; Arlidge (1892),p324.

6 *B.M.J.* 1878 August 17th, p244; Arlidge (1892), p451 & 455; 1896 Interim Report of the Dept. Cttee. on Miscellaneous Trades (C 8149), pp7-8.

7 Septum = partition. In this case the nasal septum which divides the two sides of the nasal cavity.

8 1893-1894 The Condition of Labour in the Chemical Works. Dept. Cttee. Report. (C 7235), p7.

> "The caustic action is so great it does not cease until it has penetrated to a bone. The pain of ulceration is excessively severe." 1

When the ulceration did eventually heal, it left noticeable scars.[2] The Departmental Committee which looked into chemical works in 1893, recommended that:

> "The cleansing of the exposed parts of the body by frequent ablutions and the protection of the hands by waterproof gloves in those who manipulate the chrome products, afford, in our opinion the best means of preventing the evil effects." 3

Over the period, various other chemicals were revealed to have effects on the skin. Cynide of potassium used by electro-platers caused ulcers on the hands,[4] and there were many skin ailments associated with the bleaching and dyeing trades. Arlidge observed a painful eczema in workers bleaching linen, which occurred within twenty-four hours of commencing the task. The introduction of aniline dyes in 1856 brought new hazards. Workers with the dye developed ulcers on their legs which only healed when they ceased the work. There were also reports of eczema in weavers of the finished dyed articles.[5]

Aniline can also cause cancerous growths in the bladder. Although this was discovered within the period in question, a case being reported by Rehn in Germany in 1895,[6] the main concern with occupational cancer in the 19th century, was with cancer of the skin. This cancer was clearly visible and the link between the occupation and disease was more

1 *J.S.A.* 1876 February 11th, p204. 2 Arlidge (1892), p470.

3 1893-1894 Chemical Works Dept. Cttee. Report (C 7235), p7.

4 Arlidge (1892), p468.

5 *B.M.J.* 1870 February 5th, p132; 1878 August 17th, p244; Arlidge (1892), p387, p403, p524 and pp508-509.

6 Hunter (4th edition, 1969), p827. R A M Case & Others 'Tumours of the Urinary Bladder in Workmen engaged in the manufacture and use of certain dyestuffs intermediants in the British Chemical Industry' *B.J.I.M.* 1954, Vol. 11, p75. T S Scott 'The Incidence of Bladder Tumours in a Dyestuffs Factory' *B.J.I.M.* 1952, Vol. 9, p127.

apparent. The only other internal cancer linked with occupation which was identified towards the end of the 19th century, was that lung cancer in relation to arsenical dust. Haerting and Hesse, studying the Schneeberg miners in 1879, showed a connection between the inhalation of arsenical dust and the formation of a malignant growth in the lungs.[1]

With regard to occupational cancer of the skin, this had, in fact, first been recorded in 1775, when Percivall Pott, a surgeon at St Bartholomew's Hospital,[2] published his accounts of observations made on chimney sweeps' cancer:

> "It is a disease which always makes its first attack on, and its first appearance in, the inferior part of the scrotum; where it produces a superficial, painful, ragged, ill-looking sore, with hard and rising edges. The trade call it the soot-wart. I never saw it under the age of puberty, which is, I suppose, one reason why it is generally taken both by patient and surgeon for venereal." [3]

The disease began as a soot wart on the scrotum, which could remain in existence for several years without causing any further problems but would then suddenly ulcerate and spread. Various forms of treatment were used, including removal of the ulcer, although in many instances the disease reoccurred especially if the occupation of chimney sweeping was continued. Although the number of cases reported each year were not great at the beginning of the 19th century, they appeared with regularity in the medical journals.[4] After the 1860's

[1] *B.M.J.* 1879 April 19th, p599; Hunter (4th edition, 1969), p814 'Studies in the Incidence of Cancer in a Factory Handling Inorganic Compounds of Arsenic' *B.J.I.M.* 1948, Vol. 5, p1. Richard Doll 'Occupational Lung Cancer: a review' *B.J.I.M.* 1959, Vol. 16, p181.

[2] For biographies of Percivall Pott see: John Brown & John Thornton 'Percivall Pott (1714-1788) and Chimney Sweepers' Cancer of the Scrotum' *B.J.I.M.* 1957, Vol. 14, pp68-70. M D Kipling & H A Waldron 'Percivall Pott and cancer scrotti' *B.J.I.M.* 1975, Vol. 32, pp244-246.

[3] From P. Pott *Chirurgical Observations Relative to the Cataract, the Polypus of the nose, the cancer of the scrotum (etc.)* 1775 - reprinted in full in John Brown & John Thornton (1957), p69.

[4] *The Lancet* 1824 February 15th, p229; 1825 September 10th, pp318-319; 1827 September 15th, p764; 1835 November 21st, pp312-313; *The Medical Times* 1844 July 27th, pp356-357; *B.M.J.* 1856, July 12th, p581; 1868 April 11th, p351; 1882 March 25th, p424.

the appearance of such case notes became rare, supporting the supposition that the disease was on the decline.[1]

It was believed that with greater attention to cleanliness and the substitution of mechanical devices for climbing boys, the problem of chimney sweeps' cancer would be reduced. Pressure for reform of the legislation relating to climbing boys was forthcoming from several quarters. This was not due to any widespread knowledge of chimney sweeps' cancer, but because of the poor conditions in which the boys lived and worked. They were often forced to ascend hot, narrow chimneys in which they not only got bruised and burned, but in which they sometimes suffocated. Jonas Hanway had drawn attention to their plight in 1773 and several literary figures such as William Blake (1789), Charles Lamb (1823), Charles Dickens (1837) and Charles Kingsley (1863), recorded their sufferings in poems and prose.[2] Many suggestions of mechanical devices were forthcoming. The Transactions of the Society of Arts in the first two decades of the 19th century, contain several descriptions and diagrams of such machines, after a premium had been offered for new methods of cleansing chimneys in 1796.[3] In 1803, the Society for Superceding the Necessity of Climbing Boys, by Encouraging a New Method of Sweeping Chimneys and for Improving the Condition of Children and Others Employed by Chimney Sweepers was formed, through which pressure was put on the Government to take action. This was documented by M D Kipling and H A Waldron in their article of 1975.[4]

[1] *J.S.A.* 1876 February 11th, p207.

[2] Hunter (4th edition 1969), pp140-145; William Blake 'The Chimney Sweeper' in *Songs of Innocence* (1789); Charles Lamb 'The Praise of Chimney Sweepers' in *Essays of Elia* (1823); Charles Dickens in *Oliver Twist* (1837) and Charles Kingsley *Water Babies* (1863).

[3] *T.S.A.* 1796 Vol. XIV, p97; 1805 Vol. XXIII, p255-266; 1807 Vol.XXV, pp97-100 & pp101-106; 1809 Vol. XXVII, pp209-219; 1815 Vol. XXXIII, pp131-136; 1817 Vol. XXXV, pp184-185; 1819 Vol. XXXVII, pp128-130; 1820 Vol. XXXVIII, pp73-75.

[4] Kipling & Waldron 1975, pp244-246.

The first legislation had been introduced in 1788, prohibiting the employment of any apprentice under the age of eight. Despite attempts to amend this further in 1817, 1818 and 1819, when proposed measures were thrown out of the Upper House, no further legislation was passed until 1834, when the minimum age for apprentices was raised to ten and some guidelines on the construction of chimneys and flues stipulated. Provisions were made to raise the age of apprenticeship to sixteen in an Act of 1840, which also stated that no-one under twenty-one should be allowed to sweep a chimney but the 1863 Children's Employment Commission found that climbing boys were still employed and an Amending Act of 1864, imposed prison sentences on offenders. A further Chimney Sweepers Act in 1875, introduced a system of licensing which the police were responsible for enforcing.[1]

The introduction of new regulations as well as the fact that the number of cases reported in the medical journals had fallen (although the debate as to the precise cause of sweeps' cancer continued[2]) caused many observers to consider that scrotal cancer amongst sweeps was on the decline.[3] This however was not necessarily true. There had been no change in treatment to warrant further coverage in the journals and cases which followed the normal pattern of events were unlikely to be of interest to readers, hence any supposed decline was more apparent than real. From the Registrar General's supplement in 1885, it would seem that the disease was still fairly commonplace amongst sweeps, as in the three years 1880 to 1882 inclusive, there were 242 deaths amongst this group of workers, of which 49 had died from cancer. Of this last number, 23 had died from cancer of the scrotum or its associated parts, 7 from cancer of internal organs, 6 from cancer of the face, hip, orbit, palate or neck, and for

[1] Ibid.

[2] The debate was between a frictional cause or soot, and it was not resolved until 1922, when Passey showed by experiment that skin cancer could be induced in mice using a soot extract.

[3] Including Kipling and Waldron.

the remaining 13, no organ was specified.[1] Whether this is an increase or decrease on earlier years in uncertain but the fact that 20.25% of sweeps who died in this period did so from cancer of the scrotum, would suggest that this form of cancer still presented a considerable hazard to the occupation.

Henry T Butlin, surgeon at St Bartholemew's Hospital, took up the subject in the 1890's after finding no new material on the subject whilst researching for a book on the operative surgery of malignant diseases in 1887. The result was a series of three lectures presented to the Royal College of Surgeons in 1892 in which he reviewed the incidence of cancer in sweeps and the question of why it was seldom found amongst sweeps on the Continent. After extensive inquiries, he could find no significant decline in the incidence of the disease as had been maintained by other writers. The only reason that he could discover for the Continental sweeps apparent immunity was the more meticulous attention paid to cleanliness and the wearing of more protective clothing whilst in the process of sweeping the chimneys.[2]

Although no progress had been made in treating or identifying the cause of chimney sweeps' cancer, a similar condition had come to light in Scotland amongst operatives in tar and petroleum distilleries and amonst the shale oil workers, an industry which had started in the 1860's. In 1871, Dr Alexander Ogston wrote a report in the Edinburgh Medical and Surgical Journal on the 'eruption of nodules and pimples' where the skin of shale oil workers had been exposed to the oily substance. He identified two kinds of reaction, both an acute and a chronic form. In the acute condition, parts exposed to the crude paraffin were covered with a bright red rash. These were most numerous on the wrists or where clothes

[1] *B.M.J.* 1890 May 10th, p1086; Arlidge (1892), pp280-281.

[2] Henry T Butlin 'Three Lectures on Cancer of the Scrotum in Chimney Sweeps and others' *B.M.J.* 1892 June 25th, pp1341-1346; July 2nd, pp1-6; July 9th, pp66-71.

fitted tightly but were also to be found on the back of the hands, uppers of the feet and to a lesser extent on the face and neck. In the chronic form:

> "the back of the feet and toes, the back of the hands, and the back of the fingers, between but not over the joints, present a honeycombed appearance of the skin. The skin is elevated, thickened and inelastic, so as to prevent and render difficult and painful the flexion of the fingers and hand."

and the whole of the constitution and general health was affected.[1] This condition was confirmed, in 1876, by Dr Joseph Bell, when he wrote on the 'Paraffin Epithelioma of the Scrotum'.[2] Similar observations were made abroad, Professor Volkmann of Halle in Germany in 1875 observing the development of cancerous growths in operatives in brown coal tar and paraffin works. Likewise, in 1885, a report came of the same conditions in tar distillery workers in Ireland.[3]

A controversy occurred in the flax industry over cutaneous eruptions seen in spinners. One school maintained that it was a result of the stagnant and fermenting water in which the flax was steeped; the other, more accurately, found fault with the oil used to lubricate the spinning machines.[4] The use of shale oil for the purposes of lubrication, replacing animal or vegetable oil, had begun to occur from about 1870 and in the early 20th century it was noticed by S R Wilson, a house surgeon at the Manchester Royal Infirmary, that a number of the patients suffering from cancer of the scrotum were mule spinners and not chimney sweeps. He wrote an essay on the subject in 1910, (which was not published until 1922) in which he showed how the trousers of mule spinners were constantly soaked in oil from the necessity

[1] *J.S.A.* 1876 February 11th, p206; Arlidge (1892), p516.

[2] *B.M.J.* 1892 July 9th, p68.

[3] *B.M.J.* 1885 May 9th, pp946-947; 1892 July 9th, p68; Also a report from France from petroleum refineries. *B.M.J.* 1893 January 21st, pp144-145.

[4] Arlidge (1892), pp376-377.

of leaning over a horizontal bar on the top of the spinning machines. This bar was constantly kept moist with lubricating oil thrown off from the spindles.[1] As was realised early on, the only real form of prevention was adequate protective clothing and education on the dangers of the materials handled, together with the need for scrupulous attention to cleanliness. Better designed machinery, provided with adequate guards against splashes of oil, were in some cases beneficial, but such benefits did not come until the 20th century.

[1] Hunter (4th edition, 1969), pp822-823.

6. PHYSICAL AGENTS

Physical agents can be defined as including noise, high and low temperature, eye strain and high and low pressure. In the 19th century, little attention was paid to the problem of noise, the only case cited being that of boiler makers and riveters, who suffered from hardness of hearing.[1] The question of excessive heat and cold was rarely isolated, being usually considered in conjunction with ventilation and workshop design rather than as a problem in itself. Any injury or disease of the eye which impaired vision, however, was seen as being particularly unfortunate, as it could mean the end of gainful employment.

6.a. Eye Diseases and Injuries

The chief occupational risks to the eyes came from injuries caused by chips of metal, stone or similar material, or from splashes of hot molten metal, or acidic and caustic solutions. Other hazards were exposure to extremely bright lights and high temperatures, such as met by furnacemen and glassworkers. Eyes were also subjected to strain when the worker had to carry out his job in a cramped or constrained position. The resultant illness might range from simple inflammation and soreness, through the formation of cataracts and other more complicated diseases, to the loss of sight itself and the necessity of removing the injured eye or eyes. When the Society of Arts set up an Industrial Pathology Committee in 1853, it recognised the frequent occurrence of eye injuries at work and its first, and as it turned out, only report was into trades which adversely affected the eyes.[2]

[1] Arlidge (1892), pp548-549.

[2] 'Report of Committee of Industrial Pathology on Trades which affect the eyes' *J.S.A.* 1854 January 12th, pp119-127.

i) Nystagmus

One occupational group prone to disorders of the eye were the coal miners and the British Medical Journal received the following letter in April 1882 in a plea for information on the subject:

> "Sir - Amongst coal miners the following distressing symptoms are frequently met with, and, in my experience, are very difficult to get rid of. Vertigo sets in, especially in lifting the head after bending, and with it a glimmering and difficulty of steadying the eyes on any object. The air in which they work is good, and there is no cardiac or stomach disease. Their work necessitates lying on the side, with frequent rising. Aperients and tonics have had little effect. A temporary change of work did good; but on returning to the old work, they were soon as bad as before. Any suggestions as to the treatment of such cases will much oblige.- I am etc.,
>
> A Junior Member"

A reply came from Henry Eales of the Birmingham Eye Hospital that the vertigo was probably a result of miners' nystagmus and that the only treatment was to discontinue mining and to improve general health and nutrition. He noted that in some cases, the internal administration of iron and strychnine had been demonstrated to be beneficial.[1]

The question of miners' nystagmus proved to be particularly controversial. Nystagmus is a condition in which the eyeballs show an involuntary rapid movement from side to side or less commonly an up and down or rotatory motion. It was originally only associated with children and seen as incurable. Thackrah had spoken of the intolerance to light amongst underground coal workers, but the first article in an English journal, in which the term nystagmus was applied to the eye disorders of miners, was by Charles Bell Taylor in *The Lancet* of 1875.[2] At the time of writing, Taylor was a

1 *B.M.J.* 1882 April 8th, p526; April 29th, p644.

2 Thackrah (2nd enlarged edition, 1832), p88; Charles Bell Taylor 'Observations on Miners' Nystagmus - A New Disease' *The Lancet* 1875 June 12th, pp821-822.

surgeon at the Nottingham and Midland Eye Infirmary and had observed cases of adult nystagmus from the colliery districts over a period of about twelve years. At first he did not recognise the symptoms as nystagmus, the miners themselves generally attributing their poor sight to one of the frequent accidents underground, but after a time, it was clear by the frequency of the cases and the consistency of symptoms, that it was not caused by accidents.

A typical case study is that of a collier aged 44 from the Kimberley area of Nottinghamshire, who came before C B Taylor in November 1872. This collier had found his vision to be so impaired that it was necessary for him to cease his occupation:

> "He said that on fixing his lamp in order to break up coal the light began to dance about; he turned giddy, objects seemed enveloped in a mist; and he was obliged to desist. On examination with the ophthalmoscope in a light room, the peculiar fanning motion at once developed, and the nature of the complaint made manifest. No disease of the optic disc or eyeballs was to be detected and his health was otherwise good. He was ordered to give up working in twilight or by artificial light, to wear blue glasses, and take strychnine three times a day. Under this treatment he gradually improved and in eight months time he ceased to attend." [1]

The disease generally came on in middle age and the description of seeing the lights dance is common to the majority of cases, often necessitating the collier to give up work for a time. It exacerbated the dangers of mining for if the lights appeared to be dancing, it was harder to see the blue cap on the flame which indicated the presence of firedamp.[2]

[1] Taylor (1875), pp821-822.

[2] References to the lights dancing are found in the following: *B.M.J.* 1873 July 16th, p109; 1887 August 27th, p483; 1891 July 11th, p65; 1892 October 15th, p835. The *B.M.J.* 1893 May 13th, pp1002-1003 tells of the case of a deputy who saw lights dancing whilst going up an incline with another man. He thought it was the sign that a corve or tub had run loose and so dragged his friend clear. His companion said there had been no such lights.

Although Taylor claimed to have discovered a new disease, the first to record and describe miners' nystagmus seems rather to have been the Belgian surgeon, Deconde, who published an account on the subject in 1861 in Annales d'Occilistique.[1] However, this attracted little attention, nothing further appearing in print until 1872 from the German, Schröter. From then onwards, a profusion of literature on the subject seems to have appeared, both at home and abroad. The chief foreign writers on the topic were Dransart, Nedin and Warlomont, and the main contributors from Britain were Charles Bell Taylor, Simeon Snell, Dr Oglesby, J Tatham Thompson, Dr J Court and C S Jeaffreson.[2]

The reason for such a proliferation of literature was the protracted debate about the nature of the causal factors of the disease. From time to time, the stooping position at work or the noxious gases in the pit were blamed but these and similar ideas gained little support. There were, however, two popular causal theories, both of which had a number of advocates. One was that the defective illumination, in particular the light given off by the various safety lamps, was responsible; the other was that the miner's position at the coalface whilst hewing the coal, his eyes being forced to look obliquely upwards, was the underlying problem. The disagreement between these two schools of thought led to a series of letters being sent to the British Medical Journal throughout the 1880's and 1890's, with the ophthalmologic section of the British Medical Association holding a meeting on the subject in the Autumn of 1892 and then publishing a series of articles illustrating all points of view. After the meeting, a resolution was passed for a

[1] However, Dr J E Bell of Bradford, when writing on the early history of the disease in 1892, claimed that the first recorded case of miners' nystagmus at the Bradford Eye and Ear Hospital was in 1858 and during the following years, other cases were frequently seen.

[2] Taylor (1875); Simeon Snell 'Observations on miners' nystagmus and its causes' *Ophthalological Society Transactions* 1884, Vol. IV, pp315-331. J Tatham Thompson 'Miners' Nystagmus amongst South Wales Colliers' *B.M.J.* 1891 February 7th, pp287-288. Dr J Court 'Report on the Examination of the Eyes of Coalminers in Derbyshire' *B.M.J.* 1891 July 11th, p78. C S Jeaffreson 'Miners' Nystagmus' *B.M.J.* 1887 July 16th, pp109-111.

committee to be set up to collect evidence and report in detail on the causes of miners' nystagmus.[1]

The main upholder of the hewing poisiton theory was Simeon Snell. Snell was an ophthalmic surgeon at the Sheffield General Infirmary. His first major paper on the subject was to the Ophthalmological Society in 1884,[2] which was based both on his experiences as a surgeon in Sheffield and previously at Leeds. He continued to make miners' nystagmus one of his main fields of investigation during the remainder of the century, never wavering from his support of the hewing position causal theory.

The reason why he adhered to his position was the fact that most sufferers from nystagmus were those coal miners employed as 'holers'. 'Holing' was the method of coal extraction by which a cut was driven underneath the seam of coal which was then brought down with wedges. As the 'hole' made was generally only about eighteen inches to two feet high and extended underneath the coal seam for about a yard, the men, by necessity, had to work lying on their side. To look upwards continually is in itself tiring, but by lying on his side,[3] the 'holer' was forced to look obliquely upwards which put an even greater strain on the eye muscles and was thus, according to Snell, the predominant factor causing miners' nystagmus.

1 'A Discussion of Miners' Nystagmus' *B.M.J.* 1892 October 15th, pp834-840 consisting of the following articles: 'A Chapter in the Early History of Miners' Nystagmus' J H Bell MD (Bradford) p834. 'A Case of Miners' Nystagmus associated with Double Spasmodic Torticollis' W T Cocking MD Lond. (Sheffield) p835. 'Defective Illumination as the Cause of the Nystagmus and other ocular disorders observed in miners' J Court LRCP Lond. p836. 'The combined influence of attitude and deficient illumination' H Bendelack Hewetson MRCS FL (Leeds) p838. 'Fatigue of Ocular Muscles owing to constrained attitude at Work as the main cause of Nystagmus' Simeon Snell FRCS (Sheffield) p838. 'The importance of imperfect illumination as a factor in the production of Nystagmus' J Tatham Thompson (Cardiff) p839. 'Attitude and deficient illumination both important factors in the production of miners' nystagmus' Priestly Smith MRC p840.

2 Snell (1884), pp315-331.

3 Sometimes referred to as the recumbent posture.

In support of this hypothesis, cases were pointed to where 'holers' suffering from nystagmus experienced a recovery when set to perform other tasks underground but had a recurrence of the illness if they started 'holing' again. Other supportive claims were that miners, presenting themselves at the surgery, often showed no signs of nystagmus until they placed themselves in the position they worked in and the case of the Durham miners was often cited, where virtually no cases of nystagmus had occurred and where the seams were much thicker so that the coal getters could work in a sitting position.[1] Snell made many visits underground in the course of his investigations and his articles are furnished with illustrations from photographs of 'holers' at work, showing the angle of the eye.[2]

On the other hand, writers pointed to the fact that nystagmus occurred more frequently in pits illuminated by the use of the safety lamp, than in those which relied on the use of naked candles. Mr Tatham Thompson of Cardiff, made a survey of the South Wales coalfields where two distinct varieties of coal were mined under very different conditions.[3] The two forms of coal mined were house coal and steam coal. The former was found in low seams where the men worked on their sides as described by Snell but used naked candles. The steam coal, however, was found in much thicker layers but because of the unstable conditions it was necessary, in these pits, to use the safety lamp. Mr Thompson reported that the affliction was unknown in the house coal pits where naked lights were used but that it was frequent in the steam coal pits where safety lamps had been adopted, hence, in his opinion, the defective illumination of pits was more likely to be the cause of miners' nystagmus than the position of the miners at work. The miners themselves tended to blame the

[1] Snell (1884), p326; *B.M.J.* 1884 July 19th pp121-122; 1891 July 18th, p159; August 29th, p476.

[2] *B.M.J.* 1892 October 15th, pp838-839.

[3] *B.M.J.* 1891 February 7th, pp287-288; February 14th, p365.

safety lamp but many doctors put this down to the fact that miners generally tended to resent its use and made it a scapegoat whenever possible. The argument was destined to be prolonged because 'holers' were also those miners who worked in the poorest light, hence both hypotheses could be supported by at least some of the evidence.[1]

A useful pamphlet on the subject appeared in the 1890's from the pen of Dr Court, after research he had done on coal miners' eyes in Derbyshire. Although Snell criticized him for not going underground himself to observe the position of the miner,[2] Court's examination appears to have been thorough. He compared workers from both the naked light and safety lamp pits and also looked at the methods of coal winning underground. In all, he examined 1,097 miners of whom 524 worked with safety lamps and 573 with naked lights. Of the former group, 164 or 31% suffered from nystagmus, whereas in the latter group, the number was only 32 or 5.8%.[3] This view, that defective illumination was the cause, finally was to triumph when it was upheld by the Congress of Ophthalmology held in Oxford in 1912 and supported by the careful study published by Dr T L Llewellyn in the same year. Llewellyn had found that nystagmus was six times commoner in pits worked with safety lamps than in thos worked by naked lights. He also found that 2% of all underground workers, that is about 10,000 men and boys, were unable to work due to the disease.[4]

[1] *B.M.J.* 1887 September 17th, pp623-624; 1890 August 2nd, p313; August 19th, pp422-423; August 23rd, p480. In an obsession to uphold a particular point of view the height of the miner was sometimes brought into question as explaining an inconsistent case.

[2] *B.M.J.* 1892 October 15th, pp838-839.

[3] Court (1891), p78.

[4] Hunter (4th edition, 1969), p857; Benson (1980), p46; T L Llewellyn *Miners' Nystagmus* (1912).

However, despite all the time and space devoted to the arguments as to cause and incidence, no progress was made in the recommended treatment. It remained the same as that suggested to the Junior members' inquiry in 1882. As to preventative measures, the doctors again had little to suggest, as the British Medical Journal wrote after the publication of Dr Court's pamphlet:

> "Dr Court is of the opinion that the nystagmus is due, not to the position assumed by the miner in holing, as is maintained by Mr Snell, but to the defective illumination. But upon the question of a practical remedy Dr Court does not throw more light than a Davy. 'Surely', he says, 'Science can produce a safety lamp, which will be equally safe as the Marsaut, with much greater illuminating power, and at the same time cast a smaller shadow'." [1]

Even if the correct cause had been identified in the 19th century, there was little that could have been done to remedy the situation for developments in electric lighting were required before illumination in the pits could be sufficiently improved. These advances were made at the same time as the cause of the disease was finally isolated. The numbers suffering from nystagmus reached a peak in 1922, when 4,092 cases were recorded (1 in every 225 miners employed underground) but by 1938, numbers had fallen to 1,224 cases (or 1 in every 510). [2]

Occasionally, nystagmus was reported in other occupations, for example amongst compositors, painters and metal rollers,[3] but most of these reports were made by Snell in his attempts to illustrate that miners' nystagmus was caused by position not bad lighting. Such cases were always referred to as being less marked than those of colliers and probably more attention has been given to them than was warranted due to the obsession with identifying the cause of miners' nystagmus.

[1] *B.M.J.* 1891 July 11th, p78.

[2] Hunter (4th edition, 1969) p862.

[3] *B.M.J.* 1891 July 11th, p74; 1896 June 20th, pp1503-1504; Arlidge (1892), p555.

Many trades, including the above mentioned, were associated with simple eye strain and inflammation and the recorded cases of nystagmus may well have been amongst people who already had poor vision before taking up their trade.[1]

ii) Eye Strain

The report of the Society of Arts on occupational eye diseases, included those caused by overstrain and poor light. The Committee had expected to find eyes being damaged by craft work but they discovered that there was a much lower incidence than anticipated and that in many instances,

> 'many of the affections quoted seem due rather to ignorance or neglect of well known hygiene laws, than to anything essentially connected with the occupation of the workmen." 2

Those workers commonly assumed to suffer from eye strain and inflammation were engaged in the sewing trades of tailoring, dressmaking, shoemaking, etc.; and those engaged in the printing processes as well as those working on small goods which required great precision such as watch and clock makers and jewellers. It was generally held, that as a result, they suffered premature exhaustion of the optical powers. However, Arlidge disputed this and made enquiries at the Birmingham Eye Hospital where jewellers suffering from eye complaints might be expected to have sought treatment. From the senior surgeon, he learnt that although patients from these trades did seek relief at the Infirmary, they were usually people who had unhealthy eyes anyway and were therefore unfitted for the trade.[3]

1 This could also, of course, be argued about the cases amongst miners, but here the numbers suffering were greater than might be naturally assumed to have had bad eyesight.

2 *J.S.A.* 1855 January 12th, p119.

3 Ibid.; Thackrah (2nd enlarged edition, 1832), p49; Arlidge (1892), p193 & p199; Phillips Bevan (1876), p182.

The above mentioned occupations were indoor ones and were often conducted in inadequate lighting (i.e. insufficiently bright or frequently wrongly positioned). Both candles and unprotected gas lamps produced flickering, unsteady lights which added to the problem. Compositors often worked under these conditions, and due to the fact that the gas lamps were usually placed in close proximity to the work, the eye was exposed to the full glare of the flickering light.[1] This could easily be cured by attaching glass chimneys to the lamps, preferably tinted blue, to cut down the glare, at a cost, according to John Simon, of only 6d. He felt that it was,

> "quite monstrous and inconsistent with commonsense, that they were not universally adopted. He felt that the Society of Arts had very properly taken up the subject, for he was sure, when compositors knew what was the cause of their blindness, and how easy was the remedy, they would not run the risk of being reduced to penury and pauperism by the want of chimnies for their lamps." 2

With dressmakers the problems of artificial lighting were made worse by the fact that they believed the white fabrics to be soiled by the smoke given off by gas lamps and so they tended to sew white material by day and black by night. The black material caused more eyestrain generally and by sewing by artificial light, the problem was increased. Other colours observed to be injurious to the eyes were the shades of red, especially scarlet, and amongst book binders, those employed as finishers were often near sighted supposedly from the glare of staring at gold leaf for most of their

[1] *J.S.A.* 1854 June 9th, p496; *B.M.J.* 1869 September 18th, p332; Arlidge (1892), p201.

[2] *J.S.A.* 1854 June 9th, p496. When shades were used defective vision was not such a problem. In the 1854 report Mr Cousins of Camden Town, wrote of their use amongst the compositors in the Times Office. Two hundred men were employed there, and the sick fund showed only one case of a man invalided for defective vision and he was 65 and suffering from cataracts. In some cases, it was suggested that the operatives should wear spectacles tinted blue to cut down the glare.

working day.[1] Other factors leading to eye inflammation amongst needlewomen and tailors were the long hours worked and the often overcrowded conditions of the workshop with poor ventilation. These created overheated and tiring conditions of labour which tended to weaken the constitution generally and cause catarrhal ophthalmia.[2] Thus, as the Society of Arts found in their survey, these eye diseases were caused less by the demands of the occupation itself, than by the insanitary conditions under which they were carried out.

Another aspect of occupational risk to the eye was exposure to intense heat or light. This was frequently the case amongst glassworkers and metal smelters.[3] Of these, greater suffering was endured by the glassworkers, in particular the glassblowers who worked near the furnace forming the molten glass into the required shape. In 1891, Alfred Greenwood, the secretary of the Glass Bottle Makers of Yorkshire United Trade Protection Society, noted the frequency with which members of the Society's superannuation fund were drawing on the fund after being incapacitated for work by cataracts. He had himself suffered and was partially blind.[4] The disease is now referred to as Glassblowers' cataract but this weakness of eyesight had been generally observed for some years with Thackrah commenting that amongst glassworkers, the eyesight had usually failed by the age of 50 or 60, and that amaurosis[5] was frequent.[6]

1 *J.S.A.* 1855 January 12th, pp119-122; Mr White Cooper, surgeon, reported that at times of general mourning, more tailors and needlewomen applied for relief due to inflamed eyes; Thackrah (2nd enlarged edition, 1832), p39 red colour and effect on weavers, p44 scarlet and woollen workers, p41 cloth drawers inflamed eyes when drawing scarlet.

2 *J.S.A.* 1855 January 12th, pp119-122 & p125; the latter refers to milliners working 14 to 16 hours a day.

3 Phillips Bevan (1876), p116, also mentions spindle makers who 'stretch' or strengthen the spindles suffering eye affections from the flash of light along the spindle.

4 Hunter (4th edition, 1969), p863.

5 Amaurosis = blindness, in particular the type of blindness that is caused by disease of the optic nerve, the brain or the retina, so that the blind eye looks outwardly normal.

6 See over page.

In iron foundries it was the puddlers and smelters who were most at risk as they were more or less constantly working in intense heat and light, although cases of permanent blindness were rare. Workers in other branches of iron founding were only exposed to such working conditions temporarily and were not unduly affected. In a letter to Dr Arlidge, Dr Atkinson, the medical officer at the London and North Western Railway Company's engineering works at Crewe, stated that he knew of only one case of eye disease amongst the furnacemen there, although the smiths using white heat complained of dimness of vision when removed onto ordinary smith work.[1]

There was a problem of providing protective eyeshields, for furnacemen, as although the usual suggestion for protection against excessive light was tinted glass, here it would not only modify the light but also prevent the workman from knowing when the glass or metal had reached the point of fusion, as this was indicated by the intensity of the light emitted from the fusing substances. In concluding their report, the Society of Arts had no remedy to suggest, although later, in the correspondence of the Society, one of their readers suggested the use of eyeshields fashioned in the same manner as the snow blinkers used by the Laplanders which had narrow slits for vision.[2]

[1] Thackrah (2nd enlarged edition, 1832), pp152-153; Arlidge (1892), p547; *J.S.A.* 1855 January 12th, p121.

[2] *J.S.A.* 1855 January 12th, p120 & p127; January 26th, p164.

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[6] Ramazzini (1964 translation), p63; Thackrah (2nd enlarged edition, 1832), p152; *J.S.A.* 1855 January 12th, p125; Hunter (4th edition, 1969), p863; It was called Glassblowers' Cataract in 1903 by W Robinson. The frequency of cataracts amonst glassblowers, however, had been discussed by the ophthalmological section of the British Medical Association at their annual meeting in Bristol in 1894. *B.M.J.* 1894 September 15th, p582.

At the end of the century electric welding, which exposed workers to very intense light, was just beginning to be used. The ophthalmic section of the British Medical Association discussed the matter in 1894 at their annual meeting:

> "Exposure to this light, however briefly, brought on the most excruciating eyepain, with great swelling and lachrymation. It was felt immediately, but more violently some hours afterwards. Moreover, any part of the skin left bare was burnt or blistered."

Such dangers necessitated immediate protection and the worker made sure that no part of his body was left uncovered. Over the head he wore a helmet, with a shield of six layers of glass, alternatively blue and red. Those assisting the welder, or looking on, held a shield of four thicknesses of glass in front of the eyes. It was realized, amongst those at the meeting, that it was, as they termed it, the 'chemical' rays[1] given off in the process, rather than the heat itself, wherein the danger lay.[2]

iii) <u>Dust and Vapour</u>

The dust and vapours given off in industry were a source of eye inflammation. They also caused lung complaints as was seen in sections 2 and 3. The most frequent eye complaint caused by dust was chronic inflammation of the outer covering of the eye and the lining membrane of the eyelids. Those working in textile mills were particularly affected in this way and the physician's notebook for the Quarry Bank cotton mill at Styal in the early part of the 19th century, contains frequent case notes of apprentices suffering from inflamed eyes. The usual treatment consisted of bathing the eye in one of the prescribed eyewashers or in luke-warm water.

[1] i.e. ultra violet rays.

[2] *B.M.J.* 1894 September 15th, p583; Hunter (4th edition, 1969), pp 1097-1098.

Millers also suffered ophthalmia caused by flour dust and chimney sweeps likewise, caused by soot. One of the more pernicious dusts to the eye was lime dust, a hazard met with in the building trades, and cases were recorded where instantaneous and permanent blindness occurred. Irritating vapours came from the oil in wool which reddened the eyes. Engravers on glass and china suffered from eye irritation and inflammation as a result of the fumes given off by the hydrofluric acid they used. Another substance giving off an irritating exhalation was bisulphide of carbon, used in rubber works.[1]

One other topic receiving considerable attention from those interested in ophthalmology in the 1890's was the vision of railway servants but this was more concerned with the inefficiency of the eye tests employed than the effect of the occupation on eyes.[2]

1 Ramazzini (1964 translation), p435; Thackrah (2nd enlarged edition, 1832), p55 & p122; Arlidge (1892), p209; Physicians Prescription Book, Quarry Bank Mill, Styal 1804-1827 (Manchester Central Library C5/4/2 Microfilm 732); *J.S.A.* 1855 January 12th, p120 & p125, it quotes the Irish census of 1851 - of those who were reported blind, 18 had been smiths, 100 in the spinning trade and 73 weavers' assistants; *B.M.J.* 1894 September 15th, p582; Percy T Adam 'A special form of Ophthalmia to which Hop Pickers are liable' *B.M.J.* 1893 May 13th, pp100-102.

2 See any issue of the *B.M.J.* for the 1890's, e.g. *B.M.J.* 1891 August 29th, pp466-487; 1892 April 30th, p921.

iv) Direct Injury[1]

Injury to the eye was the result either of the penetration of chips of metal, stone or glass, or of burns caused by splashes of hot, molten metal, acids or other substances. As Arlidge wrote:

> "Among the misfortunes of their occupation, stone dressers and masons, and iron workers in forges and engine shops, get very frequently sharp particles of stone, or of iron, as the case maybe, driven with force against the conjunctiva and cornea, frequently rendering the removal difficult; at times too, causing wounds, followed by opacity of the cornea, or even by ulterior injury to the interior of the eye, ending in blindness." 2

Chips of metal were particularly dangerous as in many instances they were hot and penetrating. Stone particles of soft stone presented relatively little harm, but hard rock, like flint, had the same penetrating power as metal. Removal was not always easy to perfect and many employees sought aid from fellow workmen in extracting the mote in preference to going to the local infirmary. This often led to further injury being done to the eye. Towards the end of the period, techniques of removing metal particles by electro magnets were perfectedwhich greatly improved the chances of the surgeon removing the chip without further damage to the eye. Although each individiual mote may not have done great injury, the continual dulling of the cornea by flying particles, often led to the diminution of vision.[3]

1 Although Part Two is concerned with accidents at work, it seems more appropriate to discuss eye injuries received at work now rather than later, as the means of preventing were similar to those advised for the protection against dust, vapours and intense heat or light.

2 Arlidge (1892), p547.

3 *B.M.J.* 1894 September 15th, p583; *J.S.A.* 1855 January 12th, pp124-125; Simeon Snell 'On the prevention of Eye Accidents Occurring in Trades' Pamphlet taken from *B.M.J.* 1899, p7.

Numbers affected were quite considerable.[1] In 1853, the Birmingham and Midland County Eye Infirmary treated a total of 2,336 patients. (1,184 males and 1,152 females). Of this number, exclusive of amaurosis, 194 males (8.30% of the total patients or 16.39% of the male patients), were admitted due to traumatic injury, burns, contusions and extraneous bodies lodged in the eye, the majority of which would have been caused whilst engaged in their occupations. Around the same time, the Royal London Ophthalmic Hospital, treated over 10,000 patients a year, of whom 500 to 600 suffered from injuries caused by metal fragments.[2]

In many industries, the worker was at the risk of direct eye injury. Miners suffered from pieces of rock penetrating the eye, often as a result of blasting. In 1894, of 34,995 non-fatal accidents to colliers, 1,778 (5.08%) involved eye injuries. Engineers were sometimes injured by blasts of steam and soda water bottlers risked the occasional bursting of bottles and flying corks. Sparks were frequent in blacksmiths' and foundry shops, and sight was often impaired by the common repetition of such accidents. Thos e exposed to molten liquid included those at work at the furnace, pourring the molten metal into moulds. The Penny Magazine has an illustration of a man in the process of 'teeming', as it was called, and as a footnote adds, that since the sketch was made the man had,

> "nearly lost his eye-sight from a sudden shower of sparks occasioned by a too great dampness of the mould in to which he was pouring the liquid steel." 3

1 This will be seen in the case study on the Glasgow Eye Hospitals, pages 356-357.

2 *J.S.A.* 1855 January 12th, p120; *B.M.J.* 1854 February 17th, p150; Hunter (4th edition, 1969), p1096, states that at that time, 7,000 accidents to the eye were reported annually to the Factory Department and that it was estimated that a further 250,000 lesser eye injuries occurred which were not reported.

3 *B.M.J.* 1857 July 25th, p620; 1894 September 15th, p583; *J.S.A.* 1855 January 12th, pp120-121 & pp124-125; 'A Day at the Fitzalen Steel and File Works, Sheffield' *Penny Magazine Supplement* 1844 March, p126.

Various forms of eye guards were suggested. In many cases spectacles of plain glass sufficed and, when used, soon became studded by the continual bombardment of particles. Other ideas ranged from a coarse metal netting for those exposed to the large portions of hard metal and stone, to crape spectacles for where finer dust was evolved. For grinders of steel, it was suggested that they wore eye shields of magnetised wires so as to arrest the particles better. The need for better ventilation and drawing the dust away by fans was also recognised.[1]

6.b. Compressed Air

Another physical factor causing ill health which was investigated in the 19th century was the use of compressed air. With the increasing scale of civil engineering projects during the period of industrialization, new methods of construction were necessary. In building more sophisticated bridges, new techniques were developed to excavate the foundations of the bridge piers. Previously this had been done by the use of cofferdams, which being open both at the top and bottom meant that the water could be pumped out but this system was not suitable for excavating foundations at great depths, or where the river bed was solid rock.[2] The new method devised involved the use of enclosed caissons. Essentially a caisson was a working chamber which differed from the earlier cofferdams by being enclosed at the top and hence the water was excluded by means of compressed air. When the chamber was in place on the river bed, it was connected to the surface by means of access shafts, one for the men and one for materials. There was an airlock on the access shaft in order to ensure that the pressures were equalized before the men entered the chamber or returned to

1 *J.S.A.* 1855 January 12th, p123 & p125; Snell (1899), p8.

2 Herbert Shirley Smith *The World's Great Bridges* (1953), p77.

normal atmospheric pressure after a shift. This was initially placed on top of the chamber itself but later moved to the top of the access shaft. The first caissons were constructed of timber, sheathed with iron plate but this was later replaced by total iron constructions, although for both the St Louis and Brooklyn bridges, caissons of timber clad with iron were still being used, probably for reasons of economy because of the great depths involved.[1] The degree of pressure in the chamber increased with the depth of working.

According to Hunter,[2] caissons were first used in England in 1851, at Rochester, where a bridge, for which the foundations had to be sunk to a depth of 61 feet, was built across the Medway by Cubitt and John Wright.[3] Four years later, Brunel used compressed air for the construction of the Saltash Bridge across the river Tamar. He had made limited use of the method whilst building the bridge at Chepstow but Saltash was the first bridge of any scale to employ this system.[4] At the time a medical man at Saltash, Thomas Littleton, made several observations on the workmen employed in excavating the piers and he made an appeal to other members of the profession for similar observations and also suggested that it might be a suitable topic for study by the newly formed Committee of Industrial Pathology at the Society of Arts.[5] There is no evidence that his suggestion was taken up and two years later, in 1857, a London doctor, Edward Smith, also made an appeal for any knowledge of diseases of those working at depth or in diving bells. His main concern, however, appears to have been with lung disorders rather than decompression sickness.[6]

1 Ibid. p77 & p83; Arlidge (1892), pp540-541.

2 Hunter (4th edition, 1969), p840.

3 H S Smith (1953), p77.

4 Hunter (4th edition, 1969), p840.

5 *B.M.J.* 1855 February 9th, pp127-128.

6 *B.M.J.* 1857 March 14th, p226.

The typical maladies observed by Thomas Littleton amongst the caisson workers had been painful pressure on the ears, disturbance of equilibrium and bleeding from the nose and ears. He wrote:

> "In the severe forms of the attack, the man is taken within a few minutes after coming out of the cylinder, somewhat as in an apoplectic seizure, with a loss of power, preceded by pains, in the lower limbs (paraplegia), as I have seen in two cases, or of one half of the body (hemiplegia); another, the only one I have seen so affected, was wholly unconscious remaining in that state many hours. In those who escape with less injury, their sufferings are in some instances very severe, from pains in the limbs and joints; and few, if any, have wholly escaped these effects at some time or other during the progress of the work." 1

About forty men worked in the caissons at a depth of around eighty feet. Initially they had worked a shift of seven hours, but due to the amount of illness amongst the workmen, this was reduced to three hours with beneficial results.[2]

Oliver, in his book of 1908, reported that earlier case notes on decompression sickness had appeared in France during the construction of a bridge over the river Loire in 1854. On this project sixty-four men had been involved with work in the caissons and it was reported that forty-seven remained well, twenty-five had to be discharged through sickness and two had died. Sixteen of those discharged suffered severely after decompression. They had worked in shifts of four hours at a time and had spent half an hour in decompression on their ascent to the surface.[3] The number suffering after work in caissons appears to have been generally quite substantial. Hunter, quoting from Oliver, states that in building the St Louis bridge over the Mississippi, six hundred men were involved in excavating the foundations and 119 of them suffered from the sickness. Of these, fourteen cases proved

1 *B.M.J.* 1855 February 9th, pp127-128.

2 H S Smith (1953), p81.

3 Oliver (1908), pp93-94.

fatal. Likewise, with the construction of the Brooklyn bridge in New York, there were 110 cases of illness and three deaths.[1] The numbers for the latter are confirmed in the report appearing in 'The Engineer' on the opening of the bridge in May 1883.[2] Work in compressed air had started thirteen years earlier in March 1870, when a caisson at the Brooklyn end had been sunk. The one at the New York end was started a year later and went to much greater depths, causing more problems of sickness.[3] A local doctor, Dr Andrew H Smith, was appointed surgeon to the Bridge Company[4] and Arlidge credits him with naming the set of symptoms met with as 'Caisson Disease'.[5] The chief engineer of the bridge, Washington A Roebling, was himself a victim of the disease,[6] and the final stages of the construction were directed from his sickbed. For the rest of his life, caisson disease left him crippled and partially paralysed.[7]

The same sickness was also experienced by divers and those who descended the depths in diving bells[8] but there was little understanding of its cause. H Shirley Smith, writing in 1953 on the construction of the St Louis bridge, refers to the men being issued with protective bands of armour to be worn around the wrist, ankles, arms and waist, and on the soles of the feet.[9] Littleton had felt that the quality of the air in the caissons might be partly responsible.[10]

[1] Hunter (4th edition, 1969), p840. [2] *The Engineer* 1883 June 1st, p417.

[3] David B Steinman & Sara Ruth Watson *Bridges and Their Builders* (1957) pp238-240.

[4] *The Engineer* 1883 June 1st, p417. [5] Arlidge (1892), p540.

[6] His father John Roebling had been chief engineer but died after crushing his foot whilst surveying the bridge in 1869 as, after the amputation of his toes, lockjaw set in. He handed over his work to his son to complete. H S Smith (1953), pp88-89; *The Engineer* 1883 June 1st, p417.

[7] *The Engineer* 1883 June 1st, p417; H S Smith (1953), pp90-91; Steinman & Watson (1957), p240.

[8] *B.M.J.* 1889 March 23rd, p655; June 29th, p1502.

[9] H S Smith (1953), pp83-84.

[10] *B.M.J.* 1855 February 9th, p128.

The first to study the subject of decompression sickness scientifically was the French physician Paul Bert. In 1878[1] he conducted a series of experiments which proved that the cause of the sickness was the release of bubbles of nitrogen into the blood and body tissues during decompression which thus partially stopped circulation. He also showed that the disease could be prevented by working shorter shifts in the compressed air, and by decompressing gradually.[2] On the St Louis bridge, the men had been taking only two or three minutes to decompress.[3]

Although work on the Brooklyn bridge caissons began, as stated, in 1870, it was completed after Bert's work, but in the report on the opening in 1883, it was written:

> "The 'caisson disease' is the result of living under atmospheric pressure greatly above that to which the human system is normally adapted. The blood is driven in from the exterior and soft parts of the body to the central organs, especially the brain and spinal cord. On emerging in the open air, violent neuralgic pains and sometime paralysis follow." 4

It is possible though that this report was drawn from the work of Dr A Smith, the surgeon treating the caisson workers. He wrote before 1878 and an abstract of his writings appeared in the British medical press of 1875.[5] Arlidge writing in 1892 also made no reference to Bert's discovery but refers to the writings of another French physician, M Foley. He had studied the disease amongst caisson workers on the bridge over the river Seine at Argenteuil. Arlidge does refer to the cause as being in the transition from compressed air back

1 Some references put in at 1876 (H S Smith (1953), p78) but P Bert's book 'La Pression Baromitique' did not appear until 1878.

2 Hunter (4th edition, 1969), p845. 3 H S Smith (1953), p84.

4 *The Engineer* 1883 June 1st, p417.

5 *British & Foreign Medico-Chirurgical Review* 1875 January, p234. Abstract of the article by Dr Richardson

to normal atmospheric pressure but appears to associate it more with the length of exposure to compressed air and the degree of pressure worked in, rather than the length of time taken in decompression.[1] The fact that men appeared to escape some of the effects of the illness by working shorter shifts helped to support the belief. There were no recommendations on decompression times available in Britain until 1908, when J S Haldane published a set of tables for the use of Royal Naval Divers.[2] As for treatment, the only effective remedy is to return the worker to the pressure at which he had been working and then to gradually begin decompression again.[3] The fact that the symptoms disappeared if the worker returned to the compressed air chamber had been noted by 1900 by physicians treating caisson workers,[4] although if decompression recurred again at the same speed, the chances were that the illness reappeared.

[1] Arlidge (1892), p545.

[2] Richard H Strauss MD (ed) *Diving Medicine* (1976), p5.

[3] Brown (1977), p111.

[4] Arlidge (1892), p542.

PART TWO

INDUSTRIAL ACCIDENTS

An important aspect of the question of health and safety at work is the incidence of and attitude towards industrial accidents. The lay person was probably far more aware of accidents at work than occupational illnesses, as the connection between the two was more easily observable. Equally, the press of the day, although only making occasional references to the diseases induced by work, gave detailed reports on the occurrence of accidents, especially the more tragic ones. However, at the end of the 18th century, reports on accidents appear to have been kept to a minimum, for if the Salopian Journal is at all representative of provincial papers, more space was allocated to accounts of accidents such as fire, in which property was damaged, than to accidents where personal injury resulted. The accidents which were covered were either the more tragic ones involving loss of life or the more unusual. There were relatively few reports on slighter injuries.[1] In the mid 19th century however, the coverage of accidents by the press was much wider and more detailed. For example, the Wellington Journal, covering predominately the eastern area of Shropshire, not only reported in depth on major industrial accidents nationwide together with any ensuing enquiries but also gave full details of local incidents and inquests and did not spare its readers from the more horrible aspects of the events.

Accidents at work fall into two main categories: those which occurred in the mining industries and those which occurred in other occupations. Mining was by far the most hazardous of the 19th century occupations in regard to

[1] For example in 1799, the *Salopian Journal* contained items on injury from cogs in a mill in Chester; injury from effects of sulphurous odours; wagon accidents; and over ten reports of fires in various manufactories throughout the country. In 1800, there was a report on the inquest of a boy weaver who had died from blows given by his master; a wagon accident at Snailbeach (Shropshire); and fires at a cotton mill in Macclesfield and a brewery at Bath. 1806 again had fire reports plus explosions at Park Foundry, Sheffield and of a Trevethick engine in South Wales but also had several local items of combustion of gas in the local pits and an accident at the ironworks at Snedshill.

accidents, although the rates of insurance offered by the Accidental Death Insurance Company in 1860 placed mining engineers in the same category as grooms and cattle dealers (see Table X). Although mining was not the first occupation in which the government became involved with legislation to prevent injury at work[1] it was the field in which the larger number of tragic and large scale accidents occurred and will therefore be discussed first.

[1] The first area in which the government became involved with industrial accidents was those occurring in textile mills, as will be seen later on pages 288-303.

TABLE X: Rates Advertised by the Accidental Insurance Company 1860

	Insured At			Weekly Allowance			Annual Premium		
	£	s.	d.	£	s.	d.	£	s.	d.
1. General As Professional Men, Merchants, and Gentlemen of Independent means, excluding horse risk	1000	0	0	6	0	0	2	0	0
Including horse risk	1000	0	0	6	0	0	3	0	0
2. Special As Tradesmen, Farmers, Innkeepers and all persons whose occupations are not considered absolutely hazardous	1000	0	0	6	0	0	3	10	0
3. Hazardous As Cattle Dealers, Grooms, Mining Engineers, Plumbers, Stonemasons, and other similar occupations	500	0	0	3	0	0	3	0	0

Source: *Wellington Journal and General Advertiser for Shropshire and Staffordshire* 1860 May 19th.

1. MINING ACCIDENTS

Of all the branches of mining, coal mining was by far the most hazardous. Sir Andrew Bryan has recently made a study of the evolution of health and safety in mines, examining the development of interest in the subject, through the many governmental commissions in the 19th century and the setting up of the mines inspectorate in the 1850's, to the situation at the present day. (1975).[1] The first reference that he found on the question of the protection of British colliers, was the proposal put forward in 1797 by William Thomas of Denton, Northumberland, to the Literary and Philosophical Society of Newcastle for the preservation of mining records. This was due to the inundation of a nearby mine by water from an old workings which had resulted in the death of six people.[2] The subject was not spoken of again until 1815, when between 60 and 70 persons and several horses lost their lives in Heaton Main Colliery, near Newcastle, when water from some disused mines broke through the roof into the colliery workings. Only about ten miners managed to escape.[3] Thomas had only visualized a voluntary registration of records within the North East area but the new spokesman, W Chapman, saw the need for compulsory registration in all coalfields although there was no action until 1839, when the Government set up a mining records office in the museum of Geology in London for the voluntary registration and preservation of plans. There was no compulsory registration until 1850.[4]

The North East was, in general, in the forefront of the movement for increased safety measures in mines. The reason for this can be found in the nature of the coal seams in

[1] Sir Andrew Bryan *The Evolution of Health and Safety in Mines* (1975).

[2] Ibid. p16.

[3] Report of the accident appeared in the *Salopian Journal* 1815 May 17th.

[4] Bryan (1975), p17, p28 & p50.

that area which were considerably gassy and, with the increased depth of workings at the end of the 18th century, the frequency of explosions increased and correspondingly the number of casualties grew. The incidents, with so many deaths occurring at one time, attracted much attention and led to the setting up of the Sunderland Society in 1813. They enlisted the services of Sir Humphry Davy who developed the first safety lamp in 1815.[1] The following year Dr Clanny received an award from the Society of Arts for another design of safety lamp for use in mines.[2] However, explosions still occurred with some frequency and the 1818 and 1830 Parliamentary Committees investigating the state of the coal trade, found conflicting evidence as to the value of the Davy Lamp, some feeling it was a hazard to life as it meant work was carried out in more gassy seams than previously would have been attempted. In an effort to probe further into the matter, the House of Commons appointed a Select Committee to look into coal mining accidents in 1835. It came to no specific conclusions, and it was not until after another independent enquiry in the North East and the report on the employment of females and boys in mines in 1842, that the appointment of an Inspector of Mines, Sir Hugh Seymour Tremenheere, was made in 1843. His only duties were, however, to report on the conditions of labour and he had no authority to report on safety. Tremenheere wanted the appointment of mining engineers as Inspectors to help on safety aspects but it was not until 1850 that four such Inspectors were engaged.[3] Their effect was much less than anticipated and following a further Select Committee report the number of Inspectors was increased to twelve by the 1855 Act for the Inspection of Coal Mines.[4] This Act

1 Ibid. pp18-19.

2 *T.S.A.* 1816, Vol.XXXIV, pp121-127.

3 For a more detailed account of the safety movement, see Bryan (1975) pp19-38; O P Edmonds & E L Edmonds 'An account of the founding of H M Inspectorate of Mines and the work of the first Inspector Hugh Seymour Tremenheere' *B.J.I.M.* 1963, Vol.20, pp210-217.

4 1855 Act for the Inspection of Coal Mines 18 & 19 Vict. c108.

identified seven areas of safety on which the Inspectors could act. These were:

1. adequate ventilation;
2. the fencing of shaft entrances;
3. the security of shaft strata;
4. proper means of signalling in the shaft;
5. fitting of indicators to show the position of the load in the shaft;
6. adequate brakes on the winding machine, and,
7. the provision of a proper steam gauge, water gauge and safety valve on every boiler. [1]

There was no provision for action in one of the major areas of accidents, namely roof falls and falls of coal and stone, and although the Act was amended in 1860, and the areas of safety extended, these were still not included.

Before proceeding further with a discussion of the advancement of the safety campaign, it is necessary to look at mortality figures in detail, together with the type of accidents involved. Some of the sources of danger in the pits have already been identified, namely explosions and inundations of water, but these two only formed a fraction of the accidents which occurred in mines. Although more space was devoted to them in the national press and Governmental reports this was due to the large numbers killed or injured on each occasion but in fact, the miner was more at risk of death or injury from falls of earth or coal, or from accidents in the shaft itself (or for that matter from diseases of the lungs). The classification of types of accidents, as used by the Inspectors of Mines in their statistics were as follows:

[1] Bryan (1975), p60.

1. Explosions of Firedamp.
2. Falls in mines:
   a) Falls in coal
   b) Falls in roof
3. In Shafts:
   a) Overwinding
   b) Ropes and chains breaking
   c) Whilst ascending or descending
   d) Falling into the shaft from the surface
   e) Falling part way down
   f) Things falling from the surface
   g) Miscellaneous in shaft
4. Miscellaneous Underground:
   a) Explosions of gunpowder
   b) Suffocation by gas
   c) Irruption of water
   d) Falling into water [1]
   e) On inclined planes
   f) By trams or tubs
   g) By machinery underground
   h) Sundries underground
5. On the Surface:
   a) By machinery on the surface
   b) The bursting of boilers
   c) Miscellaneous on the surface

Work on mortality amongst British coal miners from violent causes in the first half of the 19th century has been undertaken by P E H Hair, both in his thesis of 1955, when he looked at the social history of the miner in Durham, Staffordshire and the Merthyr region of South Wales, and in a subsequent article in the Economic History Review of 1968.[2]

[1] e.g. sump at the bottom of the shaft.

[2] Hair (Thesis, 1955); P E H Hair 'Mortality from violence in British Coal Mines 1800-1850' *Economic History Review* 1968 Vol. XXI, pp545-561.

By the 1850's, statistics on fatal coal mining accidents were made available from data contained in the reports of the Inspectors of Mines, and in conjunction with the census report for 1851, Hair calculates that the mortality rate amongst coal miners from 1851 to 1853 from violent causes was between 4.5 and 5.0 per 1,000 employed per annum. However, between the various coalfields he found a striking difference in the rates of mortality from violence. (Table XI). For the Black Country coalfield it was as high as 7.0 per 1,000 employed, whereas for the North East, it was only 3.5 per 1,000.[1] In examining the scattered data available for the preceding years, it was evident that the rate for the North East had been much higher, Hair putting it at or above 8.1 per 1,000 between 1800 and 1830. He attributed the decline in mortality rate to the joint efforts of the mining engineers and the safety campaign in controlling gas explosions, with the death rate from explosions in the area falling from 5.0 to 6.0 per 1,000 in the early years of the 19th century, to 0.9 per 1,000 in 1851 to 1853. Although other areas may also have benefitted from efforts to control gases the overall decline in the death rate was only slight since explosions were not such a major problem in these areas. In the Black Country, Hair put the rate of death from violence at between 6.0 and 7.0 per 1,000 for the early decades of the 19th century as well as for the period 1851 to 1853. The main reason for the high death rate in theBlack Country was the fact that, due to the nature of the strata, the seams were much thicker than elsewhere which made control much more difficult. The death rate from roof falls was 3.7 per 1,000 in 1851-1853 in Staffordshire, Shropshire and Worcestershire, compared with only 1.1 per 1,000 in the North East. The prime reason for little being done to reduce these kinds of accidents was probably an economic one; they were not so disastrous to the coal owners as the large scale explosions which wrecked the pits and killed much of the skilled labour.[2] Without

[1] Hair (1968), p546. [2] Ibid. pp559-560.

TABLE XI: Deaths by Violence in Coal Mines per 1,000 Persons Employed per annum 1851-53: Total and by Specific Forms of Accident

Coalfields (with numbers employed - 1851)	All Accidents	Explosions	Roof Fall	Other Accidents
Scotland (33,000)	2.9	0.8	1.1	1.0
Northumberland, Durham, Cumberland (42,500)	3.5	0.9	1.1	1.5
Yorkshire, Derbyshire, Nottinghamshire, Warwickshire, Leicestershire (33,000)	3.4	1.1	1.0	1.3
Lancashire, Cheshire, North Wales (36,000)	6.0	2.4	1.6	2.0
Staffordshire, Shropshire, Worcestershire (32,500)	7.1	1.1	3.7	2.3
South Wales, Monmouthshire, Gloucestershire Somerset (39,000)	4.3	1.1	1.5	1.7
All Coalfields except Scotland	4.7			
All Coalfields	4.5			

Source: P E H Hair 'Mortality from Violence in British Coal Mines 1800-1850' *Economic History Review* 1968, Vol.XXI, p546.

inspection it is unlikely that any action would have been taken to try and lessen this more minor type of accident.

Another reason for the higher frequency of accidents in the Black Country, as compared wihh the North East, was the way in which the industry was organised. In the Black Country the sub-contract or butty system was in operation whereas in the North East, in the 19th century, the coal mines were controlled directly by the coal owners. The sub-contract system consisted of the workmen being the servants not of the proprietor of the colliery but of a contractor known in the Staffordshire area as the butty. The proprietor struck a bargain with the butty to deliver coal or ironstone at so much a ton. The mine owner sank the pits and opened out the workings but it was the responsibility of the butty to hire the men and provide the working capital (horses, tools and equipment). This system had been operated on most coalfields at some stage but by the end of the 18th century it had died out. The exception was the Black Country, where it remained the dominant system of organisation well into the 19th century.[1]

The Black Country coalfield did not have as long a history as the North East coalfield. Coal mining in the Black Country expanded rapidly and haphazardly in the 18th century with the growing demand for coal for steam power and iron smelting in the immediate vicinity. There was no tradition of skilled mining engineers. The system of land ownership in the area and the ease with which the coal could be exploited, being near the surface and in thick seams, favoured a proliferation of small scale enterprises. There were few attempts to provide technical education. Technical work was carried out in the short term and little attention paid to the long term prospects. In his essay on subcontracting, A J Taylor remarks that if a coal owner was able to drive a successful bargain, then the butty would

[1] A J Taylor 'The Subcontract System in the British Coal Industry' in L S Pressnell (ed.) *Studies in the Industrial Revolution* 1960.

work the pit for his immediate gain, overworking the men and exploiting the best yields of coal at the expense of the poorer quality, making it uneconomic to work in later periods.[1] With such aims, little attention was paid to safety precautions, hence the larger number of accidents recorded in this area by mid century than in the North East. Where in the Black Country there were large blocks of mineral bearing land under one ownership, such as was the case with the mineral estates of Lord Dudley, as T J Raybould has shown, the pattern of subcontracting was replaced by more efficient systems of management. This was done on the Dudley Estate with the aid of Charles Beaumont, an eminent mineral engineer from Newcastle-upon-Tyne, who was engaged as the mineral agent for the estate[2] presumably with beneficial results on mortality figures.

The scale of production on the North East coalfield was larger and the industry older. The butty system had died out almost completely by the end of the 18th century. S. Pollard has shown how the coal owners in the area began to give more emphasis to the importance of a professional and managerial class in coal producing and how a tradition of skilled and educated mining engineers was built up.[3] The pits had to be sunk to greater depths than elsewhere which required more capital and large scale organizations dominated the field. The largest of these collieries had their own schools to train engineers and underviewers which led to a more responsible class in control of mining operations.[4] Even the problem of gas explosions was partially solved by skilled engineers in the area who put forward ideas on preventative measures. The degree of success is reflected in the figures in Table XI.

[1] Ibid. p219.

[2] T J Raybould 'The development and organization of Lord Dudley's Mineral Estate 1774-1845' *Economic History Review* 1968, Vol.XXI, pp529-544.

[3] S Pollard *The Genesis of Modern Management* (1968), pp152-153.

[4] Taylor (1960), pp220-221.

After about 1850 the butty system was openly criticised by the trade unions who saw it as exploiting the miners, as well as by enlightened employers who saw it as inefficient and wasteful, and the Mines Inspectorate, who believed that unskilled methods led to the neglect of discipline and safety methods. A court case in 1867 (*Regina v Cope*) also made it legally disadvantageous; the court decided that the liability for injuries sustained under the butty system was on the proprietor of the pit and not the contractor.[1] The 1872 Mines Regulation Act[2] required that the mine be operated by duly trained and certificated managers and extended and strengthened the code of safety to be adopted in mines, but it was not until the end of the 19th century that the sub-contract system disappeared entirely from the Black Country.

The 1860's saw many national disasters in coal mines. A major accident occurred in 1862 at Hartley Colliery in Northumberland, when the beam of a pumping engine broke and blocked the only shaft into the mine. It broke through the brattices and effectively cut off the ventilation in the pit. Over two hundred miners were suffocated, a situation which could have been avoided had there been two shafts to the mine.[3] Following Hartley, the Inspectors were able to get more co-operation from coal owners to sink a second shaft wherever only one existed.[4] The most disastrous year was 1866, when 1,484 lives were lost. Two accidents accounted for over 400 of the deaths, with 334 being killed at Oaks Colliery in Yorkshire and 91 at the Talk-o'the-Hill pits in Staffordshire.[5]

1 Ibid. p231.

2 1872 Mines (Coal) Regulation Act 35 & 36 Vict. c76.

3 *W.J.* 1862 January 25th; February 8th; February 15th.

4 Report of the Inspectors of Mines, 1861, Mr Wynne's Report, p67.

5 Bryan (1975), p61.

The period 1870 to 1900 saw an increase in the role of the Inspectorate. Twelve assistant inspectors were appointed in 1873 and the number of districts was extended to fourteen in 1875. The 1872 Mines Act increased the number of general rules to thirty-two and brought in the much needed regulations on roof supports.[1] Accidents still occurred, however, and it was only in this period that the significant role of coal dust in explosions was realized. Although this had been hinted at in the report of the Heswell Colliery disaster in 1844[2] and discussed by Faraday at the Royal Institution in 1845, the viewpoint was not generally upheld. Even by 1870 when its role was beginning to be understood, there was still much doubt until a Royal Commission was appointed in 1891 specifically to look at the influence of coal dust in originating or extending explosions in mines. The Commission reported in 1894 and confirmed that the presence of coal dust increased the danger of explosions and intensified them.[3]

Over the period in question much was done to secure better safety measures in mines, and the number of accidents per 1,000 workers employed in the industry had fallen significantly by the end of the century. Calculations from data provided in the statistical summaries of the Mines Inspectorate show that the average number of deaths from violence per 1,000 per annum in coal mines in 1891 to 1893 had fallen (from 4.5 calculated by Hair for 1851 to 1853) to 1.53 (Table XII). However the latter figure is for coal workers above ground as well as below and, due to the nature of the legislation, also includes those working in the sidings at the mine head and hence may not be directly comparable with Hair's figure. Table XIII shows the number of deaths occurring underground and shows a figure of 1.67 per 1,000 employed underground being killed by violence each year.

[1] Ibid. pp63-65.

[2] When 95 miners were killed by an explosion of firedamp.

[3] Bryan (1975), pp45-46.

TABLE XII: Deaths by Violence in and about coal mines per 1,000 persons employed per annum 1891-1893: Total and by Specific forms of Accidents

Coalfields (with numbers employed 1891 to nearest 1,000)	All Accidents	Explosions	Roof Fall	Other Accidents
Scotland (85,000)	1.43	0.05	0.71	0.67
Northumberland, Durham Cumberland (137,000)	1.11	0.03	0.57	0.51
Yorkshire, Derbyshire, Nottinghamshire, Warwickshire, Leicestershire (154,000)	1.20	0.32	0.40	0.48
Lancashire, North Wales (91,000)	1.65	0.02	0.86	0.77
Staffordshire, Shropshire Cheshire, Worcestershire (50,000)	1.62	0.12	0.75	0.75
South Wales, Monmouthshire, Gloucestershire, Somerset (130,000)	2.31	0.36	0.85	1.10
All coalfields except Scotland	1.55			
All coalfields	1.53			

Source: *Statistical Summary*, Inspector of Mines 1891, 1892 and 1893.

TABLE XIII: Deaths by Violence Underground in coal mines per 1,000 persons employed underground per annum 1891-1893: Total and by Specific forms of Accidents

Coalfields (with numbers employed 1891 to nearest 1,000)	All Accidents	Explo-sions	Roof Fall	Other Accidents
Scotland (72,000)	1.51	0.05	0.84	0.62
Northumberland, Durham, Cumberland (111,000)	1.25	0.04	0.70	0.51
Yorkshire, Derbyshire, Nottinghamshire, Warwick-shire, Leicestershire (125,000)	1.32	0.39	0.50	0.43
Lancashire, North Wales (76,000)	1.78	0.02	1.03	0.73
Staffordshire, Shropshire, Cheshire, Worcestershire (40,000)	1.83	0.15	0.94	0.74
South Wales, Monmouth-shire, Gloucestershire, Somerset (111,000)	2.43	0.42	0.99	1.02
All coalfields except Scotland	1.69			
All coalfields	1.67			

Source: *Statistical Summary*, Inspector of Mines 1891, 1892 and 1893.

There was still some variation between the coalfields, with the South Wales area being the most hazardous but the differences were not so great as in 1851 to 1853. The biggest decrease is in accidents from roof falls with the Staffordshire, Shropshire and Worcestershire area falling from 3.7 per 1,000 to 0.94 per 1,000 employed.[1] By 1891 to 1893, explosions accounted for a very small percentage of the deaths and this can be attributed to the growing understanding of the causes of explosions. Other improvements can be put down to the growing involvement and influence of the Mines Inspectorate in accident prevention and the realization amongst coal owners that safety measures could benefit the efficiency of the mine. It would seem however, that coal owners, whilst they were prepared to take action to try and prevent the explosions which had such disastrous, large scale consequences, needed prompting from the Mines Inspectors before much action was taken to prevent the more frequent accidents occurring in the shaft or as a result of falls of coal and stone.

One coalfield where such encouragement was needed was that of Shropshire. Like the Black Country the main form of organization in the 19th century was still the butty system. However, it did not have the high seams of the Black Country, nor did it have the extremely gassy seams of the North East, and tended towards small scale operations with only basic equipment. Hair made a study of mortality rates from violence amongst Shropshire coalminers in his 1968 paper. Using the Coroner's Reports for 1800 to 1819 he found that 267 miners had been killed at work in Shropshire mines, of which 49 had died as a result of explosions of firedamp. At the time, there were approximately 3,000 miners in the county which gave an average mortality from violence of 4.4 per 1,000 per annum. (0.8 per 1,000 from explosions of firedamp).[2] Table XIV shows the mortality in Shropshire coal

[1] Due to the changes in the structure of the districts the latter figure also includes Cheshire.

[2] Hair (1968), p536.

mines from 1860 to 1869 as taken from the annual reports of Mr Wynne, the Inspector of Mines for North Staffordshire, Shropshire and Cheshire. Over the ten year period, there were 118 deaths of which sixteen were caused by firedamp explosions. According to the 1861 census (Table XVII) the number of colliers in Shropshire had risen to almost 4,500 so that the average mortality over the decade was 2.6 per 1,000 per annum. (0.4 per 1,000 from explosions of firedamp). Although these figures are lower than Hair's, they do not necessarily reflect improvements in mine safety since it is unclear whether Hair's figures are for only coal miners in Shropshire or for Shropshire miners in general. In the Coroner's Reports some of the mining accidents reported were probably in ironstone pits as there were many of these mines in Shropshire. The deaths in ironstone mines from accidental causes were made reportable to the Mines Inspectors in 1860 and Table XV shows the mortality in Shropshire for the years 1861 to 1869.

In the initial year, seventeen deaths were reported at a time when just under 750 miners were employed in ironstone mines, which gives an excessively high rate of mortality of 22.6 per 1,000. For the nine years the average figure per annum is 11.7 per 1,000, the decrease in accidents being dramatic within a couple of years of reporting beginning. It seems unlikely that the Inspector could have had such an immediate effect and the figure for 1861 may instead have been rather exceptional, as two accidents accounted for nine deaths. If the mortality in ironstone and coal mines are added together, the average rate of mortality was 3.7 per 1,000 per annum between 1860 and 1869 which may be a more comparable figure with that given by Hair for 1800 to 1819.[1]

[1] Although there were other small scale mining activities in Shropshire namely lead, copper and clay.

TABLE XIV: Mortality from Violence in Shropshire Coalmines 1860-1869

Year	Explosions of Firedamp	Falls in Mine	Shaft	Misc. Under-ground	Misc. Above-ground	Total
1860	4	4	2	3	-	13
1861	1	4	6	3	-	14
1862	3	4	13*	1	-	21
1863	1	4	5	-	-	10
1864	1	5	4	1	-	11
1865	2	3	3	1	-	9
1866	-	-	3	3	-	6
1867	-	4	5	1	1	11
1868	4	5	2	3	-	14
1869	-	7	2	-	-	9
Total	16	40	45	16	1	118

* One accident killed 12 people

TABLE XV: Mortality from Violence in Shropshire Ironstone Mines 1861-1869

Year	Explosions of Firedamp	Falls in Mine	Shaft	Misc. Under-ground	Misc. Above-ground	Total
1861	6	2	6	3	-	17
1862	1	6	4	2	1	14
1863	2	3	2	-	-	7
1864	-	3	10*	-	-	13
1865	-	5	1	2	-	8
1866	1	2	-	-	-	3
1867	-	3	3	-	-	6
1868	1	4	2	-	1	8
1869	-	3	-	-	-	3
Total	11	31	28	7	2	79

* One accident killed 9 people

Source: Data for both tables taken from the Reports of the Inspectors of Mines - Mr Wynne's Report - 1860 to 1869.

TABLE XVI: Percentage of Accidents from each cause in Shropshire Mines 1860-1869

Type of Mine	Explosions of Firedamp	Falls in Mine	Shaft	Misc. Under-ground	Misc. Above-ground
Coal	13.56	33.90	38.13	13.56	0.85
Ironstone	13.93	39.24	35.44	8.86	2.53

Source: Report of the Inspector of Mines - Mr Wynne's Report - 1860 to 1869.

TABLE XVII: Number of Males (all ages) engaged in Mining and Quarrying Activities in Shropshire in 1861

	Occupation	Numbers Employed
Miners:	Coal	4,490
	Copper	2
	Lead	278
	Iron	749
	Others	1,134
Quarries:	Stone	934
	Slate	1
	Limestone (inc. burners)	259
	Clay labourers	9

Source: Census of England and Wales for the Year 1861, Population Tables Volume II (5597), p469.

As to the causes of death in Shropshire mines, over two-thirds of the accidents, both in coal mines and ironstone mines, were the result of falls in the mine and shaft. (see Table XVI). Mr Wynne placed part of the blame for these accidents on the system of work organisation employed, namely the butty system.[1] The explosions generally seem to have been the result of carelessness, not necessarily on the part of the miner. A case occurred in 1860 at the Dark Lane Pits in which the 'Doggy', who was employed to enter the mine half an hour before the miners were due to start work and test the level of gas, told the miners it was unsafe to work, but on their way out, the miners met the chartermaster who told them to turn round and go to work. An explosion then occurred in which a miner lost his life.[2] Two years later another accident occurred at the same pit. Twelve people were killed when a coupling box at the end of a wire rope broke causing the cage to fall to the bottom of the shaft. According to the code at the mine only eight men and boys should have been in the cage but it appeared at the inquest, that it was general for twelve men and boys to descend at a time. The chartermaster (the same person as in the preceding case) was seen to urge others to get into the cage after the correct number had already entered. Initially only the banksman was brought to court and was gaoled for two months with hard labour,[3] but a case against the chartermaster was brought in April 1863. He was found guilty and given a two month sentence. The sentences were upheld at the Court of the Queen's Bench and Mr Wynne wrote:

> "It is to be hoped that this will convince chartermasters that they have other duties to perform than the mere getting of coals at a cheap rate, and that the safety of their men should have their first and chief attention." 4

[1] In Shropshire the butty was often referred to as the chartermaster.

[2] Report of the Inspector of Mines, 1860, Mr Wynne's Report, pp66-67.

[3] Report of the Inspector of Mines, 1862, Mr Wynne's Report, p64.

[4] Report of the Inspector of Mines, 1863, Mr Wynne's Report, p103.

The high proportion of shaft accidents were due mainly to the old systems of winding in use in the area:

> "These causes will continue in full force so long as the rude and primitive modes of winding are continued in the district - modes, I am sorry to say, which neither the sharpening influence of self interest, the warnings of experience, nor the derision of strangers, seem to shake the confidence of those who still continue to use these rough methods; there is, however, one cheering prospect; and that is, whenever a fresh coal proprietor or manager is introduced from another district, an improved system of winding is almost always the consequence." [1]

As a result of accidents, Thomas Wynne took out proceedings against some mine owners and agents, and also prosecuted many for failing to report a fatal accident.[2] He also initiated cases where accidents had not occurred but where enfringements were found of the Mines Act. Examples of such are, failure to put up notices, not having proper indicators of the position of the load in the shaft, or gauges on the boiler and a common error was the failureto have a proper means of signalling in the shaft or adequate brakes on the winding gear. Many of the smaller owners appear to have been unaware of the regulations made under Act of Parliament or to have thought themselves outside their scope. In such cases usually only a minimum fine of 5 shillings plus expenses was charged but subsequent cases received fines of from £1 to £10.[3] Whether the Inspector had any influence over the number of accidents is unclear and although he made comments on the need of proper timbering, he had no authority in this area. The number of accidents from falls of mine and from accidents in the shaft appears to have remained fairly steady (Table XIV and Table XV) which suggests that more than advice was needed to make proprietors take action to secure safety.

[1] Ibid. p102.

[2] *W.J.* 1857 April 18th, Dark Lane Pits explosion, inadequate ventilation; 1863 June 27th, Prioslee, allowing too many to descend at a time; 1865 November 18th, female working machinery on the surface, fined £30; 1869 July 17th, man drawn over pulley when engineman was absent.

(see over page)

Not all accidents, however, necessarily resulted in death. Many more cases of injury must have occurred, some of them severe, causing major disfigurement, while other incidents may have involved nothing more than minor burns and cuts. It is impossible to obtain exact figures on injury as opposed to fatality, but some reference is made to them in local papers; the Wellington Journal and General Advertiser for Shropshire and Staffordshire, for example. Although this paper first appeared in 1855, many of the early issues are missing but for the period 1860 to 1869, the majority survive and not only give a good description of the mining accidents in the Wellington area of Shropshire but also contain many reports on other areas. The accounts rarely distinguish the exact type of mining activity but cover coal, ironstone, clay and copper mines.[1] Tables XVIII and XIX show the mortality and injuries as reported in this paper from 1860 to 1869. Table XX gives a comparison between the mortalities in the county as reported in the press and as recorded by the local Inspector of Mines. It appears from the similarity of the figures in columns 1 and 2 of this table, that there is a correlation between the deaths reported in the newspapers and in the Mines Inspector's reports. However, as both sources actually named the victims or the mine it is possible to see whether they refer to the same cases; it would appear that in many instances they did not, and that the apparent death rate amongst Shropshire miners in this period was higher. The pattern of cause of death was similar to that found by the Mines Inspector (compare Tables XIV and XV

[1] In 1864, one death was known to be at the Clive Copper Mine and in 1867 one of the deaths was in a clay pit.

(cont.)
Neglect to report accidents: W.J. 1865 September 9th, at Clee Hill Colliery; 1865 November 18th; 1868 February 29th British Colliery Oswestry.

[3] W.J. 1857 January 3rd, several cases included no rules up, no signals, inadequate brakes, no indicator; 1857 January 17th, no proper signals; 1857 December 12th, no proper brakes; 1861 July 13th, at one pit, no brake to engine, no steam gauge, no indicator, no signal, no rules of guidance, first case £10 fine, £1 and costs for each of the other offences.

TABLE XVIII: Mortality from Violence in Shropshire Mines 1860-1869

Year	Explosions of Firedamp	Falls in Mine	Shaft	Misc. Under-ground	Misc. Above ground	Unrec-orded	Total
1860	1	6	3	1	1	-	12
1861	5	3	10	6	-	1	25
1862	2	11	15	4	-	1	33
1863	1	7	5	1	-	3	17
1864	1	8	14	1	1	-	25
1865	1	5	1	2	1	-	10
1866	-	1	2	1	-	-	4
1867	-	8	7	2	1	-	18
1868	3	10	1	3	1	-	18
1869	-	10	1	-	-	-	11
Total	14	69	59	21	5	5	173

TABLE XIX: Injuries from Violence in Shropshire Mines 1860-1869

Year	Explosions of Firedamp	Falls in Mine	Shaft	Misc. Under-ground	Misc. Above ground	Unrec-orded	Total
1860	5	2	-	2	-	2	11
1861	5	4	15	-	-	1	25
1862	2	3	1	1	-	-	7
1863	15	14	3	1	1	3	37
1864	-	4	3	-	-	-	7
1865	5	8	1	-	-	-	14
1866	-	2	-	1	-	1	4
1867	11	6	8	4	-	1	30
1868	4	2	6	-	-	-	12
1869	5	1	1	-	1	4	12
Total	52	46	38	9	2	12	159

Source: Both tables drawn from accounts in the *Wellington Journal* 1860-1869.

TABLE XX: Comparison of Mortality of Named Miners as Reported in the Mines Reports and in the Wellington Journal 1860-1869

Year	Deaths in Coal & Ironstone: miners named in Mines Report	Deaths of miners named in the Wellington Journal	Death of named miners which are reported in both sources	Probable Total number of deaths
1860	13*	12	5	20
1861	31	25	23	33
1862	35	33	28	40
1863	17	17	13	21
1864	24	25	19	30
1865	17	10	8	19
1866	9	4	3	10
1867	17	18	14	21
1868	22	18	16	24
1869	12	11	7	16

Source: *Wellington Journal* 1860-1869; Inspector of Mines Report - Mr Wynne's Reports 1860-1869.

* deaths only recorded in coal mines by the Inspector.

with XVIII); the most frequent cause being falls of mine and the next most frequent, accidents in the shaft.

With respect to injuries as opposed to death, it is interesting to note more injuries were incurred as a result of explosions of firedamp than falls of earth or shaft accidents but the data is too scarce to draw many conclusions. Perhaps this is a reflection too, of what the paper thought might interest the readers, explosions being more dramatic than roof falls. Of interest is the nature and extent of the injuries which occurred with many reports of broken thighs and back injuries as well as the necessity of amputating various limbs.[1] One example of the risks of injury to the miner are illustrated in a report on March 26th, 1864 which describes an incident in which a hanger-on was killed by a fall of bricks down the shaft. From the Inspector's Report this would appear to have been G Pinner, aged 29, and the paper reports that previous to his death, Pinner had been involved in three earlier pit accidents in which he had: 1. broken his leg, 2. broken his thigh, and 3. injured his back. He had only just recovered from the latter accident when he was killed.[2]

The Shropshire coalfield, then, with its subcontracting organization and high rate of shaft and roof fall accidents was an area which was likely to benefit from the increased activities of the Inspectors of Mines, which is borne out in the figures in Tables XII and XIII.

[1] Many examples, at least one report of death or injury a month, e.g. 1863 *W.J.*:

January 3rd	2 burnt, explosion of firedamp, Dawley.
	1 burnt, Grange Pit.
January 24th	2 burnt, explosion of gas, Dark Lane.
January 31st	Severe injuries, fall of earth.
	One injured by kick from horse.
	Rope broke, 1 hurt, 2 escaped.
February 7th	2 seriously burnt, explosion firedamp, Halesfield Pit
February 21st	1 killed on incline.
	Leg broken, fall of earth.

[2] Report of the Inspector of Mines, 1864, Mr Wynne's Report, p75; *W.J.* 1864 March 26th.

2. ACCIDENTS IN OTHER INDUSTRIES

Although no other industry presented such considerable risks as mining, there were still many hazards which confronted the workforce. Wherever there was unguarded machinery or power transmission systems there was a danger of entanglement through falling into the moving parts, of being caught by sudden starts of the machinery whilst maintenance was being carried out or by loose hair or clothing becoming ensnared in the moving cogs and transmission belts. Boiler explosions were frequent, as were explosions caused from other sources, and wherever wagons or trucks were shunted or moved there was danger of injury. Construction sites were the scenes of falls from scaffolding and dangers from the collapse of structures, whilst the drawbacks in the balance and designs of cranes created hazards both at building sites and in the dockyards. Many minor injuries were caused by flying particles or splashes from hot liquids and acids. These were particularly damaging if they came into contact with the eyes.[1] Other causes of accidents were blows from falling bodies, the use of hand tools and the mishandling of goods.

Although some accidents were undoubtedly due to inattention and carelessness on the part of the worker, exacerbated on occasions by an excessive consumption of alcohol, others were due to defects and limitations in the design of plant and the layout of manufactories. Lack of understanding and experience in handling materials were also a source of danger and liability to accidents was increased by fatigue and stress caused by long hours of work and sometimes poor ventilation.

[1] As seen on pages 233-235.

2.a. Explosions

One type of accident which usually caused considerable damage, both to property and life, was that involving explosions.[1] Not only were the lives of the workmen put at risk but also those of passers by or inhabitants of adjacent buildings. Table XXI is taken from a lecture given to the Society of Arts in 1881 and gives details of the deaths from explosions as recorded by the Registrar General from 1852 to 1879 in England and Wales.[2] Three main causes of explosions were itemised, namely firedamp, steam boilers and chemical substances. (Table XXII). Of these, firedamp was the most destructive to life. The problems that it caused have been covered in the previous section on mining accidents. Boiler explosions also occurred at mines but were common in any industry which employed steam power as a motive force. The damage done to property was sometimes extensive. In 1862 a terrific explosion occurred at Fenton Park Colliery and Ironworks in North Staffordshire. The complex had consisted of two blast furnaces and two, 40 h.p. engines which were connected to four boilers. One of the boilers was undergoing repairs when the other three exploded. As a result, one blast furnace was hurled down to the foundations and the other was badly shattered. The roof of the engine house was blown off and some of the walls broken down. The engines were also damaged with one of the massive beams being broken up. As to the fate of the boilers; one was hurled over a hedge and ditch, a distance of 400 yards and finally ended up in a reservoir; a second was thrown in the opposite direction, landing on the highway; and a third was simply scattered in all directions. The boiler under repair was removed several yards, turned over and somewhat broken.

[1] Which also led to the risk of fire. Although fire might be considered a form of industrial hazard it is beyond the scope of this study.

[2] Cornelius Walford 'The Increasing Number of Deaths from Explosions with an examination of causes' *J.S.A.* 1881 March 25th, p400.

TABLE XXI: Deaths from Explosions 1852 - 1879 (England and Wales)

Year	Number of Deaths from Explosions		
	Males	Females	Total
1852	290	6	296
1853	232	9	241
1854	297	12	309
1855	206	9	215
1856	307	5	312
1857-1862*			
1863	266	12	278
1864	216	10	226
1865	164	8	172
1866	289	8	297
1867	590	12	602
1868	379	13	392
1869	407	18	425
1870	311	12	323
1871	258	73	331
1872	265	10	275
1873	171	18	189
1874	287	17	304
1875	242	22	264
1876	341	12	353
1877	131	13	144
1878	391	13	404
1879	450	12	462
Total	6490	324	6814

Source: *J.S.A.* 1881 March 25th, p400.

* 1857-1862 No returns

TABLE XXII: Causes of Deaths by Explosion 1852-1879 (England and Wales)

Year	Firedamp	Boilers	Chemical	Undefined	Total
1852	240	38	18	-	296
1853	194	16	31	-	241
1854	215	41	53	-	309
1855	128	41	46	-	215
1856	215	62	35	-	312
1857-1862*					
1863	178	62	38	-	278
1864	119	50	57	-	226
1865	74	51	44	3	172
1866	191	65	41	-	297
1867	169	42	71	320 [1]	602
1868	246	23	123	-	392
1869	274	57	94 [2]	-	425
1870	196	59	68	-	323
1871	149	16	166 [3]	-	331
1872	173	10	92	-	275
1873	89	22	78	-	189
1874	194	24	86	-	304
1875	127	38	99	-	264
1876	191	21	141	-	353
1877	72	26	46	-	144
1878	313	21	70	-	404
1879	372	37	53	-	462
Total	4119	822	1550	323	6814

Source: *J.S.A.* 1881 March 25th, p400.

* 1857-1862 No returns

Ref.:
1. All males, cause not stated but likely to be firedamp.
2. Includes 30 by steam, probably scalding from steam after explosion.
3. 63 were due to the explosion of gunpowder, all females.

Miraculously, despite the immense damage to property, only one man was killed. The cause of the accident was put down to negligence in not keeping a sufficient supply of water in the boiler so that the plates had become red hot and when water was admitted, the explosion resulted. In addition to the complete stoppage of work, the estimated damage to property was put at not less than £4,000 to £5,000.[1]

Other boiler explosions caused greater loss of life. Within two months of the above accident one of the worst boiler explosions of the 19th century occurred at Millfield Ironworks, Priestfield, in Staffordshire, with twenty-eight people being killed and ten seriously injured.[2] The Millfield Works consisted of two forges and three mills. About three-quarters of the No. 1 boiler, weighing approximately eight tons, was forced two to three hundred feet in the air, causing great destruction as it fell back to the ground. The remaining quarter was driven outwards through the forge in three directions. A newspaper account reported that it tore,

> "down the iron pillars which supported the roof, and rending the massive timber beams which rested upon them into splinters. At the same time the brickwork and masonry of the furnaces, with their contents of molten iron, and the burning coals from their fires, were hurled in all directions and with the flying debris men were driven bleeding and lifeless. Others were buried beneath the molten iron, the burning coals and the red-hot brickwork. Within an hour after the explosion, fourteen bodies had been recovered, all of them shockingly mutilated. One body was without its head, another fell to pieces as it was lifted, literally cut in two and extremities burnt away, others were badly disfigures. Fifteen others were discovered alive but sadly injured." 3

[1] *W.J.* 1862 March 1st.

[2] Walford (1881), p411.

[3] *W.J.* 1862 April 19th. The casualty figures in the quote do not tally with the later official figures.

The damage to property was put at between £2,000 and £3,000. The cause of the accident was not ascertained but it was not due to lack of water, as there had been an abundant supply in the boiler at the time of the explosion.[1]

One feature of the Industrial Revolution was the gradual change over from water power to steam power as the primary power source. Although the first steam engines presented some dangers to their users, they were not attended with the more disastrous consequences of the high pressure boilers which were adopted in the 1830's. The earlier boilers worked at a pressure of 10 to 12 lbs, with Boulton and Watt recommending a rule of 7 lbs for their engines, but the new boilers worked at 30 to 40 lbs pressure and due to a lack of knowledge of the properties of steam exceeding 10 lbs per square inch, accidents occurred.[2] There seems to be little data on boiler explosions before about 1850, when both the Registrar General and Insurance Companies began to keep statistics. A table was compiled in 1881 by E B Marten, the chief engineer to the Midland Steam Boiler Protection and Assurance Company (Table XXIII) but it is unclear on what information he based his earlier data. Although his figures include the whole of the United Kingdom, there seems to be little correlation with the number of deaths as recorded by the Registrar General. (Compare with Table XXII) in the latter years. However, the Manchester Steam Users Association also collected data and their statistics for 1865 to 1869 (Table XXIV) do relate more closely to those prepared by Marten. Marten's statistics, especially in the first half of the 19th century, are likely to be incomplete; nevertheless the apparent large increase in accidents in the second half of the century is not just a result of this, nor of more negligence but must also be a reflection of the growing use of steam power in

[1] Ibid.

[2] 1870 Report from the Select Committee on Steam Boiler Explosions Proceedings of Committee Minutes and Evidence (370) Evidence - Sir William Fairbairns 6.

TABLE XXIII: Showing approximately the number of steam boiler explosions in the United Kingdom and the loss of Life and injury resulting 1800 - 1880

Year	Number of Explosions	Killed	Injured	Total Killed or Injured
Unknown	1	-	-	-
1800-1809	1	3	5	8
1810-1814	5	10	3	13
1815-1820	7	42	33	75
1821-1825	3	8	-	8
1826	1	-	16	16
1827	5	19	-	19
1828	2	-	-	-
1829	2	1	5	6
1830	3	15	57	72
1831	3	8	10	18
1832	7	14	11	25
1833	-	-	-	-
1834	-	-	-	-
1835	3	1	-	1
1836	3	10	8	18
1837	2	1	-	1
1838	16	24	30	54
1839	5	4	2	6
1840	3	4	6	10
1841	7	10	33	43
1842	8	40	23	63
1843	12	-	24	24
1844	8	22	6	28
1845	18	36	100	136
1846	11	25	26	51
1847	17	19	64	83
1848	9	41	23	64
1849	11	12	33	45
1850	13	31	42	73
1851	14	58	23	81
1852	10	17	17	34
1853	18	35	95	130
1854	15	36	34	70
1855	35	38	55	93
1856	33	66	105	171
1857	37	80	57	137
1858	34	50	89	139
1859	39	75	71	146
1860	35	78	82	160
1861	30	46	42	88
1862	36	91	69	160
1863	51	79	78	157
1864	51	67	116	183
1865	58	50	92	142
1866	70	85	160	245

(continued...)

TABLE XXIII: continued

Year	Number of Explosions	Killed	Injured	Total Killed or Injured
1867	48	70	88	158
1868	45	57	71	128
1869	59	87	128	215
1870	70	85	138	223
1871	66	66	113	179
1872	74	50	137	187
1873	88	66	94	160
1874	76	77	198	275
1875	68	81	142	223
1876	39	93	110	203
1877	44	54	75	129
1878	46	47	84	131
1879	30	38	53	91
1880	31	71	83	154
Total	1536	2293	3259	5552

Source: *J.S.A.* 1881 March 25th, p412.

TABLE XXIV: Number of Persons Killed and Injured by Steam Boiler Explosions: 1865-1869

Year	Number of Explosions	Killed	Injured [1]	Total killed or injured
1865	48	46	79	125
1866	72	87	109	196
1867	36	60	67	127
1868	45	57	60	117
1869	58	86	126	212
Total	259	336	441	777

Source: 1870 Report from the Select Committee on Steam Boiler Explosions - Proceedings of Committee Minutes and Evidence (370) Appendix No. 3, p117 - Manchester Steam Users Association.

Ref.: *1* Only includes those seriously injured manufactories and elsewhere. The 1871 Committee on Steam Boiler explosions estimated that there were 100,000 steam boilers, exclusive of locomotive engines, steamships and domestic and hot house boilers, in use in the United Kingdom.[1]

One of the main causes of boiler explosions was the deterioration in the original strength of the boiler. This could result from unseen or inaccessible leakages causing corrosion or from hasty repairs carried out imperfectly. These problems were aggravated if the original was malconstructed or not designed for the use to which it was put. Another source of danger was the use of defective materials such as inferior or brittle plates and rivets. This made them liable to crack under the continual strain of expansion and contraction of a working boiler. A common fault was for a crack to appear between the rivet holes, or from the rivets to the edge of the plate. Where construction was difficult, defective workmanship might cause leakages and hence corrosion. A small leak was generally more dangerous than a large, as it was less likely to be detected. Inaccurate punching of rivet holes also weakened the boiler and the practice of hammering the rivets until they were cold, rendered them more brittle. Repairs were not always carried out as perfectly as they should have been due to the adverse conditions in which the job might have to be performed. Many explosions were put down to a shortness or inadequate supply of water. Although this undoubtedly did cause some accidents, it was indicated as the cause more often than was, perhaps, the case. It was easy for blame to be put on the engine man as he was often a victim of the explosion and not all inquests were supplied with technical help to enable them to detect the true cause of the accident. Another cause of explosion was undue pressure in the boiler arising from a defective safety valve in combination with some other defect which weakened the strength of the boiler. Most explosions in fact were the result of a combination of several of the above factors.[2]

1 1871 Report from the Select Committee on Steam Boiler Explosions Proceedings of Committee Minutes and Evidence (298) piii.

2 1870 Report Steam Boiler Explosions (370) Evidence of witnesses generally and notes from James Nasmyth, -120.

Concern about boiler explosions was shown early on as it was in the interests of the steam users to protect themselves against explosions. The Society of Arts awarded a silver medal to a Swedish gentleman, Chevalier Edelcrantz, in 1804 for a double, safety valve and in 1817, offered a premium of a gold medal and not less than thirty guineas to anyone 'preventing explosions in steam engines and other covered boilers.'[1] Further awards, along the lines of safety valve improvements, were made in 1825, 1836 and 1840 [2] but more positive steps towards reducing the number of accidents from boiler explosions came in 1855, with the setting up of the Association for the Prevention of Steam Boiler Explosions. This was also known as the Manchester Steam Users Association.

The Association came about due to the concern of the civil engineer Sir William Fairbairn, who in the 1830's had been called in to help with inquiries in the Manchester area into certain boiler explosions. In the early 19th century the insurance offices dealt purely with fire and life insurance.[3] Boiler owners often attempted to cover the financial loss of a boiler explosion by claiming on their fire insurance policy but the fire offices rarely admitted these claims. In 1852, the North of England Insurance Company considered the claim of Mark Tomkins of the Green Bank Saw Mill, Wapping. His 60 h.p. boiler had exploded destroying both the mill and adjacent buildings. The insurance company decided that the accident was due to the defective state of the boiler and refused to admit

[1] *T.S.A.* 1804, Vol.XXII, pp328-334; 1817, Vol.XXXV, p20.

[2] *T.S.A.* 1825, Vol.XLII Silver medal to Mr C Socke, pxxiv; 1836-38 Vol.LII Silver medal to Isaac Dodds, pp69-71; 1840-42, Vol.LIII Gold Isis Medal to Robert McEwen, pp58-62.

[3] For general history of insurance companies, see: Barry Supple *The Royal Exchange Assurance: a history of British Insurance 1720-1970* (1970), pp224-225. This deals with the introduction of accident insurance in the second half of the 19th century as technology became more sophisticated. The insurance introduced was not only for boiler explosions but also against accidents with lifts and cranes.

liability. Of the major fire insurance offices, only the Sun was prepared to contribute anything towards boiler losses,[1] Fairbairn therefore advocated the formation of a society of local mill owners to protect property and the lives of those who lived and worked near the boilers and mills operated by steam.

The Association got under way in 1855 and was strictly voluntary. Those who joined were allowed periodic inspections and a thorough one (i.e. inside the boiler as well as outside) once a year.[2] By December 31st, 1855, it had 269 members owning 920 boilers and four years later, at the close of 1859, it had 538 owners operating 1,619 boilers.[3] However, its business began to fall off with the formation of insurance companies specifically to cover boiler explosions. The first such company was formed in 1859 in Manchester and was known as the Steam Boiler Assurance Company, although it changed its name to the Boiler Insurance and Steam Power Company when it became a limited company.[4] By the end of 1860, it had received proposals for 3,149 boilers.[5]

Following the explosion at the Millfield Ironworks in South Staffordshire in April, 1862, the Midland Steam Boiler Inspection and Insurance Company was set up by George Barker who became chairman. The Steam Boiler Assurance Company had mainly directed its attention towards the textile mill owners in the Manchester area, whereas this new company was directed towards the ironmakers.[6] Due to the rise of these insurance companies and others,[7] the

1 H A L Cockerell & Edwin Green *The British Insurance Business 1547-1970* (1976), p51.

2 1870 Report Steam Boiler Explosions (370) Evidence - Sir William Fairbairn 5 & 6.

3 Walford (1881), p412; a similar association was also formed in Huddersfield in 1858.

4 1870 Report Steam Boiler Explosions (370) Evidence - William McNaught 1247 & 1249.

5 Walford (1881), p412.

6 1870 Report Steam Boiler Explosions (370) Evidence - George Barker 1601, 1602 & 1603.

7 The old fire and life assurance companies also began to open departments for accident insurance.

Association added insurance to its business in 1864 so that not only were the members given advice on inspection but were guaranteed, should an explosion occur, to receive the full value of the exploded boiler. It remained however, a non-profit making society and any surplus money was put to research into boiler construction.[1] Examination was a condition of any insurance and by 1868 the number of boilers under inspection by the four largest companies was as follows:

Boiler Insurance & Steam Power Company	10,900
Midland Steam Boiler & Assurance Company	2,600
Nation Boiler Insurance Company Limited	2,000
Association for Prevention of Steam Boiler Explosions	1,900 [2]

This gives a total of 17,400 boilers insured and inspected in some form (plus a few extra with other companies) but with the 1871 Committee estimating there to be 100,000 manufactory boilers in existence, it still left many outside any form of examination or insurance.[3]

There is no doubt that where boilers were inspected, much good resulted. From 1861, the Association published monthly reports which were also printed in the press.[4] For example, in March 1862 examinations of 363 engines and 563 boilers were carried out. Of the boilers, 10 were examined specially, 8 internally, 87 thoroughly and 458 periodically.[5]

1 Walford (1881), p412; 1870 Report Steam Boiler Explosions (370) Evidence - Sir William Fairbairn 6.

2 Walford (1881), p412.

3 By 1881 it was believed that 40,000 to 50,000 boilers were insured in the UK, Walford (1881), p413.

4 1870 Report Steam Boiler Explosions (370) Evidence - Mr Lavington, Chief Engineer, Manchester Steam Users Association 131. Copies of the report appeared from time to time in the J.S.A.. e.g. 1862 May 23rd, p442; June 13th, p479.

5 Periodic examinations were those carried out quarterly . Those carried out specifically were at the request of the owner where there was thought to be some danger. A thorough examination required a stoppage of work and the boilers cleaned and prepared ready for the inspectors. The distinction between this and an internal inspection is unclear.

138 defects were found of which 12 were considered to be of a dangerous nature. The faults discovered were:

Fracture	14 (3 dangerous)
Corrosion	47 (5 dangerous)
Safety Valves out of order	18 (1 dangerous)
Water Gauge out of order	8
Pressure Gauge out of order	8
Blow Out Cock out of order	33
Fusible Plugs out of order	4
Furnaces out of shape	6 (3 dangerous)

It was also found that five boilers were without glass water gauges, twenty-two without pressure gauges, fifteen without blow off cocks and forty-two without back pressure valves. Inthat month there were no explosions of any of the Association boilers but four occurred elsewhere, of which three involved loss of life.[1] The Association aimed to inspect the boilers every quarter, with a thorough inspection once a year.[2]

The question of the need for Government inspection arose from time to time.[3] The boilers of steamships had been under the control of the Board of Trade since the Merchant Shipping Act of 1854. Section 16 of this Act made it unlawful for passenger steamers to put to sea with twelve passengers or more unless they had a Board of Trade Passengers Certificate. This was only granted after the boilers had been inspected. The Merchant Shipping Act of 1876, extended this by giving the Board of Trade powers to detain steamships with less than twelve passengers for inspection, if they were considered in any way to be unsafe.[4]

[1] *J.S.A.* 1862 May 23rd, p442.

[2] 1870 Report Steam Boiler Explosions (370) Evidence - Sir William Fairbairn 59.

[3] Report of the Inspectors of Factories for the Half Year ending 31st October 1850 (1304) R S Saunders' Report, pp57-58. After an accident at Halifax in which 10 people were killed and 20 injured, a meeting of mill owners was held which unanimously agreed to the need of Government Inspection and to lobby accordingly.

[4] 1888 Memoranda prepared for the consideration of the Rt Hon the President of the Board of Trade (Boiler Explosions), p8.

Boilers at both coal and metalliferous mines were under the control of the relative Mines Acts of 1872.[1]

In 1869, a tragic boiler explosion occurred at Bingley which led to a lobby to the Government to set up a Select Committee to look into the causes and best preventative measures to reduce the number of boiler explosions. The explosion occurred at the premises of Messrs Town & Son, bobbin turners. Next door to the building housing the boilers was a school playground and twenty-five children were buried in the explosion. Eight children died, as did seven other people and thirty-three people were seriously injured.[2] Shortly after this incident, an explosion occurred in Swansea killing three people and injuring four others, and another at Warrington saw a death toll of six, with three seriously injured. In the terms of reference of the 1870 Committee it was remarked that:

> "The most casual readers of the public newspapers must have had forced upon their attention the constant occurrence of boiler explosions, with the distressing consequences attendant thereon." [3]

The Select Committee made two reports, the first in 1870 and the second in the following year. Although the evidence of the witnesses was broadly in agreement on the causes of boiler explosions, there was conflict over the best means of prevention. The Committee felt,

> "that the majority of explosions arose from negligence either as regards original construction, inattention of users and their servants, neglect of proper repairs, thoughtlessness in setting, and absence of proper and necessary fittings." [4]

[1] 1892 Mines (Coal) Regulation Act 35 & 36 Vict. c76; 1872 Metalliferous Mines Regulation Act 35 & 36 Vict. c77.

[2] W.G. 1869 June 12th; 1870 Report Steam Boiler Explosions (370) Evidence - Mr Lavington 134 & Appendix, p113.

[3] 1870 Report Steam Boiler Explosions (370), Appendix, p113.

[4] 1871 Report Steam Boiler Explosions (298), piv.

Although they deplored the setting up of boilers in the heart of large centres of population and saw the value of inspection as carried out by the Association and Insurance Companies, they felt that compulsory Government inspection was not called for. The reasons given were that although, on average, there were fifty explosions per annum, this only amounted to about one in every two thousand boilers and that many of the explosions which did occur, resulted from causes which would not have been found in any periodic examinations. They were also concerned that Government inspection might lessen the responsibility of the boiler users, who were in fact in the best position to ascertain the condition of the boiler and the competency of the men employed to operate them.[1] They recommended that in the event of an explosion the coroner should be supplied with technical assistance to help in the inquiries. No recommendations were made on the setting up of new boilers, although this was obviously a cause of concern amongst the public, with the Broughty Ferry Commission of Police writing to the Factory Inspectorate in 1876 to see if they had any powers to inspect boilers under construction.[2]

A Boiler Explosions Act was passed in 1882[3] but it simply gave the Board of Trade powers of inquiry and not inspection. It required that on the occurrence of an accident, notice be given to the Board of Trade who could then appoint an independent engineer if they felt circumstances demanded it, to investigate the cause of the accident[4].

1 Ibid.

2 Report of the Inspectors of Factories for the Half Year ending 30th April 1876 (1572) Alexander Redgrave's Report, pp31-32.

3 1882 Boiler Explosions Act 45 & 46 Vict. c22.

4 Some special reports by the Board of Trade into specific boiler explosions were: Report Boiler Explosion at Messrs Hill & Smiths Works, Brierly Hill, 1882 (C 3227); Report Boiler Explosion at Messrs Wm Wallace & Co.'s Works, Burnbank, Glasgow 1882 (C 3308); Report Boiler Explosion at Messrs Burrow & Burrow's Blue Brickworks, Great Bridge, Staffs. 1882 (C 3286).

An attempt was made in 1887 to get a bill passed requiring registration and inspection of boilers but it failed, and although a further Boiler Explosions Act was passed in 1890, it only made slight amendments to the 1882 Act and gave no powers on inspection.[1]

The subject was discussed again in 1900[2] when it was still felt that compulsory Government inspection was undesirable. The reasons given were two-fold; there was opposition to diminishing the responsibility of owners and it was argued that any inspectors within a Government department would follow strict guidelines on inspection which would hamper the development of boiler improvements. The Committee reported that the best way to increase voluntary inspection and insurance was to inflict heavier penalties on owners brought to court under the Boiler Explosions Acts of 1882 and 1890 and found not to have had their boiler regularly inspected by a competent person or who had worked their boiler at a pressure above that certified as suitable, or who had been negligent in carrying out the recommendations of the inspector. They also suggested that an extension of the Factory Acts could be made so that Factory Inspectors could call upon boiler users to produce a certificate or some other proof, that their boiler had been inspected within the last year by a competent engineer. Where the Factory Acts did not apply, they suggested that the same authority could be vested in the police. The Committee considered that,

> "The boiler making industry has made great strides in recent years; that boilers are, as a whole, better designed, better made, and better managed and understood than they were only a few years ago; and that legislation giving any Government Department control over the inspection of boilers would be a grave mistake." 3

1 1888 Memoranda (Boiler Explosions); 1890 Boiler Explosions Act 53 & 54 Vict. c35.

2 1900 Boiler Registration and Inspection (294).

3 Ibid. p2.

Firedamp and steam boilers were not the only cause of explosions. Explosive accidents occurred in the handling and manufactury of certain chemicals, gunpowder, fireworks and gas, and some dusts also had explosive properties. Another source of danger was when molten metal came into contact with water. This usually occurred in ironworks. For example, in a forge in Hunslet, in February 1859, a puddler accidentally dropped a puddled ball into some water which caused the heated iron to explode, sending one fragment, weighing 58 lbs, through the roof.[1] The usual cause of such accidents was fatigue, inexperience or carelessness of the worker.[2] There was considered to be little that could be done to prevent such accidents except words of caution to workers.

Gunpowder was, of course, designed to be destructive but it could easily be ignited unintentionally. One problem of using it as a blasting agent in mines and quarries was the risk of premature ignition and many miners and quarrymen were injured in this way.[3] Gunpowder and explosives were, in general, treated with the respect due to them. Mills were placed in remote areas, such as the Lake District, in order to prevent damage to other property and the processes were carried out in detached buildings in order to lessen the risk of explosion and danger to human life within the complex. Explosions did still occur but the damage was kept to a minimum where the above precautions had been taken. It was also an industry which

[1] *W.J.* 1859 February 19th.

[2] *W.J.* 1863 June 6th; a youth threw wet sand at some hot cinders, causing explosion with several burnt. Other incidents: *W.J.* 1866 October 20th, water came into contact with hot slag; 1869 September 25th, waste iron was run in liquid state into a mould and turned out before cool, it came in contact with water and exploded.

[3] Mines, *W.J.* 1859 March 19th, Maws, Benthall, Salop; 1861 January 19th, Mossey Green, Salop; 1862 March 8th, Little Flints Pit, Salop. Quarries, *W.J.* 1858 December 18th, Limeworks Dudley Port; 1865 September 9th, Fertinlog Slate Quarries; 1868 August 1st, Oswestry.

employed very few people.[1]

Cartridges and percussion caps were made entirely by female labour. The London factories tended to be better managed than those in Birmingham, where the buildings were much older and less suited for the occupation. An explosion in 1859, in Birmingham, killed 19 girls and another in 1862 killed 9 (three aged 10, 13 and 14) and injured 40.[2] Arsenal stores and firework factories also presented problems. In July 1858, an explosion of fireworks occurred in a factory on the Westminster Road, London. A rocket was ignited by the explosion which landed in the premises of another firework factory on the opposite side of the street This set off a further explosion. Five people were killed and over 300 injured in the confusion that followed.[3]

1 The Society of Arts issued a silver medal in 1819 to Mr Monk of Tonbridge for a method to reduce explosions whilst grinding and mixing gunpowder. The premium was first offered in 1797. Examples of explosions at powder mills are: *W.J.* 1861 October 26th powder mill at BallinCollig, Cork, Ireland - 5 killed. A previous explosion had occurred on the site in August 1859, 5 killed. A further explosion in 1869; *W.J.* 1869 October 16th, when three of the 24 sheds were destroyed; *W.J.* 1867 April 6th, Faversham Powder Mill, 4 killed, one seriously injured, explosion occurred in the mixing house; 1868 August 1st, Ulverston Powder Mill, 9 killed; 1869 May 22nd, total destruction of 8 powder mills after explosion of gunpowder at New Sedgwick Gunpowder Works, near Kendal. See also the list of explosions in Walford (1881), p409 and Paul Wilson 'The Gunpowder Mills of Westmorland and Furness' *Transactions of the Newcomen Society* 1963-1964, Vol.XXXVI, pp47-65. Examines the development of the industry in this area and also lists the explosions which occurred (p63).

2 *W.J.* 1859 October 1st; 1862 June 28th; Phillips Bevan (1876) p112. *B.M.J.* 1870 December 17th, p667, reports on four explosions in Birmingham cartridge manufactories within 6 to 7 weeks. In one, 18 people were killed and 50 injured.

3 *W.J.* 1858 July 17th; Example of firework explosion. *W.J.* 1868 October 10th; Firework manufactory in Barnsley, 7 killed and 7 injured: only employed 15 people. Examples of explosions at arsenals are those which occurred at the Woolwich Arsenal in the 1860's. *W.J.* 1861 August 31st: rocket explosion, no loss of life as since the last fatal accident when several lives were lost, the sheds had been rebuilt, detached, with corrugated roofs and rapid means of escape; 1866 October 6th, another explosion, no cause ascertained; *BMJ* October 12th p320; explosion occurred on October 5th, 22 injured of whom 11 were serious. The report gives details of each man's injuries; 1867 October 19th, p342, five of the above since died and two or three more not expected to live.

The risk of explosion was present to a greater or lesser degree in chemical stores. An incident in Gateshead and Newcastle in 1854 caused an estimated £600,000 worth of damages, when a fire, which had broken out in a worsted manufactory in Gateshead, spread to an adjoining building in which various chemicals were stored. This included 47 tons of sulphur covered by a tarpaulin on which 45 tons of nitrate of soda has been placed so that with the intense heat of the fire, an explosion occurred. It was such that shipping on the Tyne was ignited and the fire was carried over to the Newcastle side of the river where it destroyed many houses. The warehouse had been considered to be a double fireproofed building, as it had metal pillars and floors, and was lined with iron sheeting.[1]

In an attempt to control these and similar accidents, the Explosives Act of 1875 was passed.[2] This contained a number of far reaching rules on the production and storage of gunpowder and other explosives. The essence of these regulations was that gunpowder and explosives should be kept in separate stores and no two explosive substances should be kept within the same store. To reduce sparks the buildings in which processes of manufacture and mixing were performed, should be constructed so that there was no exposure of iron and steel, and the only tools used should be made of wood, copper, brass or some other soft metal. The workers were to be provided with suitable clothing and shoes, and the whole area kept free of grit. Smoking was banned and no other person under the age of 16 allowed to work or enter such buildings unless supervised by an adult. As many explosions were the result of powder mills being struck by lightning, factory magazines and buildings housing dangerous materials were required to be fitted with lightning

[1] Walford (1881), p401.

[2] 1875 Explosives Act 38 & 39 Vict. c7. Gunpowder had been subjected to several earlier Acts, going back as far as a Fire Ordinance of the City of London in 1667, mostly to do with storage and sale.

conductors.[1] Firework manufactories were required to be located away from densely populated areas.[2] The regulations if put into operation, provided useful means of reducing the level of explosions but some managers neglected to enforce them, as was found by an Inspector of Explosives when examining an incident at the powder mill at Elterwater, near Ambleside, in which three people were killed and one injured. The manager of the works appeared to have failed to ensure the observance of the Special Rules, which were habitually disregarded there.[3]

Gas explosions, other than firedamp, were usually associated with the production of coal gas for illumination. Due to the nature of the demand, gasworks were frequently located in densely populated neighbourhoods. The explosions more often than not occurred whilst the holders were undergoing some form of repair or maintenance.[4] There was also considerable risk to shipping engaged in the steam coal trade and in 1876, the Board of Trade held an inquiry after an explosion on board the Atalanta at Cardiff. She had been carrying 1,400 tons of steam coal in her hatches and the accumulated gases had been ignited by the second mate lighting a match. The report recommended a system of ventilation to reduce the risk.[5]

1 1875 Explosives Act s 10, general rules for gunpowder factories and magazines, s 17 for gunpowder stores and s 40 for other explosives.

2 Walford (1881), p407.

3 Ibid. p410; the incident occurred in 1878.

4 Suggested in Walford (1881), p416 and seen in the following examples of explosions at gas holders: W.J. 1861 August 31st, Bridgnorth, Salop; 1862 June 14th, Dawley, when adjusting a gasometer after it had been moved by high winds. Three burnt, one later dying; 1865 November 4th, explosion at London Gas Light Co. Nine Elms - 10 killed.

5 Walford (1881), p408.

Dust for a long time had been known to be inflammable and an accessory in extending the force of an explosion but it was not suspected of being an explosive agent in its own right until the last quarter of the 19th century. Apart from coal dust which has been discussed in the previous section,[1] other explosive dusts were flour, rice, malt, wood and cotton. First suspicions of the dangerous nature of flour dust came in an enquiry after an explosion at the Tradeston Mills and Granaries, near Glasgow, in July 1872. The circumstances of the fire appeared, to the owners and the fire offices, to be inexplicable, as the business was conducted along model lines, with every precaution taken. The fire offices thus appointed W J Macquorn Rankine and Stevenson Macadam to investigate. The cause was traced to an accidental stoppage in one of the feeds to a pair of grinding stones allowing them to become hot and to throw off sparks. This appeared to have ignited the dust entering the exhaust conduits and the sudden combustion caused an explosion which burst the exhaust box, thus releasing a large cloud of flour dust. This ignited in a second explosion, reducing the mill to rubble and setting the woodwork on fire.[2] This theory helped to explain other accidents in flour mills; for example, the explosion at the Albion Flour Mills in 1791, which caused an estimated £150,000 damages, and at the time was thought to have been caused by arson. It was also the explanation advanced in a Government report of 1882, on an explosion at a corn mill in Macclesfield where £5,000 to £6,000 of damage was done.[3] The Secretary of the Millers Mutual Fire Insurance Company said that between 1876 and 1882 there were, to his knowledge, 84 serious fires in corn mills, of which 56 had been from unknown origins but which were most likely to have been the result of an explosion of flour dust. Similar, if not

[1] See pages 245-266.

[2] Walford (1881), p407.

[3] Tim Shaw 'A Blaze for the London Mob - The Burning of the Albion Mills' *Country Life* 1966 December 29th, pp1722-1724; *J.S.A.* 1882 March 10th, p452.

greater risks were seen in the cleaning and grinding of rice. Fire insurance premiums were consequently high and several companies refused to insure them at all.[1]

2.b. Machine Accidents

A second category of industrial accidents was those involving machinery and although not causing injury and damage to the extent produced in explosions, the injuries to the individual were often extensive and could sometimes prevent the person from pursuing further employment. The mutilation caused public concern, although there was a feeling amongst some that the accidents were due to the carelessness of the operatives and that the situation therefore demanded increased attentiveness at work, rather than action by the employers, in order to be remedied.[2]

The types of machine accidents were extremely varied but can be placed in four categories: danger from the water wheel or steam engine; from the shafts, belts and straps transmitting the power; from the machinery used in making the product; and from the hoists or teagles employed in factories to transport materials and people from one floor to another. The chief danger came from moving parts being left unfenced allowing workers to become entangled by loose clothing or hair, or permitting the hands to get too close to rollers and cogs. Another hazard came in oiling or cleaning the machinery without stopping it first, and also in trying to put a belt in gear by hand whilst the power source was connected or in repairing and replacing straps.[3]

[1] *J.S.A.* 1882 March 10th, p452.

[2] For example see remarks made by W Cooke Taylor in 1844 and recorded in Maurice Walton Thomas *The Early Factory Legislation* (1970), pp225-226.

[3] For examples of individual accidents see any of the Half Yearly Reports of the Inspectors of Factories from the 1840's onwards.

The Commission into child labour in 1833 reported:

"One of the great evils to which people employed in factories are exposed is the danger of receiving serious and even fatal injury from machinery. It does not seem possible, by any precautions that are practicable, to remove this danger altogether. There are factories in which everything is done it seems practicable to do to reduce this danger to the least possible amount, and with such success that no serious accident happens for years together. By the returns which we have received, however, it appears that there are other factories, and, that these are by no means few in number nor confined to the smaller mills, in which serious accidents are continually occurring, and in which, notwithstanding, dangerous parts of the machinery are allowed to remain unfenced. The greater the carelessness of the proprietors in neglecting sufficiently to fence the machinery, and the greater the number of accidents, the less their sympathy with the sufferers. In factories in which precaution is taken to prevent accidents, care is taken of the workpeople when they do occur, and a desire is shown to make what compensation may be possible. But it appears in evidence that cases frequently occur in which the workpeople are abandoned from the moment an accident occurs; their wages are stopped, no medical assistance is provided, and, whatever the extent of the injury, no compensation is afforded." [1]

The original bill for the 1833 Act had contained a clause to provide compensation for dependants of operatives killed by unfenced machinery but this had been dropped during the progression of the bill through Parliament, due to opposition from manufacturers.[2] As finally passed, the Act of 1833, which covered various branches of the textile trade,[3] had no provisions on fencing and did not even require that accidents be reported. Apart from making the first Factory Inspector appointments, it was concerned with limiting the age and hours of work of children employed in textile mills, making some provisions for their education.

[1] Quoted in Report of the Inspectors of Factories for the Half Year ending 30th June 1840 (261) Leonard Horner's Report, p13.

[2] M W Thomas (1970), p226.

[3] Woollen, worsted, cotton, line, jute, flax and tow.

Although the Inspectors set up by the Act thus had no powers at all over accidents occurring in mills, it did not prevent them from making comments in their reports. As early as 1835, both R J Saunders and T J Howells drew attention to the frequency of machine accidents and to the grave mistake of omitting them from the provisions of the Act.[1] Howells, in 1839, justified his remarks on accidents, although not within the scope of the Inspectorate, by referring to the danger in which the Inspectors themselves were placed by the close proximity of unguarded, moving machinery whilst making their inspections of mills.[2] The case of *Cotterell v Stocks* in 1840 helped step up the campaign to get machinery guarded. This was the case of a 17 year old girl, Elizabeth Cotterell, who worked at the cotton mill of Samuel Stocks & Son in Heaton Mersey. Whilst at work, her clothes had been caught up by an unboxed shaft and she had received severe injuries. The case was taken up by Lord Ashley, who sued the millowners for the damage done to the girl. The proceedings took place at the Liverpool Assizes and were found in favour of the girl, who was awarded £100 damages and costs.[3] At the same time, a Select Committee was investigating the working of the 1833 Act and made its report in February 1841, in which it showed concern over the frequency of machine accidents. It proposed that the cleaning of machinery whilst in motion should be prohibited and that all dangerous machinery should be boxed off.[4] Following the report, the Inspectors were asked to make a special investigation into the 'practicability of legislative interference to diminish the frequency of accidents to children and young persons employed in factories, arising from the machinery being left unguarded'. They reported at the end of the year and recommended:

[1] Report of the Inspectors of Factories for the Year 1835 (342) R J Saunder's report, p3, T J Howells report, p5.

[2] Report of the Inspectors of Factories for the Half Year ending 30th June 1839 (201) T J Howells report, p5.

[3] Report of the Inspectors of Factories for the Half Year ending 30th June 1840 (261) L Horner's report, p7.

[4] M W Thomas (1970), p227.

"1) that all upright shafts should be inclosed, or boxed off to the height of at least seven feet from the floor, but if a drum or pulley necessarily intervenes so as to prevent a casing so high as seven feet, such shafts should be cased as high as possible.

2) that all horizontal shafts elevated less than seven feet above the floor should be boxed off in all those places under which people may pass.

3) that all drums on the main shafting which revolve in passages or gangways, within seven feet from the floor, should be boxed off.

4) that all bevelled or spur wheels on the main shafting working within seven feet from the floor, and upper or near which persons may pass, should be boxed off." 1

There was no immediate action and the anxiety of the Inspectors over the situation can be seen from their reports, in which they began to list, in detail, the accidents occurring within their own districts. They urged the Government to take legislative measures[2] which occurred in 1844 with an Act to amend the laws relating to labour in factories.[3] This did not take up the recommendations of the 1841 Committee but instead, provided under section 20 that no child or young person should be allowed to clean any part of the mill gearing whilst in motion, nor should they work between the fixed and traversing part of a self-acting mule whilst it was moving; and under section 21, that every flywheel directly connected to a steam engine, water wheel or any other mechanical power and every hoist or teagle near to which children or young persons worked or passed and all parts of millgearing should be securely fenced. The wheel race also had to be fenced off. Millgearing was taken to be any shaft whether horizontal, vertical or oblique.

[1] Report of the Inspectors of Factories for the Half Year ending 30th June 1844 (583) T J Howells Report, p34; Report of the Inspectors of Factories for the Half Year ending 30th April 1854 (1796) Joint Report, p49.

[2] Report of the Inspectors of Factories for the Half Year ending 30th June 1842 (410) L Horner's Report, p27.

[3] 1844 Factory Act 7 & 8 Vict. c15.

These were the only items of machinery which were specifically required to be fenced but under section 43, the Inspectors had the power to notify as dangerous any part of machines or driving belts and straps which they felt could cause bodily harm. The section, however, had a clause which allowed the occupier to take the matter to arbitration within fourteen days of receiving such a notice, if he felt that it was unnecessary to fence off the part of the machine or belt in question, or if he felt such fencing would hinder the workability of the machine. In order to collect data on accidents, it was also made compulsory for the proprietor of the factory to notify the certifying surgeon in the area of any accidents causing bodily harm and which prevented the person concerned from returning to work by 9 am the next day.

There were many defects in the law, not least the fact that straps and belts had been excluded from compulsory fencing. The Government had felt that the layout in each mill was different and hence it would be difficult to introduce any standards on boxing. There were difficulties over the issue of notices of dangerous parts of machinery. Before doing so, the Inspector had to identify the exact part and show the practibility of fencing without hindering production. He often lacked the technical and engineering knowledge to do so and hence was likely to issue notices only on obvious dangers where the millowners were not likely to resort to arbitration. Even where he did issue notices on obvious dangers, such as parts of throstle machines and blowing boxes, if the owner did not comply, the Inspector could only take action if a subsequent accident occurred in which a person was injured. In this case it was possible for the victim to get some compensation but if the person died, there was little the Inspector could do and no compensation was available for the dependants. With regard to machinery which was required by law to be fenced, few prosecutions appear to have been made and the majority of them resulted only after serious injury or death had occurred.[1]

Due to strong representations by the millowners and in the absence of evidence to prove otherwise, the Factory Inspectors did not initially enforce the legislation with regard to fencing horizontal shafts above seven feet, as it was not felt that they could be dangerous. However, with the collection of data on accidents the facts appeared differently and in June 1853, the Secretary of State, drew the Inspectors' attention to this area of neglect and they began to record separately all injuries resulting from elevated, horizontal shafts. In the three years 1851 to 1853, 128 accidents occurred from such shafts, of which 35 were fatal and none were trivial injuries. The commonest causes were from persons being caught whilst carrying out the necessary regular lime washing as required by law, or from oiling the parts whilst in motion, or from mending straps or replacing those which had fallen.[2] A general circular was issued on 1st January 1854 reminding millowners that the Act had required all shafts to be fenced securely and that in future the Inspectors would insist on elevated shafts being boxed as well. Many millowners objected and in March a deputation of them protested to Lord Palmerston; and so a second circular was issued on March 22nd, suspending the first. It allowed a very broad interpretation of how shafts over seven feet should be fenced and being unclear, very few manufacturers took any heed of it.[3] A third circular was issued in January 1855

1 Notices on throstle machines were issued by L Horner in 1845 and on blowing boxes, by T J Howell in 1845. Prosecutions, for example: for the half year ending 31st October 1847 for all Inspectors were: neglect to guard machinery required by law to be fenced, 2 informations, 2 convictions, 1 fine £5, other let off on payment of costs. Three neglecting to guard machinery causing bodily harm, 2 fined £10, no other convictions in this field; for the half year ending 30th April 1848: neglect to guard machinery required by law to be fenced, 3 informations and convictions, 2 at £5, 1 at £20, neglect to guard machinery causing bodily harm. 5 informations and convictions, 3 at £10, 1 at £15 and 1 fined at £50.

2 Report of the Inspectors of Factories for the Half Year ending 31st October 1853 (1712) Alexander Redgrave's Report, p106; see any report from 31st October 1853 to half year ending 30th April 1857.

3 Report of the Inspectors of Factories for the Half Year ending 30th April 1854 (1796) Joint Report Appendix 1 and 2.

to explain the situation and it also contained drawings of various approved methods used at Hyde, near Manchester and Blackhall, near Glasgow, to guard machinery. It was considered that strap hooks were adequate to secure against the frequent accidents caused by the straps lapping, but that they were not considered as secure fencing against other accidents, e.g. when whitewashing and oiling.[1] Some areas, for example Yorkshire, where the practice of using strap hooks had been in use long before the first circular had been issued, accepted the circular[2] but the mill occupiers around Manchester were outraged. They set up the National Association of Factory Occupiers who had as one of their aims the reform of the factory laws to relieve the trade of government interference and restrictions.[3] After a contradiction in rulings by two magistrate's courts on the subject, a case was brought before the Court of the Queen's Bench in 1856, which held that the rule had to be strictly observed.[4] However, in the same year, another Act was passed with the aim of clarifying the terms but which also provided that the only mill gearing required by law to be securely fenced was that with which either children, young persons or women were liable to come into contact either by passing or in their ordinary occupation; a retrograde move. All millgearing with which children and young persons did not ordinarily come in contact with was to be regarded as machinery and hence the only action open to the Inspectors to attempt to get such gearing fenced, was to serve a notice of dangerous machinery in respect of it. Very few such notices were issued, however, as it was felt that millowners would resort to arbitration and by law, the arbitrators had to be persons 'skilled in the construction of the kind of machinery' in question. Such

1 Report of the Inspectors of Factories for the Half Year ending 30th April 1855 (1947), pp57-63 copies of all three circulars, L Horner's Report, pp6-29.

2 Ibid. Alexander Redgrave's Report, p42.

3 Ibid. L Horner's Report, p5.

4 Report of the Inspectors of Factories for the Half Year ending 31st October 1855 (2031) T J Howells Report, p35.

engineers were unlikely to know much about accident prevention or to see the need to fence polished, horizontal shafts at elevated heights.[1] The Inspectors ceased to collect data, specifically on horizontal shaft accidents, although from time to time showed their disapproval at events. Leonard Horner writing an account on his district for the six months, April to October 1859, remarked:

> "Of the sixteen deaths by machinery, it will be seen that seven were caused by the person being drawn up by straps and carried round unfenced horizontal shafts. Millowners represented that it is not practicable to fence all horizontal shafts, and the Act of 1856 was passed which practically relieved them from the obligation to fence all the dangerous parts of their machinery imposed by the Act of 1844." [2]

Through the necessity by law to report accidents, from October 1st 1844, the Inspectors began to present statistics of injury in their half yearly reports. Initially they recorded separately the cases arising from machinery required by law to be fenced (Table XXV) but they discontinued this separate record in 1851. The number of such accidents fluctuated from year to year but appeared, on the whole, to decline. However, the cases of fatality remained as a high proportion of the accidents recorded each year. The figures may not be a true reflection of all such accidents, as the Inspector for Scotland and the North of England, Mr Stuart, never gave a separate table and it is hard to believe that this was because there were no accidents from this source in his district. Moreover, in the later years, Leonard Horner appears to have stopped separately recording accidents arising from machinery required by law to be fenced, so the decline in numbers may mean very little. Table XXVI shows the total number of accidents from machinery from 1844 to 1864 in the textile industries. Up until 1860, the figures included accidents only in spinning and weaving factories of

[1] Report of the Inspectors of Factories for the Half Year ending 30th April 1857 (2247) Joint Report, pp3-8.

[2] Report of the Inspectors of Factories for the Half Year ending 31st October 1859 (2594) L Horner's Report, p11.

TABLE XXV: Accidents Arising from Machinery Required by Act to be fenced 1845-1851

Half Year	Causing death	Amputation right arm or hand	Amputation leg or foot	Fracture of limbs or bones of trunk	Fracture of hand or foot	Injuries to head or face	Other Injuries	Total
* 1.10.44 - 30.4.45	3	1	-	4	1	5	4	18
1.5.45 - 31.10.45	9	-	-	2	-	-	4	15
1.11.45 - 30.4.46	7	1	-	7	-	-	8	23
1.5.46 - 31.10.46	3	-	-	1	-	2	2	8
1.11.46 - 30.4.47	2	-	-	3	-	-	1	6
1.5.47 - 31.10.47	1	-	-	2	1	-	1	5
1.11.47 - 30.4.48	1	-	-	3	-	1	4	9
1.5.48 - 31.10.48	-	-	-	1	-	-	-	1
1.11.48 - 30.4.49	5	-	-	2	-	-	4	11
1.5.49 - 31.10.49	2	-	-	2	-	-	2	6
1.11.49 - 30.4.50	6	-	-	-	-	-	5	11

* Seven month period, after that the Inspectors reported every six months.

(continued...)

TABLE XXV: continued

Half Year	Causing death	Amputation right arm or hand	Amputation leg or foot	Fracture of limbs or bones of trunk	Fracture of hand or foot	Injuries to head or face	Other Injuries	Total
1.5.50 - 31.10.50	1	-	1	-	-	-	1	3
1.11.50 - 30.4.51	-	-	-	1	-	1	1	3
1.5.51 - 31.10.51	2	1	-	-	-	1	-	4

Source: Half Yearly Reports of the Inspectors of Factories, 1845-1851.

cotton, woollens, worsted, silk, hemp, flax, linen and tow but from 1860 and 1861 bleach and dyeworks and lace factories came under the factory acts although the clause requiring machinery to be fenced was not applicable to them.[1] From 1864, a further series of industries besides textiles were included which would affect the totals. They have therefore been excluded from the calculations in Table XXVI.

The initial increase after the first seven months is probably a reflection of more accurate and widespread recording of accidents to the certifying surgeons. In certain periods, that is the half years ending 31st October 1849, 30th April 1852 and the 30th April 1858, the apparent decreases are false, as in each of these periods one of the four Inspectors died and consequently no report from their respective districts appears to have been made. From 1860, there appears to be a decline in the total number of injuries from machine accidents but it must also be remembered that it was a period of depression in the cotton trade, hence, many mills were not working at full capacity or were closed. Looking next at the type of injury caused by machine accidents, there appears to be no significant change over the period with most accidents causing minor lacerations and contusions and with injuries, both fractures and amputations, to fingers coming next. The number of deaths, although fluctuating, does not greatly alter over the period, in fact the percentage of deaths to total injuries is higher in the half year ending October 31st 1846 (Table XXVII) and this is true of most of the more serious kinds of accidents. The data could indicate that the Inspectorate failed to reduce the level of accidents or it could be interpreted as indicating a growing awareness of industrial safety and greater vigilance in following up on reports of accidents.

1 1860 Bleach Works & Dyeing Works Act 23 & 24 Vict. c78; 1861 Lace Factory Act 24 & 25 Vict. c117.

TABLE XXVI: Total number of Accidents as reported to the Inspectors of Factories in their Half Yearly Reports 1845 - 1864

Half Year	Causing Death	Amputation of right arm or hand	Amputation part of right hand	Amputation of left hand or arm	Amputation of part of left hand	Amputation of leg or foot	Fracture of limbs or bones of trunk	Fracture of hand or foot	Injuries to head and face	Lacerations, contusions and other injuries	Total
1.10.44-30.4.45*	18	235				–	94	149	129	1315	1940
1. 5.45-31.10.45	33	136		94		–	82	181	128	1730	2384
1.11.45-30.4.46	25	119		104		–	89	152	149	1748	2386
1. 5.46-31.10.46	20	10	115	12	94	6	92	176	105	1735	2365
1.11.46-30.4.47	11	13	105	9	91	2	84	154	100	1314	1883
1. 5.47-31.10.47	12	6	68	9	56	3	75	135	68	949	1381
1.11.47-30.4.48	12	11	57	7	43	2	66	94	56	830	1178
1. 5.48-31.10.48	11	6	69	5	49	2	57	108	58	955	1320
1.11.48-30.4.49	19	10	114	11	61	1	66	129	85	1096	1592
1. 5.49-31.10.49	10	5	68	6	47	1	58	119	55	886	1255
1.11.49-30.4.50	15	14	69	6	73	–	75	135	94	1248	1729
1. 5.50-31.10.50	12	5	89	4	64	2	77	140	106	1487	1986
1.11.50-30.4.51	11	13	103	11	83	–	114	133	80	1443	1991
1. 5.51-31.10.51	19	5	118	10	80	–	81	130	106	1464	2013
1.11.51-30.4.52	13	8	65	4	62	–	59	123	78	1105	1517
1. 5.52-31.10.52	15	17	117	13	85	3	68	130	71	1385	1904
1.11.52-30.4.53	27	11	177	16	125	–	89	152	96	1426	2119
1. 5.53-31.10.53	21	13	164	20	118	1	108	182	118	1455	2200
1.11.53-30.4.54	21	24	138	29	85	3	97	138	107	1202	1844
1.5.54-31.10.54	21	12	150	11	132	5	97	155	116	1272	1971
1.11.54-30.4.55	18	14	147	9	109	1	97	124	101	1168	1788
1. 5.55-31.10.55	21	13	119	17	106	2	97	138	102	1186	1801
1.11.55-30.4.56	23	18	116	9	118	2	100	185	98	1193	1862

(continued...)

TABLE XXVI: continued

Half Year	Causing Death	Amputation of right arm or hand	Amputation part of right hand	Amputation of left hand or arm	Amputation of part of left hand	Amputation of leg or foot	Fracture of limbs or bones of trunk	Fracture of hand or foot	Injuries to head and face	Lacerations, contusions and other injuries	Total
1. 5.56-31.10.56	20	8	137	13	109	5	85	163	109	1270	1919
1.11.56-30.4.57	29	18	161	10	100	4	81	155	127	1191	1876
1. 5.57-31.10.57	16	23	176	16	117	10	105	173	107	1184	1927
1.11.57-30.4.58	24	13	92	10	77	5	65	140	93	950	1469
1. 5.58-31.10.58	31	9	133	10	97	3	101	159	103	1156	1802
1.11.58-30.4.59	37	15	138	10	102	6	97	173	126	1152	1856
1. 5.59-31.10.59	27	12	147	6	103	6	92	193	115	1382	2083
1.11.59-30.4.60	30	16	120	16	87	6	110	184	94	1384	2047
1. 5.60-31.10.60	40	15	100	13	61	4	93	170	111	1520	2127
1.11.60-30.4.61	26	16	98	17	67	-	90	163	111	1475	2063
1. 5.61-31.10.61	27	13	143	9	122	1	99	129	115	1252	1910
1.11.61-30.4.62	21	9	56	10	45	2	74	111	86	946	1360
1. 5.62-31.10.62	13	13	85	9	69	4	53	111	73	773	1203
1.11.62-30.4.63	18	6	98	5	67	4	83	84	85	752	1202
1. 5.63-31.10.63	30	15	108	11	88	1	66	122	85	1001	1527
1.11.63-30.4.64	23	8	97	15	79	6	70	107	75	977	1457

Source: Half Yearly Reports of the Inspectors of Factories 1845-1864

* Seven month period - after that the Inspectors reported every six months.

TABLE XXVII: Percentage of Types of Injury to Total Accidents from machinery - in three selected half year periods

Half Year	Causing Death %	Amputation right hand or arm %	Amputation part of right hand %	Amputation left hand or arm %	Amputation part of left hand %	Amputation leg or foot %	Fracture limbs or bones of trunk %	Fracture hand or foot %	Injury to head or face %	Other injuries %
1.5.46-31.10.46	0.85	0.42	4.86	0.51	3.98	0.25	3.89	7.44	4.44	73.36
1.11.54-30.4.55	1.01	0.78	8.22	0.50	6.10	0.06	5.43	6.94	5.64	65.32
1.11.63-30.4.64	1.58	0.55	6.66	1.03	5.42	0.41	4.80	7.34	5.15	67.06

Source: Half Yearly Reports of the Inspector of Factories for Half Years ending 31st October 1846, 30th April 1855 and 30th April 1864.

TABLE XXVIII: Percentage Distribution of Machine Accidents by Age of Workers in nine selected half year periods

Half Year Ending	Adult		Young Persons		Children	
	Male %	Female %	Male %	Female %	Male %	Female %
31.10.45	17.37	18.33	25.67	27.89	6.88	3.86
30.4.46	17.35	18.44	25.82	28.12	6.45	3.82
31.10.46	16.19	20.72	24.95	29.39	4.99	3.76
31.10.56	20.74	19.28	25.59	23.50	7.71	3.18
30.4.57	20.84	20.04	22.87	24.89	7.36	4.00
31.10.57	20.24	18.63	25.74	25.01	6.49	3.89
30.4.63	22.96	20.05	23.21	24.21	6.32	3.25
31.10.63	23.58	18.73	22.46	25.61	6.02	3.60
30.4.64	21.35	22.44	22.99	23.27	6.66	3.29

Source: Half Yearly Reports of the Inspectors of Factories for Half Years ending: 31st October 1845; 30th April 1846; 31st October 1846; 31st October 1856; 30th April 1857; 31st October 1857 30th April 1863; 31st October 1863; and 30th April 1864.

Accidents were fairly evenly distributed between males and females except in children where boys appear to have been more susceptible than girls. When considered by age groups (Table XXVIII), approximately half the accidents occurred to young persons and about a third amongst the adult population. Over the twenty year period, there was a slight swing towards more accidents in the adult group, especially adult males. This perhaps was a reflection of the 1856 legislation requiring millgearing to be securely fenced only near where children and young persons and women worked and passed in their ordinary occupations. What the figures do show is that many accidents occurred within a group of population who were thought to be able to help themselves. Redgrave speaks of the large number of 'self carelessness' accidents in his reports, i.e. where workpeople, very familiar with their work, looked away for a few seconds and without thinking placed their hands on the machinery.[1] It was said in 1861, that 'new machinery is now fenced when sent out from the machine makers' shops',[2] and this was undoubtedly a result of the Inspectors drawing attention to the necessity of securely fencing dangerous machinery.

Machine accidents were not, however, restricted just to the textile industries and were frequent wherever machinery was involved in production. Many of the injuries were inflicted on the hands, especially those using power presses and saws. The Children's Employment Commission in 1864, on a morning visit to the General Hospital in Birmingham came across eight cases of injuries to the hands. These were: a boy of 12 who had smashed two fingers on a print machine; a boy of 11 who had sawn two fingers off whilst working in a saw mill; a lad, 19, who lost two fingers saw grinding; another, 14, had lost a middle finger whilst holding down a

[1] Report of the Inspectors of Factories for the Half Year ending 31st October 1858 (2463) Alexander Redgrave's Report, p62.

[2] Report of the Inspectors of Factories for the Half Year ending 30th April 1861 (2845) R Baker's Report, p30.

piece of metal under a stamp for another person to work; a boy, 10, who had lost the end of his finger on a press for stamping blanks of metal; another, 14, had hurt his fingers stamping nails; a lad, 15, had caught his hand between the machinery employed in grinding sugar and had lost the tips of the second and third fingers; and lastly, a young boy who had cut his hands whilst working in a gun making shop.[1]

From 1864, the manufacture of earthenware, lucifer matches, percussion caps, cartridges, paper staining and fustian cutting were brought within the bounds of the Factory Acts and accidents had to be reported. In 1867, all the remaining manufactory establishments became reportable.[2]

The Inspectors had long complained of the waste of expenditure on reporting every accident which prevented a workman from returning to work the next day[3] and with the increase of manufactory reports, the situation became impossible. So, in 1871, a new enactment was passed whereby any accident which caused loss of life had to be reported, together with any which caused bodily harm having been caused by machinery, an explosion of gas, steam or metal and which prevented the employee from returning to work within 48 hours.[4] The laws on fencing machinery were also slightly amended by the Acts of 1878 and 1891. By the 1878 Act, millgearing had to be fenced near where any person was liable to pass or work and the Act of 1891 extended the above clause so that it all had to be fenced. Machinery could still be subjected to a notice of being dangerous,[5] and all manufactories were now covered. Because of this, the 1878 Act also brought in

[1] 1864 Children's Employment Commission Report (3414), p148.

[2] 1864 Factory Act Extension Act 27 & 28 Vict. c48; 1867 Factory and Workshop Act 30 & 31 Vict. c103.

[3] Complained of as far back as the Report of the Inspectors of Factories for the Half Year ending 31st October 1849 (1141) L Horner's Report, p17.

[4] 1871 Factory & Workshop Act 34 & 35 Vict. c104 s7.

[5] 1878 Factory & Workshop Act 41 & 42 Vict. c16 s5 & s6; 1891 Factory & Workshop Act 54 & 55 Vict. c75 s6.

rulings on other forms of accidents. Vats and containers of hot liquids and acids had to be fenced if the Inspector served notice of danger on them, and grindstones had to be securely fixed to prevent the grindstone from exploding. This kind of accident is discussed in detail in the section on Sheffield Grinders, whilst a discussion of eye injuries from splashes of liquids and splinters of metal can be found in the section on the Glasgow Eye Hospitals.[1]

There were other bodies, besides the Government, which tried to promote safety measures to prevent accidents at work. The Society of Arts, although not concerned with machine accidents, did try and promote safety in the use of wheel cranes, and offered a premium for ideas to overcome some of the technical difficulties which caused them to overbalance and collapse. They also published ideas on safety measures for those at work on high scaffolding in an attempt to prevent accidents from falling.[2] The Mulhouse Society for the Prevention of Accidents in Factories in France, was also responsible for setting up exhibitions on safety ideas and other exhibitions on inventions in general, often included displays of safety equipment.[3] However, as important as all the movements to fence machinery, was the employers' Liability Act of 1880, as it helped to stimulate employers who were lagging behind others to adopt safety measures. It lay the foundations of the principles that it was the duty of industry to pay compensation for death and injury to its workers, which was confirmed and strengthened by the Workmans Compansation Act of 1897. Many of those who were slow in erecting guards and barriers, were also parsimonious at giving support to the injured; but, with the requirement of having to pay compensation, they realized that prevention was cheaper.[4]

1 41 & 42 Vict. c44 s7 & s8; For Sheffield grinders see pages 306-345, and for Glasgow Eye Hospitals see pages 356-377.

2 *T.S.A.* 1792 Vol.X, pp XII-XIII; 1793 Vol.XI, pp192-201; 1805, Vol. XXIII, pp267-284.

3 *J.S.A.* 1867 September 6th, p654; see catalogues of exhibitions at Exhibitions of Inventions in *J.S.A.* in about March or April each year, 1858 onwards.

4 1880 Employers Liability Act 43 & 44 Vict. c42; 1897 Workmans Compensation Act 60 & 61 Vict. c36; Bruce (4th edition, 1968), p177.

PART THREE

CASE STUDIES

1. THE SHEFFIELD TRADES

"The situation of Sheffield at a distance from marshes and stagnant pools, placed at the junction of two principal rivers, and surrounded by a fine mountainous country, cannot fail of being highly advantageous to the general health of the inhabitants. Occupying a plot of ground rising from the Don and Sheaf, every part of the town is open to the purifying breezes from the country, and consequently we find Sheffield less subject to epidemical disorders than most large manufacturing towns. It must indeed be allowed that the atmosphere of Sheffield is exceedingly charged with smoke, but its effects are not found to be in the least injurious to the health of the inhabitants, the higher and middle classes in life being as healthful and robust as those of any other town in the kingdom.

The classes in conjunction with those of every place where manufactures are carried on to a great extent, must feel the ill effects attendant upon a close confinement during the hours of labour; but at Sheffield it is in a great measure counteracted by many of them occupying small gardens, the cultivation of which contributes to amuse their leisure hours, and affords a great opportunity of enjoying the benefit of pure air and wholesome exercises.

But there is one body of workmen, the dry grinders, which suffer from the effects of their employment to an extent greatly to be deplored. Their position, when at work, is that of stooping over the grindstones, which turn with great velocity. The effects of such occupation where many are employed in the same apartment may be easily conceived. The imperceptibly small dust both of stone and metal, is inhaled by the workman, and produces a disease termed 'The Grinders' Asthma'."

(Thomas Ramsay 1824)[1]

Sheffield has had a long history of specialization in the cutlery trades and by the time Ramsay wrote in 1824 the trade was large. There had always been some specialization in the small metals but by the 19th century there was a chain of craftsmen, including forgers, cutters, grinders and hafters, behind each item produced. With the increased demand for cutlery and a consequent increase in the demands on grinding, towards the end of the 18th century there was considerable pressure on water power resources. Although

[1] Thomas Ramsay *The Picture of Sheffield* (1824), pp69-70; for a history of Sheffield Labour in general see S Pollard *A History of Labour in Sheffield* (1959).

the region was well endowed with water power, from 1786, some employers introduced steam power.[1] It has been said that it was the employment of steam power which indirectly brought about the increase in the disease known as 'The Grinders' Asthma',[2] nevertheless, the proliferation of small, water powered forges and grinding shops persisted into the mid 19th century, many still being operational in 1900.[3] Whether from the larger numbers employed or because of changes in work organization in the cutlery trades, the incidence of grinders' asthma increased. Discussions of the problem and suggestions for preventative measures were to continue throughout the period under consideration and publicity of the case of the Sheffield Grinders placed grinding high on the list of the most dangerous occupations.

Grinders' asthma was not the only hazard which the Sheffield cutlery workers faced. A small section of the workforce, namely the file cutters, were subjected to the risk of lead poisoning, and many cutlers suffered from eye infections and injuries from flying, metallic particles. Where wet grinding occurred, the grinders complained of rheumatic disorders and all grinders faced the risk of the sudden breaking of a grindstone. Other problems were the more general ones of overcrowded and ill-ventilated workshops together with the strain of working for long hours in an awkward position.

In the 19th century there was a rapid expansion in the population of Sheffield. It doubled from 45,745 in 1801 to 91,782 in 1831 and continued to increase rapidly, reaching 185,195 in 1861, 284,568 in 1881 and 324,241 by 1891. The number of houses, by comparison, did not keep pace with the growth and a stock of 22,733 houses in 1841 had only increased

[1] Arnold Knight 'On the Grinders' Asthma' *North of England Medical and Surgical Journal* 1830-31 Vol. I, p85.

[2] Ibid. p87; John Woodward and David Richards *Health Care and Popular Medicine in 19th century England* (1977), p144.

[3] W T Miller *The Watermills of Sheffield* (1949).

to 66,794 by 1891. Overcrowding, coupled with inadequate drainage and privy facilities and the existence of many small, unpaved courtyards and back to back houses, led to a high mortality rate especially amongst children.[1]

The problems of atmospheric pollution in the city were also considerable. Sheffield was amongst the first towns to appoint a smoke control inspector; a Smoke Bye Laws Committee being set up in 1854.[2] The social and environmental conditions in Sheffield undoubtedly influenced mortality rates. The area seems to have experienced a high incidence of pulmonary disorders. From 1848 to 1854, the average annual mortality from these causes in Sheffield was 8.39 per 1,000 males and 6.70 per 1,000 females. By comparison, the average for ten standard districts in Devon and Cornwall in the same period were 4.46 and 3.46 respectively and for six standard districts in Surrey and Sussex 4.11 and 4.54.[3] From Ramsay's description of Sheffield's geographical setting and from the writings of Dr Holland,[4] there seems to be no reason to suppose that the area was peculiarly conducive to respiratory disorders, in fact, its geographical position would appear rather to have been, at least in theory, healthy. The social and environmental problems were also no worse than those in other towns. The main explanation for the high incidence of pulmonary diseases lies in the occupations of Sheffield at the time and any investigation of the awareness of industrial health and safety for the period should commence with the notorious 'Grinders' Asthma'.

1 1848 Report on the Sanitary Conditions of the Borough of Sheffield. Reports on one privy midden which served nineteen families and was also used by the children of a nearby school. Quoted in Vernon Thornes William Dronfield 1826-1894 (1976 pamphlet), p3. The same report said that one third of all children died before the age of five.

2 From correspondence with the Sheffield Local Studies Library.

3 Greenhow (1860), p115 and p120.

4 G C Holland *The Vital Statistics of Sheffield* (1843), p111.

The name grinders' asthma was given to the disease by the grinders themselves, although in reality it was more comparable with consumption than asthma. Knight felt that part of the reason for the grinders applying this term was to disillusion themselves about its fatal nature,[1] but it would seem more probable that it was ignorance of medical pathology by the grinders. With only a limited understanding of chest complaints in the medical world, it is highly unlikely that the grinders would have known the clinical differences between complaints with similar symptoms, hence any cough or congestion of the lungs might be labelled 'asthma'. By the time the disease had been correctly identified the term was in common usage.

Prior to the 18th century, the disease was rare for there was not a high degree of job specialization and the amount of time spent at the grindstone was short, being interspersed with activities at the forge and workshop as well as agriculture. Even during the 18th century, after grinding became a distinct occupation in the cutlery trades, the disease was uncommon, although around mid-century several grinders had died in similar circumstances and upon inquiry their fellow grinders had found that the deaths had been caused by a complaint peculiar to their trade.[2] But the incident does not appear to have caused widespread alarm.

At this period the sole source of power was water, and the grinding shops were scattered along the river banks. The workshops were generally small scale, containing six to eight stones. The rooms were fairly large and lofty, being open to the roof which gave a free circulation of air. It was often the case that the grinders had to walk two or three miles to work and, due to the fact that the water supply was not constant, during the dry months it was often only possible to operate the grindstones for four to five

[1] Knight (1830-31), p85.

[2] Ibid. p86.

hours a day, so that the work was then combined with some agricultural pursuit.[1] The population tended to live in more scattered communities than was the case in the mid 19th century. All these factors appear to have contributed to keeping the level of the disease low.

A precedent for change was established in 1786 however when for the first time steam power was applied to the grindstone.[2] The building in which the grinder worked was called the 'wheel' and in 1770 there were 133 'wheels' around Sheffield, all operated by water power. In 1794 there were 86 'wheels', three of which were steam powered. By 1841, there were 40 water and 50 steam 'wheels' and by 1865, 32 and 132 respectively.[3] Although the change over to steam may appear to have been gradual, each 'wheel' contained a number of rooms called hulls,[4] and these in turn contained the troughs or trows which housed the grindstones. If the 1794 figures are expanded, it is seen that the 83 water 'wheels' contained 1095 troughs, whereas the three steam 'wheels', alone, contained 320 troughs.[5]

[1] Also as old regulation of the Cutlers' Company, passed in the reign of Elizabeth I, provided that, *"No person engaged in the said manufactures, either as a master, servant, or apprentice, shall perform any work appertaining to the said science or mystery of cutlers for eight and twenty days next ensuing the eighth day of August in each year; nor from Christmas to the twenty-third day of January, upon pain for forfeiture for every offence, found and presented by twelve men of the said fellowship, of the sum of twenty shillings. No person occupying any wheel for the grinding of knives to allow of any work being done during the holiday months: penalty as before". B.M.J.* 1857 March 28th, p250. D Hey 'The Rural Metalworkers of the Sheffield Region' *Dept. of English Local History Occasional Paper* 2nd series, No.5 (1972), examines the question of dual occupation of the metal workers.

[2] Although this appears to have been destroyed by fire in 1796; C A Turner *A Sheffield Heritage* (1978), p17.

[3] G I H Lloyd *The Cutlery Trade* (1913), p179 and p443; *B.M.J.* 1857 March 21st, p234, states there are 16 water and 80 steam 'wheels' which would appear to be an underestimation.

[4] The grinder would rent a trough or a hull from the owner of the 'wheel'.

[5] Lloyd (1913), p443.

Steam power thus increased the scale of production and the buildings, erected to house this new source of power, were erected nearer to the centre of Sheffield itself. These factories tended to have smaller rooms, containing more troughs than the old, water powered workshops. Moreover, the circulation of air was reduced since the windows and doors were kept closed, so that the quantity of dust was not only greater but could not escape so easily to the outside atmosphere. Work was no longer dictated by the water supply and the periods of lay-off ceased. With the grinders now having to work regularly at the grindstone, there was a tendency for them to move closer to the source of employment, and they began to take up residence in the town.[1] These factors were conducive to a rapid increase in the incidence of grinders' asthma.

As seen in the discussion on needle pointers, Dr Johnstone had read a paper to the Medical Society of London in 1796 on the occurrence of pulmonary complaints peculiar to needle manufacturers in the Redditch area[2] and in 1805, the Society of Arts had offered a premium for a method to prevent the prejudicial effects to persons employed in pointing needles because the particles of grindstone and steel were known to cause asthma, consumption and other painful disorders.[3] It appears that there was a lag of some twenty-three years between the first discussion of grinders' asthma in Redditch and the publication of a paper on the Sheffield grinders; Dr Arnold Knight addressing the Medical and Surgical Society of Sheffield on the subject of 'Grinders' Asthma' in September 1819. However, the Committee appointed to look into the merits of a New Grinder's Health Preservative when reporting in 1822, offered its thanks to Dr Knight for "bringing this subject repeatedly forwards" which suggests

[1] Knight (1830-31), p87.

[2] See pages 141-147on needle grinders.

[3] *T.S.A.* 1805 Vol. XXIII, p14.

that he may have spoken on the topic on several occasions previous to his 1819 paper.[1]

By the 1820's, the incidence of grinders' asthma was high. The report of the Sheffield General Infirmary for the years 1789 to 1820 included 578 cases of asthma of which it was stated that many "were what is termed the grinders' asthma'".[2] Knight states that in inquiries made in 1822, of some 2,500 grinders:

> "There were not thirty-five who had arrived at the age of fifty, and perhaps not double that number, who had reached the age of forty-five: and out of more than eight fork grinders, exclusive of boys, it was reported that there was not a single individual thirty-six years old." [3]

The disease affected some of the grinding branches more than others. The differences can be explained by the conditions found in the various grinding processes.

The grinders can be divided into three groups according to whether they were occupied solely on dry stones or wet stones or were employed on both. The size and shape of the stone varied with the object to be ground and each hull contained troughs for several types of stone. An object would generally first be rough ground (either wet or dry) on a large, coarse, sandstone wheel and then, after corrections had been made to its form, passed onto a fine, hard, dry stone called in the trade a 'whitening stone'. The next stage was to obtain a first polish on a 'glazing' stone: the 'glazer' being a wooden wheel which varied in size from a

[1] Arnold Knight 'Observations on the Grinder's Asthma' - Extract of the paper read before the Medical and Surgical Society of Sheffield, 1st September 1819 (1822) (Sheffield City Library Local Pamphlet, J. Vol. 12. No.4).

[2] Robert Ernest *A synopsis of medical and surgical cases at the Sheffield General Infirmary during 22 years, Jan. 1798 to Jan. 1820* (1820).

[3] Knight (1830-31), pp87-88.

diameter of four inches to four feet. It was covered with leather, dressed with glue and emery and rubbed over with emery cake. The final polishing process was known as 'buffing' for which a wheel called a 'buff' was used. This was a small, wooden wheel covered with soft leather and dressed with various polishing powders. Certain items, namely pen-knives, razors and the better quality scissors, were polished on a 'lap', which was a wooden wheel faced with lead and rubbed over with oil and emery.[1] It was maintained that articles made from wrought iron had to be ground wholly on a wet stone. Conversely, those made from steel and cast iron, such as awl blades, forks, table knife bolsters, and backs of razors, had to be ground on a dry stone. It was said that if a wet stone were used for the latter objects, the friction would soon rend the stones uneven, thus damaging both the tools used and the final product.[2]

The initial grinding process would generally have been performed by the grinder himself, whereas the polishing processes were often given out to his apprentices or to a hired journeyman.[3] Both the processes saw a reduction in the weight of the object being worked on. J C Hall, for his report in 1857, conducted an experiment on razors ground by John Wilson in a 'wheel' belonging to J Rogers and Son. Hall followed the production of two types of razors and came up with the following results. (Table XXIX).

[1] Lloyd (1913), pp48-50; *B.M.J.* 1857 March 21st, p235.

[2] *B.M.J.* 1857 March 21st, p235; 1868 February 29th, p204.

[3] Greenhow (1860), p122.

TABLE XXIX: The Loss in Shaping and Grinding in Making 12 Razor Backs of Two Different Types

Shape of Razor Back: Quill Backs	lbs	ozs
Twelve razor blades forged in rough	2	4
Twelve razor blades shaped	1	15
Twelve razor blades finished	1	10

Loss in Shaping = 5 ozs per doz. (dry)

Loss in grinding = 5 ozs per doz. (wet)

Shape of Razor: Swaged Backs	lbs	ozs
Twelve razor blades forged in rough	2	0
Twelve razor blades shaped	1	10
Twelve razor blades finished	1	8

Loss in Shaping = 6 ozs per doz. (dry)

Loss in Grinding = 2 ozs per doz. (wet)

Source: J C Hall *B.M.J.* 1857 March 21st, p235.

Forks in grinding were reputed to lose about one quarter of their weight, all in the form of dry dust. The grindstones themselves were worn down considerably. According to the objects being ground they could last anything from five to six weeks, or as many months. After a dozen razors had been ground on a stone with a diameter of seven inches, it was reduced by nearly an inch. At Messrs Turton & Co.'s makers of file tools and saws, where thirty-six grindstones of five foot diameter by ten or twelve inches thickness were employed, it was found that after six weeks continuous use they had been reduced from a five foot diameter to thirty inches.[1]

Dust was also produced in large quantities during the processes or 'razing' (preparing) and 'hacking' the grindstone.

[1] Greenhow (1860), p121; *B.M.J.* 1857 March 21st, p235; 5th Report of the Commission appointed 1868 to inquire into the best means of preventing pollution of rivers - Pollution arising from mineral operations and metal manufacture - Report 1874, p32.

As has been seen, sometimes the life of the grindstone was very short indeed and whenever a new stone was obtained in the rough state, it had to be hung and raced. To obtain an even surface the stone was slowly revolved whilst a steel bar was held against it. This caused clouds of dust to be formed which filled the atmosphere of the workshops and also collected in the bottom of the troughs, so that after the 'razing' had been completed, which could take up to half an hour with a large stone, more dust was raised in sweeping out the trough.[1] To keep the grindstone smooth it was sometimes necessary to 'hack' the stone, with a chisel, at least once a day. Both 'razing' and 'hacking' presented great danger to all classes of grinders, since both processes, of necessity, had to be performed on the stone whilst in a dry state. Dr Greenhow observed that:

> "Excepting that some of the more prudent workmen cover the mouth with a handkerchief, to prevent their inhaling the dust, no precaution is used to guard against the danger to health arising from this cause." 2

By the 1820's, the medical world was well aware of the fact that dust was the main cause of grinders' asthma. Thackrah, in 1832, described the symptoms of the disease as:

> "Difficulty of breathing, such as to require generally the action of the muscles auxilliary to respiration; tightness of the chest; hoarseness of voice, and tenderness of the larynx; sonorous cough; spitting of blood; expectoration of mucus, containing often dust, and, in the latter stages, of fetid and purulent matters; muddiness of complexion; anxiety of countenance; pulse quickened, not at first but in the after stage; colliquative sweats and diarrhoea; emaciation; in a word, the signs of slow but certainly fatal consumption." 3

1 Greenhow (1860), p121; *B.M.J.* 1857 March 21st, p235.

2 Greenhow (1860), p121.

3 Thackrah (2nd enlarged edition, 1832), p94; case study notes from the books of the Sheffield Public Dispensary, illustrative of this, can be seen in *B.M.J.* 1857 April 11th, pp294-295. A few typical cases are given in Appendix IV.

Grinders were customarily taken on in the trade at the age of fourteen, although there were many exceptions, especially amongst the children of grinders who might begin as early as eight or nine.[1] Those of a weak constitution may soon have succumbed to disease and moved out of the trade, whereas those of a stronger nature may not have felt any signs of disease until the age of twenty, by which time, the irreversible symptoms could have set in. The medical world, at the time, was hampered in its understanding of the disease by the lack of bodies for post mortem examinations:

> "The cause, the symptoms, the treatment and the result of the Grinders' Asthma, leave little doubt as to the precise nature of the disease; still it must be regretted that its pathology has not been confirmed by that demonstrative evidence which post mortem examination alone can supply. We are thus compelled to infer the morbid anatomy from the symptom, instead of explaining the symptom from the ascertained alteration of structure." [2]

Ten years later, the cause was taken up by Dr Holland who contributed much important, scientific knowledge to the study of the disease in his books, 'The Mortality, Sufferings and Diseases of Grinders' (1842), 'The Diseases of the Lungs from Mechanical Causes' (1843) and 'The Vital Statistics of Sheffield' (1843). Dr Holland's twofold aims were to publicize the general facts of the disease and to induce the legislature to take steps to enforce preventative measures.[3]

Other doctors took an interest in the disease, such as Dr Hughes of Sheffield and Dr Favell.[4] The latter undertook interesting and important post mortem work, but unfortunately died before the completion of his investigations.[5]

[1] Knight (1830-31), p170.

[2] Ibid. p174.

[3] *The Medical Times* 1843 June 17th, p19.

[4] *The Medical Times* 1844 December 7th, p217; *Transactions of the Provincial Medical and Surgical Association* 1846 Vol.XXIV (N.S. Vol.II), p143n.

[5] *B.M.J.* 1857 April 11th, p294.

Discussion of the pathology of grinders' asthma was furthered in the 1850's by Dr J C Hall and later by Dr Greenhow in his famous 1860 and 1861 reports on lung diseases. Dr Greenhow then went on to complete many interesting post mortem examinations of diseased lungs which included those of workers who had died from grinders' asthma.[1] By the time Arlidge came to write in the 1890's there had been considerable pathological advances in the study of grinders' asthma but the question must be asked whether the increased knowledge had any effects on the grinders themselves in respect either of prevention of the disease or of its treatment?

Remedies were suggested from the earliest writers onwards. The ideas offered generally followed one or two themes, either a system of ventilation to draw off the dust from the stones or some kind of respirator for the protection of the individual, although simple remedies such as dusting the machines before commencing work and shorter hours were also put forward, as was the rather controversial suggestion that as fork grinding was such a dangerous but relatively unskilful occupation it should be given to convicted criminals to perform.[2] Dr Johnstone in his 1796 paper had suggested the making of a 'crape hood' or 'gauze helmet' for the Redditch needle pointers but after a short while in use the dust, mixed with the moisture from breathing, made the hood impenetrable and breathing became very oppressive.[3] The first awards made under the Society of Arts premium to protect needle pointers,[4] went to Thomas Wood, George Prior and Thomas Roberts.[5]

[1] J C Hall 'The Sheffield Grinder's Disease'. A series of articles in the *B.M.J.* for 1857. Dr Greenhow 'Specimen of diseased lung from a case of grinder's asthma' *Transactions of the Pathological Society of London* 1865, Vol.XVI, p59.

[2] Knight (1830-31), p95.

[3] Johnstone (1799), p92; Knight (1830-31), p88.

[4] This premium was extended to all dry grinders in 1822.

[5] *T.S.A.* 1811, Vol.XXIX, pp143-144, Thomas Wood, silver medal; 1813 Vol.XXXI, pp206-211 George Prior, silver medal and ten guineas; 1816, Vol.XXXIV, pp233-234 Thomas Roberts, Ten guineas.

The proposals of all three had involved some kind of covering for the grindstone but there are no references to their practical use or adaptation to the Sheffield trades. Samuel Roberts, when addressing the Committee appointed to investigate the merits of the New Grinder's Health Preservative in 1822 (see later), mentioned the early attempts of a Mr Lucas who, he believed, had drawn up a practicable plan for a kind of ventilating box.[1] The two preventative measures which received most attention came from J H Abraham and J Elliott, both Sheffield men and familiar with the problem, although neither of them seems to have worked in the trade.

Although both Abraham and Elliott were looking into the problem at the same time, Abraham was the first to receive recognition for his work, when in 1822, he was awarded the large gold medal by the Society of Arts. The apparatus he recommended consisted of two parts. One part was a wooden covering to the stone so that only the portion used in the actual working was revealed. This apparatus was to be lined with sacking or flannel and kept moist to absorb the dust.[2] The second part, and the one for which he was most acclaimed, was the magnetic guard, sometimes called the 'magnetic moustache' by the workmen[3] as it basically consisted of a series of sixteen magnets used as a mouthpiece in order to attract the metallic particles of dust.[4] Although the faceguard also incorporated some crape to protect against stone dust, the primary intention was the arrest of metallic particles and this, therefore, was one of its weaknesses since stone dust was equally, if not more, pernicious.

[1] Samuel Roberts 'Mr Elliott's Grinder's Preservative' to the meeting of the Committee to investigate the merits of the New Grinder's Health Preservative, Cutlers Hall, 11th September 1822, p9. (Sheffield City Library Local Pamphlet, J.Vol.12, No.4).

[2] *T.S.A.* 1822, Vol.XL, pp145n.

[3] *B.M.J.* 1868 April 25th, p408; *T.S.A.* 1822, Vol.XL, p150. Abraham in his original plan also suggested that a "semicircular frame...having the magnets only on the face, may be worn round the neck with considerable advantage."

[4] *T.S.A.* 1824, Vol.XLII, pp165-166. There is a letter of thanks to a Mr A Westcott, who had invented a frame hood for the grindstone containing bars of magnets, smeared with oil, in order to attract both the earthy and metallic particles. The apparatus was sent for trials to Redditch in 1817, but no results were sent back.

The magnetic guard was warmly received and many testimonials are printed in the Transactions of the Society of Arts from needle manufacturers in Derbyshire and Redditch as to its efficiency. There was also a certificate, signed by fourteen people (mainly proprietors and occupiers of grinding wheels, but including three medical men) to the merits of the apparatus for dry grinding:

> "The almost impalpable dust, and particles of metal, which are arrested by the arrangement of magnets, and the retainer, is a sight at once alarming and gratifying. To witness the clearness of the atmosphere in a grinder's room of that description when they are in use, and its rapid impregnation with the dust of the metal and stone, on their removal, is enough to produce a thorough conviction of the utility of the invention." [1]

Despite such optimistic beginnings, it does not appear to have had the hoped for success and never appears to have been generally adopted. Where it was put into practice it seems to have been abandoned after a few months use. The correct adjustment of the magnets was too difficult for the grinders to do themselves and the magnets often became so heavily loaded with particles of metal, that they required to be cleaned once or twice an hour.[2] Another problem with Abraham's apparatus was that in covering the stones, he applied a small tilt to the front of them. This in fact created a new hazard as the light particles of dust, which had previously been carried away from the grinder by the velocity of the stone, were now directed back at his face and the magnetic guard did not have any deterrent effect on them.[3]

The idea of individual respirators was not abandoned. The Medical Times, when commenting on Abraham's invention in 1843, states that 'Jeffrey's respirator is likely to be of

[1] *T.S.A.* 1822, Vol.XL, pp135-150.

[2] Roberts (1822), pp9-10; Tomlinson (1854, Vol.II), p322.

[3] Roberts (1822), pp9-10.

more service,'[1] and Dr Hall later suggested a very simple form of filter, being a piece of wadding enclosed in two pieces of silk, which was large enough to cover both the mouth and nose, and was secured with a band of elastic.[2] In 1870, Dr Taylor suggested a respirator with a cotton filter, as was used in the snuff manufactories where it had proved both cheap and effective, but how ever well these protectors might have served the purpose, the general medical opinion seems to have been that:

> "The men are either so ignorant of the dangers to which they are exposed by inhaling dust for a long period, or' - and this we regret to state is very often the case - so careless of their health, and so regardless of all warnings, that measures are seldom taken to prevent the inhalation of dust until the lung disease is firmly established." 3

Dr Holland noted two important features that would need to be incorporated in respirators. They would need to be cheap, in order to be purchased in the first place, and simple, so that they would be maintained. Even then, he claimed:

> "If such an invention could afford them complete protection, and were furnished gratuitously; not one guard in six, in twelve months, would be in use. They would not give it the little attention necessary to keep it in an effective state." 4

The second line of protective measure was in the field of ventilation. Early attempts had involved a constantly falling shower of water in front of the stones to dampen down the dust; a plan of a pipe-way from the stones to the outside air; and attempts to direct the dust into a box of water. The latter on trial had proved ineffectual as only the heavier

1 *The Medical Times* 1843 December 9th, p131.

2 *B.M.J.* 1857 March 28th, p250.

3 John Taylor *An Enquiry into the Causes of the Mortality of Sheffield* (1873), p35; *B.M.J.* 1868 April 25th, p408.

4 G C Holland *Diseases of the Lungs from Mechanical Causes* (1843), p53.

particles had sunk and the lighter and more pernicious ones were directed back at the workmen.[1] The first ventilation system to arouse any real attention was that of Elliott, which was awarded the Gold Vulcan Medal for 1823 by the Society of Arts. The Society had already awarded prizes in this field but it was felt that Elliott's plan was "more simple than others awarded by the Society and thus hoped to be more practicable."[2] The award was delayed due to a rival claimant for its invention but a Committee set up to investigate the merits of the 'new Grinder's Health Preservative' at Cutlers Hall in September, 1822 decided that Elliott had all the claims to it.[3] A subscription fund was established for him because Elliott did not patent his idea as this would have increased the cost of his apparatus and meant that many of the grinders would not have been able to afford it.[4]

Elliott's initial plan was a box lined with crape canvas. The box was wide at one end to encompass the stone and then tapered away. When in use it was intended that the canvas be kept moist, but in practice, the dust and air from the stone dried up the moisture. However, he also discovered that the current of air, coming off the stone, was enough to drive the dust through the box and this led to a series of further improvements. Firstly, he attached a chimney to the box covered with crape, but the fine particles still passed through and so was unsatisfactory. He then added a piece of wet cloth suspended above the crape and later led the chimney through a hole in the wall to the outside. This created a further problem, as the current of air off the stone was not sufficient to drive the dust this extended distance and to overcome this difficulty, he proposed to introduce a fan

1 Roberts (1822), pp10-11.

2 *T.S.A.* 1823 Vol.XLI, pp194-198.

3 John Elliott 'Plain Matters of Fact' *The Scrutineer* No.V (Sheffield City Library Local Pamphlet J.Vol.2 No.3); Resolutions of the Committee to look into the merits of the New Grinder's Health Preservative (Sheffield City Library Local Pamphlet J.Vol.2 No.4).

4 Ibid.

at the entrance to the chimney.[1]

The apparatus appears to have been installed in several manufactories with minor modifications to fit individual needs. Thomas Champion, master of the Cutler's Company, knew of the installation of twelve 'Grinder's Life Preservatives', as it was commonly called, but on examination discovered there were upwards of thirty in constant use in the town and other places were about to erect them, the cost of installation being about 10s 6d.[2] Unlike the respirators, it was claimed:

> "Here is an apparatus which being always in its place, will require trouble to remove it." 3

Praise for the apparatus came from all directions and it was even publicized in areas where no grinding of any importance took place.[4] Dr Knight wrote:

> "By an union of scientific, perservering, and ingenious efforts, it has been discovered that such a current of air is excited by the mere revolution of the stone, as to carry the dust evolved from it, through a tube reaching to the outside of the building. The simplicity of the principle, the ease with which it may be applied, and its complete efficiency, show that it is nearly perfect; and we may reasonably hope, that if it be generally and properly adopted, the grinder's asthma will be checked in the present, and considerably diminished in the rising generation." 5

1 Ibid.; *T.S.A.* 1823 Vol.XLI, pp194-198.

2 *T.S.A.* 1823 Vol.XLI, p197. Letter from Thomas Champion.

3 Roberts (1822), p15.

4 e.g. *Salopian Journal* 1822 October 16th carried the following report in its pages, after describing Elliott's invention. "As dry grinding is resorted to in most towns, we are desirous of calling the attention of masters to so valuable a discovery. Mr E we understand, waves all 'patent right' and most generously devotes the full benefit of his invention to the public."

5 Knight (1822), p7.

Unfortunately, the answer to the problem was not so simple and eight years later Knight had to admit that the Grinder's Preservative had not lived up to optimistic expectations and that disappointment had bred indifference, so that by 1830 it was scarcely in use anywhere. The problem appears to have been that although most dust was driven through the box, a considerable proportion of the finest, deadliest dust, was carried around the stone and blown back into the face of the grinder. Proposals were put forward to direct a current of air under the stone to try and counteract the problem, but interest had waned and it does not appear to have been attempted.[1]

After the initial invention, other people were inspired to put forward ideas. The London Society for Bettering the Conditions of the Poor offered a premium in 1824 and the following year paid out 10 güineas to William Carlton and eight pounds to Peter Redfern for fan and airduct systems of dust removal.[2] A Mr Thomason of Birmingham offered a model of a ventilator to the Literary and Philosophical Society of Sheffield but it was too expensive and complicated for general use and there are doubts as to its efficiency had it been actually constructed.[3] The only person to seek a patent for his ideas was John Tappen whose device was patented in 1843 but as yet no record has been found of this apparatus in use.[4]

[1] Knight (1830-31), p90.

[2] Lloyd (1913), pp228-229.

[3] Knight (1830-31), p90; Thomason had patented an idea in 1820 for an improved method of inserting a cutting edge ot the blade (Patent No. 4492).

[4] Patent No. 9770 - 10th June 1843 - Apparatus for grinding and polishing cutlery and other articles so as to obviate the deleterious effects produced by the dust and metallic particles resulting therefrom.

Many writers blamed the grinders for the failure of these attempts to improve working conditions. Reasons advanced included carelessness, adjusting the equipment inaccurately or not at all, as well as wishing to keep the occupation unhealthy in order to maintain high wages. The Penny Magazine in 1844 observed that whatever the reason:

> "certain it is that dry-grinding is still what it has ever been - one of the most disastrous occupations connected with the manufacturing arts; and it is equally certain that unless the men aid the attempts made for their comfort, all such attempts must be fruitless." 1

At this time, however, Dr Holland was organizing a campaign to get ventilation for the grinding wheels, by publishing several articles on the subject in the popular press and medical journals, and urging the legislature to step in and help. He also secured the co-operation of the grinders themselves, as although many may have been careless or uninterested in the danger, there were just as many who were prepared to try any remedy put forward to improve conditions. Many proprietors were concerned that the structural improvements needed to install the proposed ventilation systems would be financially prohibitive and so, in opposition, they set up the Mill Owners Association in 1854.[2] The system of ventilation recommended by Dr Holland was the one he had seen in use at the spindle manufactory of Messrs Yeoman & Shaw. It consisted of a system of funnels from each grindstone, linking to a central channel (under the floor to prevent accidents) at the end of which there was a fan, acting very much on the principles of a winnowing machine, which expelled the dusty air to the outside. The fan was operated by a pulley, which acted automatically as soon as the grindstone began to turn.[3]

1 'A Day at the Sheffield Cutlery Works' *The Penny Magazine* 1844 Supplement April, p165.

2 Lloyd (1913), p230.

3 In the Yeoman & Shaw system, when the dusty air was taken outside, it was passed through a water trough. Holland (1843 Diseases of Lungs), p55.

This system was introduced into some of the hulls with beneficial results,[1] but Dr Holland argued that:

> "The plan, however, will never be generally adopted, or in any degree steadily maintained, unless enforced by special legislative enactment." 2

But how hazardous was the trade? In the 1820's, Dr Knight had given the life expectancy of fork grinders (dry) as between 28 and 32, for razor grinders (mixed) between 40 and 45 and table knife grinders (wet) 40 and 50.[3] Dr Holland in the 1840's issued similar figures and on examining fork grinders found that of the 19 who were over 40, ten had either started in the trade late in life or had been absent for several years whilst serving in the army. These figures seem to have been generally accepted at the time by the public, the medical world, workers and operatives alike and there is little evidence to refute them. The fork grinders, in their petition in the 1840's, asserted that their average age was not more than 30.[4] Dr Hall was still drawing a similar

1 *B.M.J.* 1857 March 28th, p250; Hall reports seeing this system of fan in operation in the hull of G Tricket at the Union 'wheel', at one of the hulls of the Soho 'wheel' and at the hulls of J Rogers & Son. One of the razor grinders at the Suffolk Works was convinced he would not be alive without it. "If I were to shape twelve razors without a fannie I could hardly breathe next day; with a fannie I can shape them and feel as well as ever I did in my life".

2 Holland (1843 Diseases of the Lungs), p55.

3 Knight (1830-31), p86.

4 Holland (1843 Vital Statistics), p196; Fork grinders address to the public as quoted by Holland. "It is part of our duty to allude to the destructive influence of our trade, which is a most serious part of the question; for be it known, that in respect to the pernicious effect of grinding trades upon health, our branch is by far the worst. We can show, by irrestible facts, drawn from the statistics of our trade, that the average age of fork grinders does not exceed thirty years. Nor is this to be wondered at, considering the poisonous atmosphere we have to breathe, which renders the far greater part of us mere shadows of men, and produces a complication of diseases, of which the most formidable is the asthma and dry cough, known by the name of the grinders' complaint, attended as it is by consumption, which no medical man can cure. In such cases life is a burden to the poor sufferers. Their frames gradually emaciated and wasted by a repetition of slow tortures; and when they have nearly closed their mortal career, they have perhaps the better reflection of leaving behind them, their wives and poor helpless infants to suffer the horrors of want, unpitied or relieved by any."

picture in the 1850's, publishing the following table in his report to the medical world in 1857. (Table XXX). From his report of visits to the various 'wheels' it would appear that the grinders themselves were of the opinion that they had short lives, one grinder commenting: "I shall be thirty-six years old next month; and you know measter, that's getting a very old man in our trade." [1] However, three years later, Dr Greenhow in his report wrote:

> "The Sheffield grinders are said to breakdown in health at an early age. One of the most intelligent among them said that he did not believe there was a grinder at work in the town who had passed his 40th year and another confirmed, what is nearer the truth, that the greater number become ill before attaining that age. A like statement was made by other persons of the same class, and, indeed such seems to be the general impression in the district; facts, however, do not entirely confirm this belief; one man belonging to the class of mixed grinders who had paid into a club continuously for thirty years, had not once during that long period had occasion to make any claim upon its funds on account of sickness. In one 'wheel', where fifty men and boys are employed, there were: one man aged 61 years still at work, two aged 58, one aged 54 and five or six aged 50 or thereabouts. Out of 8 fork grinders in another establishment, one man, who had been a grinder from boyhood, was said to be 61 years of age, and yet fork grinding is the most injurious branch of the business." [2]

From 1861, it is possible to make a detailed study using the statistics of mortality collected by the Superintendent Registrar of Sheffield. Although the numbers involved in each separate branch of grinding are small, the three fork grinders who died in 1861 were aged 49, 55 and 58, which must throw doubts on the belief that few fork grinders survived their 40th year. (Although it is not known when they took to the trade). Ten years later in 1871 two deaths of fork grinders are recorded and these again had both attained ages above forty, being 45 and 46 years old at death.

[1] *B.M.J.* 1857 March 21st, pp235-236. A fork grinder aged 26 at the Soho 'wheel' remarked, "that he reckoned, in about two more years, at his trade, he might begin to think of dropping off the perch; adding, a fork grinder is an old cock at 30."

[2] Greenhow (1860), p123.

TABLE XXX: Average Living Age of Sheffield Grinders in 1857

Branches of Grinders		Numbers Employed Men	Boys	Average age of all the men now living
1.	Forks	160	120	29
2.	Spring Knives	685	600	34
3.	Razors	300	220	31
4.	Scissors	300	200	32
5.	Table Knives	800	250	35
6.	Edge Tools & Wool Shears	200	80	32
7.	Saws	160	50	38
8.	Surgeons Instruments	15	12	-
9.	Files	160	85	35
10.	Sickles	50	20	40
11.	Jobbing Grinders	280	210	-

Source: J C Hall *B.M.J.* 1857 March 21st, p236.

It is true that many of the grinders in the survey do not have their branch of the industry specified,[1] but from the fact that those who are identified as fork grinders, the supposed worst occupation, all lived longer than might have been expected from Dr Hall's report in 1857, the question naturally arises as to whether conditions had improved remarkably between 1857 and 1861 to account for this difference, or whether the earlier beliefs were unfounded?

Table XXXI shows the age at death of various occupations in Sheffield in 1861. Although it is difficult to draw many conclusions from the data due to the small numbers involved, it would seem that although grinders were living longer than perhaps would be expected from other reports, on the whole their lives were shorter than most other trades in Sheffield, with a noticeably small proportion of deaths after the age of 70 (only 1%) in comparison with all other categories. Although coal mining shows a high number of deaths in the early age brackets, this is partly due to the high level of risk from accidents; deaths from accidental causes

[1] The average age of death of all grinders in 1861 was 45 years.

TABLE XXXI: Mortality of Males (10 and over) by selected trades in the Borough of Sheffield 1861

Occupation	Occupational Total	AGE AT DEATH																											
		10 - 14		15 - 19		20 - 24		25 - 29		30 - 34		35 - 39		40 - 44		45 - 49		50 - 54		55 - 59		60 - 64		65 - 69		70 and Over	
		No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total	No.	% of occup total
Grinders	71	-	-	1	1.41	8	11.27	3	4.23	1	1.41	10	14.08	15	21.13	6	8.45	6	8.45	11	15.49	5	7.04	4	5.63	1	1.41
Cutlers[1]	110	-	-	3	2.73	7	6.36	9	8.18	7	6.36	10	9.09	16	14.55	8	7.27	3	2.73	12	10.91	6	5.46	7	6.36	22	20.00
File Makers, File Hardeners, etc.	67	-	-	6	8.96	4	5.97	7	10.44	3	4.47	6	8.96	4	5.97	8	11.94	6	8.96	6	8.96	4	5.97	6	8.96	7	10.44
Razor, Scissor & Penknife Makers	20	-	-	-	-	3	15.00	1	5.00	-	-	3	15.00	1	5.00	-	-	1	5.00	3	15.00	4	20.00	1	5.00	3	15.00
Edge tool, Shear & Scythe Makers	24	-	-	-	-	2	8.33	3	12.50	2	8.33	2	8.33	-	-	3	12.50	2	8.33	2	8.33	1	4.17	3	12.50	4	16.68
Saw Makers	13	-	-	-	-	2	15.39	2	15.39	1	7.69	2	15.39	-	-	1	7.69	-	-	1	7.69	-	-	1	7.69	3	23.07
Horn Scale Presser/ Cutter	9	-	-	-	-	-	-	-	-	1	11.11	-	-	2	22.22	1	11.11	1	11.11	3	33.34	1	11.11	-	-	-	-
Iron & Steel workers & Furnacemen	27	-	-	-	-	2	7.41	8	29.63	1	3.70	-	-	2	7.41	6	22.22	1	3.70	-	-	2	7.41	1	3.70	4	14.82
Blacksmiths & Whitesmiths	20	-	-	-	-	-	-	1	5.00	2	10.00	1	5.00	4	20.00	1	5.00	-	-	2	10.00	2	10.00	2	10.00	5	25.00
Coal Miners	17	1	5.88	2	11.77	2	11.77	2	11.77	-	-	1	5.88	1	5.88	1	5.88	-	-	2	11.77	1	5.88	1	5.88	3	17.64
Labourers	95	-	-	1	1.05	6	6.32	4	4.21	11	11.58	5	5.26	10	10.53	5	5.26	6	6.32	9	9.47	11	11.58	7	7.37	20	21.05
Shopkeepers & tradesmen	46	-	-	1	2.18	2	4.35	2	4.35	2	4.35	4	8.69	6	13.05	5	10.87	3	6.52	3	6.52	5	10.87	4	8.69	9	19.56
Agricultural workers	23	-	-	-	-	-	-	-	-	2	8.70	-	-	-	-	-	-	1	4.34	2	8.70	2	8.70	2	8.70	14	60.86
All other occupations[2]	566	48	8.48	54	9.54	46	8.13	29	5.12	36	6.36	35	6.18	34	6.01	36	6.36	40	7.07	44	7.78	45	7.95	42	7.42	77	13.60
TOTAL	1108	49	4.42	68	6.14	84	7.58	71	6.41	69	6.23	79	7.13	95	8.57	81	7.31	70	6.32	100	9.03	89	8.03	81	7.31	172	15,52

Source: Superintendent Registrar for Sheffield 1861 Mortality Returns for the Borough of Sheffield

References: 1. *Includes table knife forgers, strikers, etc. and all workers in the cutlery trades who are not grinders.*
2. *Also includes all males 10 and over for whom no occupation is indicated.*

accounting for four of the mortalities, including a boy of 11. The labourers' mortality statistics for the year are also increased through accidental injuries, with five labourers being suffocated when a tunnel collapsed, three of whom were in their twenties.

When these mortality figures are related to cause of death[1] there appears a high incidence of mortality from diseases of the lungs amongst the grinders, with 28 deaths caused by tubercular diseases (four actually being described as grinders' disease), and 23 from diseases of the respiratory organs, leaving only 20 deaths from other causes (Table XXXIII). Thus 71.43% of all deaths of grinders in 1861 were from diseases of the lungs. If the total mortality figure for Sheffield in 1861 is examined (Table XXXII), the number of deaths from tubercular disorders is 15.30% of the total and from respiratory diseases 18.64% giving an overall figure of 33.94% for all lung diseases, but with more than half the deaths in the borough being those of children under the age of 5, this figure is not meaningful. If the deaths of children under 5 are excluded from the totals, the revised figure for the percentage of deaths from diseases of the lungs is 37.88% (22.46% tubercular and 15.42% respiratory disorders). It would thus seem that grinders suffered excessively from diseases of the lungs in comparison with the total population of Sheffield and it would not be unrealistic to assume that this was at least in part due to their dusty occupation.

Some indication that grinders suffered more from lung diseases than other trades can be seen in Table XXXIII, for although the sample is small and it would be more satisfactory to look at several years, amongst cutlers dying in 1861, only 44.54% suffered from lung diseases (26.36% tubercular and 18.18% respiratory diseases). There is no reason to believe that either of these groups experienced markedly different environmental or social conditions, any difference in causes of

[1] See Appendix IV for causes of death of grinders in 1861.

TABLE XXXII: Causes of Death (male and female) in the Borough of Sheffield in 1861

Cause of Death[1]		Under 5 No.	Under 5 % of deaths in class from each cause	5 and over No.	5 and over % of deaths in class from each cause	Total Population No.	Total Population % of deaths in class from each cause
Zymotic Diseases	1 Diseases observed to be epidemic, endemic or contagious	637	27.02	278	12.32	915	19.83
Constitutional Diseases	2 Diseases of uncertain or variable seat	20	0.85	149	6.60	169	3.66
	3 Tubercular Diseases	199	8.44	507	22.46	706	15.30
Local Diseases	4 Diseases of the nervous system	443	18.79	192	8.51	635	13.76
	5 Diseases of the organs of circulation	9	0.38	142	6.29	151	3.27
	6 Diseases of the respiratory organs	512	21.71	348	15.42	860	18.64
	7 Diseases of the digestive system	87	3.69	169	7.49	256	5.55
	8 Diseases of the urinary system	1	0.04	33	1.46	34	0.74
	9 Diseases of Childbirth & organs of generation	-	-	33	1.46	33	0.72
	10 Diseases of Locomotion	1	0.04	21	0.93	22	0.48
	11 Diseases of the Integumentary system	1	0.04	1	0.04	2	0.04
Diseases of growth, nutrition, or decay	12 Malformation	9	0.38	4	0.18	13	0.28
	13 Premature Birth and Debility	235	9.97	-	-	235	5.09
	14 Atrophy	147	6.24	9	0.40	156	3.38
	15 Age	-	-	210	9.30	210	4.55
	16 Sudden (cause unknown)	1	0.04	31	1.38	32	0.69
	17 Violent causes	51	2.16	114	5.50	165	3.56
	18 Causes not spec.	5	0.21	16	0.71	21	0.46
TOTAL		2358	100	2257	100	4615	100

Source: Superintendent Registrar for Sheffield 1861 Mortality Returns for the Borough of Sheffield.

Ref.: 1. Classifications of cause of death are those used by the Superintendent Registrar in his summary.

TABLE XXXIII: CAUSES OF DEATH (ALL MALES OVER 10) IN SELECTED SHEFFIELD TRADES 1861

Cause of Death		All males over 10		Grinders			Cutlers			Filemakers, Hardeners etc.			Iron & Steel, Furnacemen			Blacksmiths & Whitesmiths			Coal Miners			Labourers			Agricultural Workers			All Other Occupations		
		No.	% deaths in class from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause	No.	% deaths from each cause	deaths as % of total from each cause
Zymotic diseases	1 Diseases observed to be epidemic, endemic or contagious	89	8.03	3	4.23	3.37	9	8.18	10.11	8	11.94	8.99	4	14.81	4.49	-	-	-	-	-	-	8	8.42	8.99	-	-	-	57	8.41	64.05
Constitutional Diseases	2 Diseases of uncertain or variable seat	28	2.53	2	2.81	7.14	-	-	-	-	-	-	-	-	-	-	-	-	1	5.88	3.57	3	3.15	10.72	2	8.70	7.14	20	2.95	71.43
	3 Tubercular diseases	262	23.65	28	39.44	10.69	29	26.36	11.07	18	26.87	6.87	7	25.93	2.67	4	20.00	1.53	3	17.65	1.15	11	11.58	4.20	2	8.70	0.76	160	23.60	61.06
Local Diseases	4 Diseases of the nervous system	136	12.27	3	4.23	2.21	13	11.82	9.56	13	19.40	9.56	5	18.52	3.68	4	20.00	2.94	1	5.88	0.74	10	10.53	7.35	2	8.70	1.47	85	12.54	62.49
	5 Diseases of the organs of circulation	75	6.77	5	7.04	6.67	7	6.36	9.33	6	8.95	8.00	3	11.12	4.00	-	-	-	-	-	-	1	1.05	1.33	-	-	-	53	7.82	70.67
	6 Diseases of the respiratory organs	207	18.68	23	32.39	11.11	20	18.18	9.66	10	14.93	4.83	4	14.81	1.93	4	20.00	1.93	1	5.88	0.48	18	18.95	8.70	6	26.08	2.90	121	17.85	58.46
	7 Diseases of the digestive system	88	7.94	3	4.23	3.41	14	12.73	15.91	8	11.94	9.09	-	-	-	1	5.00	1.14	2	11.77	2.27	4	4.21	4.55	2	8.70	2.27	54	7.96	61.36
	8 Diseases of the urinary system	20	1.81	-	-	-	1	0.91	5.00	-	-	-	1	3.70	5.00	-	-	-	-	-	-	2	2.11	10.00	1	4.34	5.00	15	2.21	75.00
	9 Diseases of childbirth & organs of generation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10 Diseases of Locomotion	16	1.44	1	1.41	6.25	-	-	-	3	4.48	18.75	-	-	-	-	-	-	-	-	-	1	1.05	6.25	-	-	-	11	1.62	68.75
	11 Diseases of the Integumentary system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diseases of growth nutrition or decay	12 Malformation	1	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.15	100.00
	13 Premature birth and debility	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14 Atrophy	2	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.29	100.00
	15 Age	101	9.12	1	1.41	0.99	12	10.91	11.88	1	1.49	0.99	2	7.41	1.98	3	15.00	2.97	3	17.65	2.97	12	12.63	11.88	8	34.78	7.92	59	8.70	58.42
	16 Sudden (cause unknown)	6	0.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0.89	100.00
	17 Violent causes	72	6.50	2	2.81	2.78	4	3.64	5.56	-	-	-	1	3.70	1.39	4	20.00	5.56	6	35.29	8.33	23	24.21	31.94	-	-	-	32	4.72	44.44
	18 Causes not specified	5	0.45	-	-	-	1	0.91	20.00	-	-	-	-	-	-	-	-	-	-	-	-	2	2.11	40.00	-	-	-	2	0.29	40.00
	TOTAL	1108	100	71	100		110	100		67	100		27	100		20	100		17	100		95	100		23	100		678	100	

Source: Superintendent Registrar for Sheffield 1861 Mortality Returns for the Borough of Sheffield.

death being more likely to be due to the nature of the work. Similarly only 31.80% of the filemakers died from lung disorders (26.87% tubercular and 14.93% respiratory diseases) and for coal miners and agricultural labourers the figures were 23.53% (17.65% and 5.88%) and 34.78% (8.70% and 26.08%) respectively. Another interesting feature of the Table is the percentage in each occupational group who died from 'old age'. Only 1.41% of grinders and 1.49% of filemakers (an occupation which will later be seen to be hazardous due to exposure to lead) met death through old age. In no other group selected was this percentage below 7.00%, being as high as 34.78% amongst agricultural workers. Another point illustrated in the Table is the risk of accidents to coal miners, with 35.29% having died in 1861 from violent causes. This figure is also high amongst black and white smiths being 20%, and amongst labourers, 24.21%, although 1861 may be an unrepresentative case for the latter due to the collapse in a tunnel (mentioned previously).

Towards the end of the century the collection of relevant statistics increased. Dr Ogle, for the three years 1880 to 1882 inclusive, showed that for all workmen in the cutlery trades, the percentage of deaths from phthisis was 28% and from respiratory diseases 29%. The total for all lung diseases was thus 57%. His data covers all cutlery workers, not merely the grinders but if the 1861 data for cutlery workers and grinders is aggregated, the figures can be compared. From Table XXXIII it can be seen that the total number of grinders and cutlery workers who died in 1861 was 181 and that of these 100 died from some form of lung disease, that is 56%. This would suggest that there had been no general improvements between 1861 and 1880, but what is not known, is the actual age of death of the 1880 to 1882 cutlers.[1]

[1] *Annual Report of the Health of Sheffield* 1885, pp45-48.

From 1885 the Medical Officer of Health for Sheffield included a breakdown of trade statistics for the Borough in his annual report. The Officer for that year was Sinclair White and he showed that the percentage of deaths from phthisis amongst all cutlery workers was 19% and for respiratory diseases, 22%, a total of just 41%. From White's data it is possible to isolate the grinders and by doing so, the figures are adjusted to 23% for deaths from phthisis and 25% for all other respiratory disorders (48% in all). These figures would thus seem to suggest that there had been some form of improvement. White wrote:

> "The proportion of deaths from phthisis and other affections of the lungs is somewhat greater than the average for all males in England; but the figures under consideration do not bear out the hitherto prevalent beliefs and more or less established fact, that these trades are highly conducive to the development of lung affections." [1]

However his views appear to have been over optimistic as later statistics show no such improvements (Table XXXIV) with the percentage of grinders dying in 1891 from all forms of lung disease being 72% (as compared to 71% in 1861).

TABLE XXXIV: Deaths of Sheffield Grinders from Tubercular Diseases and Respiratory Disorders between 1861 and 1899

Year	Tubercular Diseases	Diseases of the Respiratory Organs	Total from all Diseases of the Lungs
1861	39%	32%	71%
1871	42%	27%	69%
	Phthisis	Other Respiratory Diseases	
1885	23%	25%	48%
1891	36%	36%	72%
1899	33%	34%	67%

Source: Mortality Returns of the Superintendent Registrar for Sheffield 1861 and 1871; Annual Reports of the Health of Sheffield by the Medical Officer of Health, 1885, 1891 and 1899.

[1] Ibid. p48.

Having considered the statistics more closely it would appear that while it is not possible to refute the claims made in the 1820's and 1840's that grinders were old men at 30, seldom reaching their 40th year; by 1861 at least, approximately 70% of the grinders were over the age of 40 at death. Although it is true that few lived to 70, about half the deaths in 1861 were accounted for within the age bracket 40 to 60. Despite this apparent lengthened life, however, when causes of death are analysed there was still a high incidence of death from diseases of the lungs amongst grinders and this tendency continued until the end of the period. What is not known, at present, is the age of death attained by the grinders in the 1890's, and whether the trend of an apparent increased longevity seen between 1820/40 and 1861 continued to 1900.[1] Assuming that the opinions of doctors, writers and the workmen themselves were correct on the life expectancy of the grinders in the early 19th century, to what can the increased longevity in 1861 be attributed?

The remedies suggested by Knight in 1830 to counteract the pernicious effects of the trade had been:

1. Isolation of wet and dry grinding into separate 'hulls' as opposed to the general practice of carrying out both in the same 'hull', thus exposing the wet grinder to the more pernicious effects of dry grinding.
2. Dusting the machines before the commencement of the day's work.
3. Reduction in the hours of labour.[2]
4. Substitution of wet for a dry stone wherever possible.
5. The erection of large flues on the floor for ventilation purposes through which a current of air was to be passed driven automatically by machinery, without any additional attention being necessary on the part of the grinder.
6. Fork grinding to be carried on by criminals.[3]

[1] Lloyd (1913), p456 does give the average age of death of male workers in the cutlery trades in Sheffield for the five years 1901-1905. However, he does not indicate from what material his statistics are drawn and does not give a comparison for other trades. For the five years, his average age at death for grinders (in general) is 50 and fork grinders (specifically) 57 which would indicate that life expectancy had continued to increase between 1861 and 1890.

(continued...)

Although this last suggestion can hardly be taken seriously, the others formed the basis for most of the preventative measures promoted throughout the period, with the additional, later recommendation that boys should be prevented from being apprenticed to the trade at an early age.[1]

The early experiments in ventilation systems and respirators have already been discussed, and it has been seen that their effect in reducing the level of dust inhaled was far from satisfactory. The respirators proposed can hardly account for the increased length of life because their use, as seen was irregular and opposed by many grinders themselves, who found them cumbersome to use and often complained that they made breathing difficult. Modern occupational health practitioners do not regard personal protection as a good remedy for any industrial hazard, it often being referred to as the 'last line of defence'. The reason is that it does not eliminate the source of the danger which remains unaltered, hence, to have any effect at all, a respirator needs to be used, to be kept in good condition, and receive daily attention; practices which are often neglected. Due to the different physical build of people, for full protection, a respirator needs to be personally fitted for the individual user, which is seldom the case. These early respirators are unlikely to have played any large part in improving health at work and a handkerchief held across the nose, as seen by Greenhow, was probably just as effective as a respirator and was more likely to have had the dust shaken out of it when it became clogged up. One fear with issuing any form of personal protection is that it may lead to complacency. The employer may consider that he has done enough and take no

[1] *B.M.J.* 1857 March 28th, p250.

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[2] There was a general belief that the idle and drunken lived longer, attributing this to washing the dust down with alcohol, but in reality, any increase in longevity was due to their absence from the hull and hence influence of the dust.

[3] Knight (1830-31), pp90-91.

further action to remove the danger at source; the workmen may believe that they are fully protected and become less cautious in carrying out their work.

As to the early attempts at ventilation, although those of Elliott proved futile they were a basis for other people to work on, and the later systems of fans and flues described by Drs Holland and Hall, do seem to have cleared the atmosphere of the visible signs of dust, although as discussed in the section on dusty trades, a large part of the problem was the dust which was not visible to the human eye.[1] Despite this fact not being known at the time, the merits of the installation of fans can be judged.

Joseph Rogers and Sons was one of the leading firms in taking preventative measures. They installed fans in all the hulls at their 'wheel' and when the British Medical Association's 44th annual meeting was held in Sheffield in 1876, a general invitation was given to all conference delegates to go and inspect the 'wheel' themselves, to see the clear atmosphere and the beneficial effects of their fan installation.[2] But this was not the case in all 'wheels'. In 1857 Hall only described fans as being in one hull in the Union 'wheel' and one hull of the Soho 'wheel' and not in general use. In some 'wheels' no fans at all had been erected; at others, one man might work with a fan whilst his neighbour was without, hence, the beneficial effects of the former's precautionary action were almost entirely lost; in some hulls even though a fan had been installed it was not used because of complaints from the grinders of noise and draughts; in others careless handling and defective designs made them ineffectual even when in use; "in another the man at the end trow had put up a fan that would serve the whole hull, which

[1] See the discussion on dust on pages 146-147.

[2] *B.M.J.* 1876 August 26th, p271. J Rogers & Son were an unusual 'wheel' in many respects, not only for using a fan and being well constructed, but as the men mainly worked on high class, quality goods, they were not required to labour so hard.

he charged, perhaps, each man a penny a week for; the man next him paid for the fan, but not having been at the trouble to fix a box, it was useless to him." [1]

Although the need for suction pipes and fans was generally accepted by 1860 one of the major hinderances to their general installation was the system of work organisation which meant the virtual independence of the individual operative. The grinder would hire a trough from the owner of the 'wheel' or he might rent the whole hull and either set apprentices to work or in turn, sublet to other grinders. This situation meant that many 'wheel' owners felt it was the responsibility of the grinders to put up fans for their protection and likewise, many of the grinders thought the owners should meet the bill. The Factory Acts Extension Act in 1867,[2] made an attempt to insist on the use of fans in situations where grinding, glazing and polishing were carried on to such an extent as to produce harmful quantities of dust, but although well intentioned, these provisions proved impossible to enforce, and were ambiguous as to who was responsible for the erection of such fans. The 1895 Factory and Workshop Act[3] ironed out some of these problems, by placing the responsibility for the installation of suction pipes onto the shoulders of the owner of the 'wheel' whether or not he was the operator, whilst the grinder had to provide the actual fan for his trough. Although this was clearly an improvement on the former situation, as each now knew his responsibilities, there was no obligations regarding the efficiency of the equipment installed and ducts were often of poor design with dust being emitted to the outside atmosphere close by a window so that it merely returned into the workshop. There

[1] *B.M.J.* 1857 March 28th, p250; also *B.M.J.* 1868 February 29th, pp203-204 "A man who has worked in shops in various parts of the kingdom tells us that the fan is rarely used, unless there are from thirty to fifty men at least in the workshops, and the men are pretty close together at their work."

[2] 1867 Factory Acts Extension Act 30 & 31 Vict. c103 s9. Extended to workshops in the 1867 Hours of Labour Regulation 30 & 31 Vict. c14 s8, and incorporated in the 1878 Factory & Workshops Act 41 & 42 Vict. c16 s36.

[3] 1895 Factory & Workshop Act 58 & 59 Vict. c37 s24.

was also no obligation for the grinder actually to use the fan when installed, thus, although some improvements followed from the passing of the Act, it needed further regulations in 1909 and 1910 fully to modify the trade in this respect.[1]

There were no regulations as to the employment of children in grinding until 1867[2], when children under eleven were prevented from entering the trade. This was a beneficial move but too late to account for any improvements mid-century. There also appear to have been no regulations as regards hours of labour, which would have been advantageous, although half days on Saturdays were introduced in about 1840.[3]

It remains to reconsider changes in the technology of grinding over the period, in particular the gradual change in some branches of the trade from dry to wet grinding. Although as discussed previously, this was not considered possible for all branches, there were some which could make the change over relatively easily. By about 1840, most spring knife grinders (i.e. pen and pocket blades) were using the wet stone in place of the former dry stone.[4] This would mean that by the 1860's most of the spring knife grinders who had formerly ground dry would have died and there would have been a new population of wet grinders, experiencing the benefits of the change over.

In conclusion, the inadequacy of mortality data for grinders in the early 19th century requires that the assertions of medical observers regarding the low average age at death to be questionned. It is possible that the situation was exaggerated although the persistent enquiries of medical

1 Lloyd (1913), p230.

2 30 & 31 Vict. c103 s7.

3 Lloyd (1913), p181.

4 *B.M.J.* 1857 March 21st, p235; March 28th, p249.

practitioners and the oral tradition of high mortality amongst the grinders themselves would support the assertion. In the absence of reliable statistics it cannot as yet, therefore, be proved that the longevity of grinders increased in the course of the 19th century although since it is known that average longevity increased for all males during the period it would be reasonable to assume that this was so. Whilst ventilating systems and fans would have had some beneficial effects, and the substitution of wet for dry grinding reduced the dangers in some branches, it is questionable whether the consolidation of these minor technical changes alone could account for the apparent increased longevity of grinders in the second part of the century. Other factors were also involved.

Firstly there may have been general improvements affecting health in social conditions, housing, sanitation and diet with the consequence that grinders would not have succumbed to industrial diseases so quickly. Secondly the growth in the medical understanding of the nature of grinders' asthma in particular, and growing knowledge of medical welfare and practice in general, meant that doctors were able to offer some better advice on treatment to prolong the life of the grinder. However, even if the early mortality figures are accepted with the inevitable conclusion that the longevity of grinders had increased by 1861, grinders as an occupational group still experienced a higher mortality rate per 1,000, mainly due to lung diseases, than men employed in other occupations in Sheffield during the remainder of the 19th century. Even by the early 20th century, the average annual death rate per 1,000 living males aged 20 and over from 1901 to 1909 was 16.6 whereas for grinders it was 30.4 (Table XXXV).

The other risk to the grinder was accidental injury from the breaking of a grindstone when it was running at high speed or had not been properly hung.[1]

[1] The speed was increased with the introduction of steam power.

TABLE XXXV: City of Sheffield Mortality in certain trades during nine years 1901-1909 from all causes, from phthisis and from diseases of the respiratory system

Trade	Workers: Number	Workers: Ages	Average Annual Death Rate per 1,000 living: All causes	Phthisis	Respiratory Diseases
Grinder	3941	18 & over	30.4	15.1	5.4
Cutlers	3889	18 & over	29.3	5.8	6.9
File Cutters	1850	20 & over	29.8	5.2	5.6
Silver etc. workers	2380	20 & over	26.2	5.3	4.6
Tailors	941	15 & over	20.4	1.5	3.8
Printers	487	20 & over	16.4	3.7	2.7
Joiners	2286	15 & over	13.8	1.7	2.8
All males	124000	20 & over	16.6	2.7	3.4

Source: Quoted in G I H Lloyd *The Cutlery Trade* (1913), p454. From the Report of the Medical Officer of Health, City of Sheffield 1909.

The Infirmary report of 1820 spoke of the great injury to the face and nasal bones resulting from this cause, often accompanied by 'fracture and depression of a portion of the skull.'[1] The saw grinders seem to have been more exposed to this danger than others, due to the large size of the stones and the higher likelihood of them having some defect as well as the velocity at which they turned. Another problem with their occupation was the cumbersome nature of the article being ground, and injuries sometimes resulted from entanglement with machinery.[2]

[1] Ernest (1820), pp9-10.

[2] Holland (1843 Vital Statistics), p176. Of the 78 living members in the Union for saw manufacturs, listed below are some of the accidents they had suffered:

1. Lame nine months, from the breaking of a stone.
2. Lame six months, drawn over the stone.
3. Arm broken from being entangled in the machinery.
4. Skull severely fractured, was incapable of work for nine months, and the individual has broken eleven stones.
5. Drawn over the stone; severely hurt, in bed nine months.
6. Severely hurt, confined two months, has broken seven stones.
7. Hand cut; confined one month.
8. Leg entangled in the machinery; for twelve months unable to work.
9. Arm severely lacerated; lame three months.
10. Lamed, from the stone breaking; ill three months.
11. Hand lacerated; incapacitated from work.
12. Hand lacerated; lame two months.
13. Leg broken and now a cripple.

The Infirmary report concludes that, "in consequence of some wise regulations in the grinding wheels, such terrible accidents have for many years past been comparatively rare"[1] but they still occurred steadily throughout the 19th century. Between 1821 and 1843 of the 42 saw grinders who died, five were killed by stones breaking[2] and the 1871 report of mortality of Sheffield records a scissor grinder of 28 as being accidentally killed by the breaking of a grindstone.

From early times the grinder had tried to provide some protection for himself from the stone flying forwards (which was more likely to occur than the stone flying upwards), by working astride the stone on a wooden horse chained down to the floor but the series of accidents which continued to occur shows the difficulty of trying to provide protection. In 1810 John Slater took out a patent for an improved method of hanging grindstones to secure them from breaking in the middle. Instead of using wedges to hold the stone, he placed a wooden washer around the central spindle on each side, and then bolted on an iron ring. By mid-century, it had become general practice to fit the stone with plates and screws, instead of as formally by using wedges but although reducing the number of accidents, it did not completely solve the problem.[3] The 1867 Factory Act[4] had a clause on securely fixing grindstones, granting the Inspectors similar powers of action as when machinery was found to be inadequately fenced. The 1895 Act brought in more stringent regulations in an attempt to mitigate the danger, such as not placing a grindstone in front of a fireplace.[5] When the Dangerous Trades Committee visited Sheffield in 1897 this was one area they investigated.[6]

1 Ernest (1820), p10. 2 Holland (1843 Vital Statistics), p175.

3 *B.M.J.* 1857 March 21st, p235; Patent No. 3301, 12th February 1810; *The Repertory of Arts, Manufacture and Agriculture* 1810 Vol.XCIX Second Series August, pp139-141.

4 30 & 31 Vict. c103 s10.

5 See Appendix IV.

6 *B.M.J.* 1897 December 11th, p1766.

An allied problem was the large number of eye injuries from flying particles of stone and metal. It was a hazard more attached to dry than wet grinding and caused serious problems. Firstly, because of the force with which the particles struck the eye, either causing the extinction of sight from concussion or causing severe penetrating wounds with the fragment often becoming embedded in the eyeball,[1] and secondly, because the chips of metal were generally hot.[2] These particles were called motes by the grinders and often there was a recognized workman in the trade known for his skill in removing them, frequently performing the operation with a pin, blunt lance or penknife.[3] More satisfactory treatment was the wearing of plain glass spectacles. These after a short time became studded with marks caused by the heated particles of metal striking them.[4] The risk from this source was reduced when fans were installed because although intended primarily for protection against grinders' asthma it also drew the particles away from the face and eyes of the grinder:

> "Streams of sparks, as the red-hot particles given off from the friction of the stone and steel appear to be, were observed suddenly to turn downwards into the shaft as they came within the influence of the indraught of air."[5]

Thus by the use of these two measures, the risk of injury was greatly reduced. How extensively they were put into practice, however, is not easy to assess.

1 Simeon Snell *On the prevention of eye accidents occurring in trades* (1899) "If the cornea of a grinder be carefully examined with a magnifying glass it will not infrequently be found to be studded over with minute nebulae; though, therefore the damage done by each 'mote' may often not be serious, yet the frequent repetition by dulling the cornea, will in many cases, diminish the acuteness of vision."

2 *J.S.A.* 1855 January 12th, p124.

3 *B.M.J.* 1894 September 15th, p583.

4 *J.S.A.* 1855 January 12th, p122, Mr. Wilson, foreman of Messrs Rogers, Sheffield; *B.M.J.* 1857 March 21st, p235.

5 Greenhow (1860), p121.

The last area of industrial health hazards to be discussed in relation to Sheffield is that of the file cutters' disease which, as seen from the following case study, is a classic example of lead poisoning.

> "Samuel Wheatley, file cutter, aged 17, was admitted at the Sheffield Public Dispensary on May 4th, 1854. He has had frequent attacks of severe pain in the abdomen; his fingers have often felt numb; and his wrists are weak. The blue line is marked round several of the teeth in the lower jaw. Six weeks ago he was attacked with epilepsy. He says, 'I have had a fit every day; they often attack me in my sleep. I have had as many as three in one night.' He walks badly and articulates very indistinctly." [1]

As lead poisoning has been dealt with in detail elsewhere,[2] only a brief account will be made to it here as it relates to file cutting.

The file cutters were exposed to the risks of lead poisoning[3] due to the fact that during the process of cutting, the file rested on a bed of lead. Although lead dust rose up with every blow of the chisel,[4] the disease was often contracted through carelessness and uncleanliness as was the case in other manufactories using lead. Another source of danger was the habit of wetting the fingers and thumb of the hand by licking them and a peculiarity of the file cutter's disease was the paralysis of the left hand.[5]

The preventative measures advanced were the simple ones suggested for most industries where lead was used, being the exclusion of young children, the provision of adequate washing facilities, separate rooms for meals and the issue of overalls to wear whilst at work. To prevent the danger arising from licking the fingers, John Taylor, a Sheffield

[1] *B.M.J.* 1857 May 9th, p385. [2] See pages 57-60 for lead poisoning discussion.

[3] Thackrah (2nd enlarged edition 1832), p95, when talking of file cutters, he makes no reference to lead poisoning.

[4] *B.M.J.* 1857 May 9th, p385. Cutting rasps, the workman used about ¾lb of lead a week and for large square files about 1 lb of lead a week.

[5] *B.M.J.* 1865 October 28th, p452.

surgeon, suggested a simple apparatus consisting of a syphon bottle with a projecting cup at the bottom. The cup contained a sponge, moistened by a solution of carbonate of soda from the bottle. The idea was that the sponge would take the place of the lips to moisten the chisel, and the carbonate of soda would tend to turn the lead into the less harmful carbonate form. However, when he tried to introduce it into the file cutting shops, he was informed by the workmen that only careless people suffered from lead poisoning and if they could not be bothered to wash themselves, they were highly unlikely to bother using his invention and so he let the matter rest.[1]

It is hard to estimate the number of people who suffered from this disease as many recovered to die from other causes and even if they did die from lead, it was seldom acknowledged in the mortality returns. In 1899 only one death from plumbism was recorded in Sheffield, that of a file cutter aged 46.[2] Although the Dangerous Trades Committee, 1897, took evidence on the effects of file cutting, lead poisoning, as a trade disease, was already beginning to disappear due to the substitution of machine-made files. The final disappearance of file cutters' disease was due to this cause rather than any preventative measures taken.[3]

The Sheffield trades between 1780 and 1900 make an interesting case study of industrial health and safety. At the beginning of the period the incidence of grinders' asthma was apparently low, yet it increased to unprecedented levels in the early part of the 19th century. Despite continued publicity and growing knowledge of its nature and cause, no real remedy was discovered in the period (although the basis for later developments were established). At the close of

[1] Taylor (1873), pp32-33.

[2] *Report on the Health of the County Borough of Sheffield* 1899, p56.

[3] *B.M.J.* 1894 January 20th, pp155-156; 1897 December 11th, p1760; Hunter (4th edition, 1969), p253.

the century, the grinders still suffered excessively from phthisis and respiratory illnesses when compared with the rest of the adult population of the area.

Although file cutters' disease was recognized during the period, no successful preventative measures were introduced and if a decline did come about in the 1890's, it was due, like other cases of industrial lead poisoning, to changes in techniques; new technology removing the worker from contact with the toxic material. This change in the manufacturing process was not necessarily brought in for health reasons but rather to increase production.

Hazards, such as eye injuries, were easier to remedy. Plain spectacles were cheap to supply but it was left to the individual grinder to take the initiative to provide and wear them. The risk of the sudden breaking of the grindstone and resulting injuries remained throughout the 19th century but new methods of fixing the grindstone, developed and improved over the period, led to a reduction in the incidents. Although many grinders were conscious of risks to their health and prepared to take precautionary measures, others were careless. The system of work organization in the trade blurred areas of responsibility and it was felt by many that no extensive advance in health and safety measures could take place unless the Government intervened. The first attempts at control by the Government did not solve the ambiguities of responsibility but were important preliminary steps, paving the way to eventual acceptance of Government intervention in health and safety at work in the Sheffield trades.

2. WORCESTER POTTERY

Beside the concentration of pottery workers in the North Staffordshire area there were other areas in the country producing earthenware and china, for example Worcester. Porcelain had first been produced there in June 1751, when the Worcester Porcelain Company had been established. At the beginning of 1752, the company acquired the factory of Miller and Lund in Bristol and was able to transport both moulds and workmen to Worcester. Throughout the 19th century, it saw a series of changes in ownership and fortunes but in 1862 its composition changed fundamentally with the formation of a joint stock company under the name 'The Worcester Royal Porcelain Company Limited.'[1] The company showed concern over the welfare of its workforce and established a Works Institute in 1884. Earlier it had organized a sick club which worked on the principle of a sliding scale of small weekly contributions.[2] In 1879, the company also established a 'Benefit Fund', of which the award books for the years 1879 tc 1906 survive and from which it is possible to make some assessment of the health risks of different occupations within the pottery industry.[3] Unfortunately, the award book does not record how long the workers had been employed in their particular trade at Worcester or elsewhere.[4]

The scheme was designed to make a payment to the family or representative of any person who died whilst in the company's employ or to any employee who was incapacitated by old age, accident or disease, the amount varying according

[1] Stanley W Fisher *Worcester Porcelain* (1968), pp5-23; Henry Sandon *Royal Worcester Porcelain from 1862 to the Present Day* (1973), Introduction, ppxix-xxi.

[2] Sandon (1973), p10.

[3] BB Employees' Benefit Fund Awards; BB2 Employees' Benefit Fund Members' Register; both held at the Dyson Perrins Museum, Worcester.

[4] From studying the 1871 census material for the Coalport China Workers in Shropshire, it is clear from the fact that the county of of birth for many of the workers was Staffordshire and Worcestershire, that there must have been frequent movement between the factories.

to length of service. To receive such an award, the employee had to have been in the service of the company for at least seven years and there were increases in the payments paid out after fourteen and twenty-one years respectively. The company could also make special awards for emergency cases of less than seven years service which was done in 1900 and 1902 for cases of lead poisoning. Special awards were also sometimes granted to widows of persons who were not employed by the Royal Worcester Porcelain Company at the time of their death but had previously given long service. A supplementary grant was sometimes made, usually in the case of long term illnesses.

The scale of payments-out was based on the following (Table XXXVI):

TABLE XXXVI: Scale of Payments-Out Adopted by the Worcester Royal Porcelain Company for its Benefit Fund in 1879

	Sum in £'s for Service								
Class[1]	7 Years			14 Years			21 Years		
	£	s	d	£	s	d	£	s	d
1	20	0	0	40	0	0	60	0	0
2	15	0	0	30	0	0	45	0	0
3	10	0	0	20	0	0	30	0	0
4	7	10	0	15	0	0	22	10	0
5	5	0	0	10	0	0	15	0	0
6	3	15	0	7	10	0	11	5	0

Source: BB Employees' Benefit Fund Awards Book held at the Dyson Perrins Museum, Worcester.

Reference: 1. See following discussion for an explanation of classes

The payments made by the Company were made at the directors' discretion and they varied from time to time. Unlike the sick club, the employees did not subscribe to the scheme. Initially, the Company set aside £1,075 for the fund, a sum which was to be increased when profits allowed. The document setting out the scales of payments-out does not provide a complete key to the classes but it is possible to deduce which class many of the workers were grouped in by the payments made.

Until 1893, the only award made in class one was to a commercial traveller. Class two appears to have included the clerical workers and the foremen of the important sections in the manufactory, including potters and decorators. Class three included the foremen of the less prestigious departments such as polishers, china firemen and gilders. In this group were also those with some important skill or responsibility, for example figuremakers. Class four contained the majority of the branches of the trade employing males, such as potters, pressers, gilders, placers, dippers, painters and groundlayers, and also included the timekeeper. Class five included the female workers, the scourers, burnishers, paintresses, glaze trimmers and transferers but awards in this group also went to flint sifters and slip makers. The only awards granted in class six were to labourers, with the one exception of a boiler attendant.

The whole system seems to have been revised in 1893, when the workforce was divided into four groups only. Class one appears to have remained unaltered with commercial travellers and salesmen, but with the addition of various supervisors, such as those for potters and art. Class two was an amalgamation of the former groups two and three, thus the former class four became class three. The new class four was equivalent to the former classes five and six. The scale of payments-out remained the same as for the top four classes in 1879 with the addition of two more service periods, presumably for twenty-eight and thirty-five years service. The largest payment recorded over the period went to a widow of a salesman who had entered the company's services in October 1868, aged 14 and who had died, from diabetes in October 1904, just short of his 51st birthday. His widow received £100. A new category of award was also introduced in 1893 which was made on leaving the service after at least seven years. continuous employment. This was not necessarily connected with any illness and was instead a reward for service. This became the main reason for receiving payments in the later years of the records.

The system was thus based on status in the Company rather than on the risks involved at work, with many of the most hazardous jobs like scourers, sifters and glaze trimmers, being in the lowest class of awards.

Table XXXVII shows, in detail, the awards made between 1879 and 1906 which in all totalled 380. Of these, 22 were supplementary grants to assist those who were incapacitated through illness for a long period of time, with some receiving as many as six or seven grants in all. In three cases special awards were made on dismissal to cover the costs of debts. Excluding both these groups and also those who received payment on leaving the company, 204 awards were made for sickness, old age or death. In 1889, the Worcester Royal Porcelain Company Ltd. took over the china business of George Grainger and Company, also in Worcester, whose factory had been known as the St Martin Gate Factory. Production was continued on this site until 1902, although from 1889 it was known as the Royal China Works,[1] and four payments were made to employees at this works. All the rest were made to workmen at the Company's porcelain works.

The causes of death are examined in Table XXXVIII and of the total of 135 deaths, 68 (50%) were from respiratory diseases. It is interesting to note that the causes of death of all the scourers who died were either phthisis or bronchitis, confirming the claims made by such authors as Greenhow and Arlidge.[2] It is also noticeable that the pressers succumbed to phthisis and bronchitis. Dr Greenhow had found that this group of workers was generally exposed to much heat and the position of work often constricted the chest causing bronchial troubles. His claim, however, that they rarely reached fifty years of age is not borne out by Table XXXIX.[3] The kilnmen who worked in excessive tempera-

1 Sandon (1973), p.xx and p24.

2 See the discussion of dust diseases in the potteries, pages 154-163.

3 Greenhow (1860), pp107-108, 111-112.

TABLE XXXVII: The Number of Awards made each year by the Employees' Benefit Fund of the Worcester Royal Porcelain Company Limited - 1879 - 1906

Year	Total Number of awards	Paid Upon Death	Paid for Incapacity Through Illness or Old Age	Paid for Injury From an Accident	Paid as Supplementary Grant	Special Awards for other Causes	Paid on Leaving the Company[1]
1879	2	2	-	-	-	-	-
1880	5	4	1	-	-	-	-
1881	4	3[2]	1	-	-	-	-
1882	5	2	3	-	-	-	-
1883	6	4	2	-	-	-	-
1884	9	9[3]	-	-	-	-	-
1885	7	5[4]	2	-	-	-	-
1886	10	9[5]	1	-	-	-	-
1887	7	5[6]	2	-	-	-	-
1888	8	3	5	-	-	-	-
1889	9	5	1	-	3	-	-
1890	10	9	-	1	-	-	-
1891	9	4	1	-	4	-	-
1892	14	7	3	-	4	-	-
1893	13	2	3	-	-	-	8
1894	28	5	2	1	2	-	18
1895	34	11	1	-	3	2	17
1896	29	5[8]	5	-	-	-	19
1897	26	9[9]	2	-	-	-	15
1898	30	1	7	-	1	-	21[8]
1899	15	5	3	-	2	-	5
1900	12	4[8]	3[7,8]	-	-	-	5
1901	11	2[2]	3	-	1	1	4
1902	23	7	5[7]	1	1	-	9
1903	15	7	1	-	1	-	6
1904	26	4	5	-	-	-	17
1905	5	2	1	1	-	-	1
1906	8	-	2	-	-	-	6
TOTAL	380	135	65	4	22	3	151

Source: Award Book of Employees' Benefit Fund - Worcester Royal Porcelain Company.

References:
1. *New Scheme introduced 1893.*
2. *Includes one death by suicide, no award actually made.*
3. *One died as the result of an accident.*
4. *One was already diseased before commencing work at the Wocester Royal Porcelain Works.*
5. *Includes two payments made to former employee.*
6. *One death caused by lead poisoning.*
7. *Includes one employee incapacitated through lead poisoning - a special award being made.*
8. *Includes one employee at the Royal China Works.*
9. *Includes two employees at the Royal China Works.*

Table XXXVIII: To show cause of death of the 135 awards made on the death of an employee by trade followed: 1879 - 1906

OCCUPATION	CAUSE OF DEATH: Phthisis	Bronchitis	Pneumonia	Other lung & respiratory diseases	Heart Disease	Disease of nervous system	Disease of digestive system	Kidney disease	Cancer or Tumour	Spinal Disease	Typhus Fever	Lead Poisoning	Blood Poisoning	Gangrene	Burning	Suicide	Old Age	Unknown	TOTAL
Scourers	5	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	11
Burnishers	1	2	-	2	1	2	1	-	1	1	-	-	-	-	-	-	-	1	12
Kilnmen	2	-	-	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-	9
Pressers	6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8
Placers	1	2	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Painters/ Paintresses	2	-	1	1	1	-	2	1	2	2	-	-	-	-	-	1	-	-	13
Gilders	2	1	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-	7
Potters	2	3	-	2	3	2	-	-	-	1	-	-	-	-	-	-	-	1	14
Misc Workers on pottery	4	4	3	1	2	2	1	2	2	-	-	1[1]	1	-	1	-	-	1	25
Warehouse Workers	2	-	-	-	1	2	-	-	-	-	1	-	-	-	-	1	-	-	7
Labourers	1	2	1	-	2	1	-	-	-	-	-	-	-	1	-	-	-	-	8
Craftsmen *	-	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	4
Office/Misc**	2	1	-	-	-	1	2	2	-	-	-	-	-	-	-	-	1	2	11
TOTAL	30	22	7	9	17	12	8	6	5	4	1	1	1	1	1	3	1	6	135

Source: Award Book of the Employees' Benefit Fund - Worcester Royal Porcelain Company. Ref. 1. Was a mill attendant

* other than potters. ** workers not on pottery

TABLE XXXIX: To show the age of the 135 employees on whom awards were made on death by trades followed: 1879 - 1906

Occupation	Age at Death												
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	Unknown
Scourers	-	2	-	2	-	2	3	1	-	-	-	-	1
Burnishers	1	1	-	1	1	1	1	-	3	-	1	-	2
Kilnmen	-	-	2	2	3	-	-	1	1	-	-	-	-
Pressers	1	1	-	-	1	1	-	-	3	-	-	-	1
Placers	-	-	-	1	1	-	1	1	1	1	-	-	-
Painters/ Paintresses	-	5	3	1	1	-	1	1	-	1	-	-	-
Gilders	1	-	-	-	1	-	-	2	2	1	-	-	-
Potters	-	1	1	1	1	3	4	-	2	1	-	-	-
Misc Workers on pottery	-	1	5	4	2	3	1	4	2	1	-	1	1
Warehouse Workers	-	2	-	1	1	-	-	1	-	2	-	-	-
Labourers	-	-	-	1	-	1	-	-	-	1	2	2	1
Craftsmen other than potters	-	-	-	-	1	-	1	-	-	-	1	1	-
Office/Misc workers not on pottery	-	-	1	1	2	2	2	-	1	-	1	-	1
TOTAL	3	13	12	15	15	13	14	11	15	8	5	4	7

Source: Award Book of the Employees' Benefit Fund - Worcester Royal Porcelain Company.

tures appear to have died mainly from lung diseases and heart complaints which could have been associated with their occupation but it is interesting to see that the death from lead poisoning was in a mill attendant and not a dipper, glaze trimmer or majolica painter as might have been expected although it is possible that he was in attendance at the mixing of glazes.

Table XXXIX shows the age of death of those receiving awards and apart from one burnisher who was in her early seventies, the other deaths over seventy were amongst clerical and labouring groups within the Company or in crafts unrelated to the manufacture of pottery, such as carpentry and plumbing. The Table indicates that it was safer to be employed on the non-manufacturing side. However, several of the workers in the pottery branches did reach their 60th year and although none of the scourers who died attained this age, at least five were in their 50's. How long they had been in the trade, however, is not known. A curious point is that there were seven paintresses who died, of whom the eldest at death was thirty-three. Why this should have been the case is open to speculation, there being no apparent correlation between trade followed and the causes of death.[1]

Sixty-nine awards were made for persons incapacitated from work. The reasons given were:

Incapacitated to work	13	All over 50 with the exception of one who was 25.
Partially incapacitated to work	4	All over 50
Illness unspecified	25	
Illness specified	14	
Old Age	9	Ranging between 69 and 78
Accidents	4	

[1] Of the seven paintresses the age and cause of death were as follows: 25, Heart Disease; 26, Pleuro-pneumonia; 27, Phthisis; 27, Phthisis; 28, Peritonitis; 31, Disease of Spine; 33, Enteric Fever.

Of those incapacitated through old age, the youngest was a boatman of 69 and the eldest, the forewoman of the paintresses, who was 78. The majority of those cases simply described as incapacitated to work were probably due to old age, as they were nearly all over 65. In neither of these groups were there any scourers, sifters, polishers or placers, nor any of the occupations pointed out by the various 19th century writers as being harmful.

Of the fourteen specified cases of illness, the reasons given were as follows:

Phthisis	2	Potter (54); Flat Presser (48).
Consumption	2	Paintress (25); Flint Sifter (?).
Chronic Lung Diseases	3	China Scourer (52); Placer (65); Slipmaker (43).
Lead Poisoning	2	Groundlayers Assistant (45); Glaze Trimmer (?).
Paralysis	2	Labourer (64); Show Room Assistant (35).
Kidney Disease	1	Transferer (55).
Heart Disease	1	Paintress (61).
In Powick Asylum	1	Gilder (30).

In the group incapacitated through unspecified illness, there were three scourers (one who was 65), five placers, three firemen, two gilders, a glaze trimmer and ten others. One of the scourers later died.

In the absence of detailed data on length of service with the Company and on the average age in different departments, and taking into account the relatively few deaths over the period, the data from the Benefit Fund Award Books is open to several interpretations. It is likely, for instance, that the external environment in Worcester was less polluted than that of the Potteries. The evidence, such as it is, suggests that it would be misleading to attach too great a significance to any apparent links between illness, cause of death and occupation of employees at the China Works. Indeed the data could suggest that at this porcelain factory working conditions were relatively good for the time. Nevertheless, the majority of the diseases were of a respiratory nature, the highest incidence being amongst those working in the dustiest and hottest departments.

3. EYE INJURIES IN THE GLASGOW AREA

Some of the worst industrial eye injuries were the result of accidents in iron and steel or engineering works, and the large shipbuilding yards around Glasgow were no exception. Any injury to the eye is potentially serious as there is no certainty that a minor injury will not cause major impairment to vision or even result in the eventual loss of sight. Even today the risk of eye injury in industry is considerable and it is said that there are around 1,000 eye injuries caused every working day.[1]

The first infirmary specifically for eye diseases, The London Dispensary for Curing Diseases of Eyes and Ears,[2] was set up in 1804. Others soon followed in Liverpool, Manchester and Edinburgh, and the Glasgow Eye Infirmary opened its doors to out-patients on June 8th, 1824, at 19 Inkle Factory Lane, North Albion Street. In 1835 it expanded and moved to premises in College Street, and moved again in 1851 to Charlotte Street. In 1874 the new Eye Infirmary was opened in the west end of the city, at the corner of Berkely Street and Claremont Street, although the Charlotte Street premises were still maintained.[3]

Although not set up for industrial purposes, the Glasgow Eye Infirmary dealt with many industrial victims and in 1833 a plea was made for such individuals to seek immediate attention at the Infirmary instead of resorting to the help of a fellow worker.

> "There can be no excuse for anyone neglecting to apply at the Eye Infirmary till he finds his sight rapidly failing him under the inadequate means of relief generally prescribed by non-professional advisors, or the foolhardy and rude manipulation of blacksmiths and

1 T.U.C. (1978), p113.

2 Later known as Moorfield Eye Hospital

3 A M Wright Thomson *The History of the Glasgow Eye Infirmary 1824 - 1962* (1963).

> other pretenders, as no recommendation has ever been demanded in such cases. The patient requires only to present himself, to receive gratuitously the assistance and advice of the Medical attendants of the Eye Infirmary." 1

Tables XL and XLI indicate the number of both indoor and outdoor patients dismissed from the Infirmary as being either cured, partially relieved or sent away as incurable, for the period 1824 to 1886. Although the annual reports give no account of the actual breakdown of the diseases treated in relation to the occupations of the patients, some indications of the extent of the industrial injuries may be gained from looking at the numbers dismissed each year who had been treated for inflammation of the eye through injury, foreign bodies in the eyeball and its appendages and other selected causes which appear purely accidental in nature. This has been set out in Tables XLII and XLIII. However, there are certain precautions to be borne in mind when studying the tables; the first of which is the changes over time in the classification used in describing the various illnesses. For the initial years the breakdown was incomplete and for this reason the first decade of the Eye Infirmary's existence has been omitted from the Table. Surprisingly too, when both Charlotte Street and Berkely Street were in operation the annual reports from each institution used a different system of classification of disease. In 1884, the terminology for diseases of the cornea were changed at Berkely Street, making it impossible to extract the causes of injury. The following year a similar change accurred in the accounts for the premises at Charlotte Street. Secondly, the figures include cases of injury from domestic accidents or the results of brawls and other mishaps; moreover, some cases of industrial accident will have been missed as they will have been included under the headings of cataracts, hernia iridis and others. It is not likely that the two will cancel each other out but some check on the inaccuracy of the Tables can be made, as occasionally the annual reports do state the

1 9th Annual Report of the Glasgow Eye Infirmary January 1833 HB3/3/1 (GHB)

TABLE XL: Number of Patients Dismissed from the Glasgow Eye Infirmary 1824 - 1873

Year	Number of Patients Dismissed	Year	Number of Patients Dismissed
1824[1]	149	1849	688
1825	273	1850	1032
1826	407	1851[3]	1048
1827	498	1852	1136
1828	410	1853	1139
1829	576	1854	1042
1830	622	1855	1606
1831	424	1856	1258
1832	851	1857	1718
1833	675	1858	1613
1834	748	1859	1446
1835[2]	681	1860	1672
1836	726	1861	1902
1837	762	1862	1834
1838	670	1863	2207
1839	966	1864	2174
1840	966	1865	1962
1841	844	1866	2055
1842	1098	1867	2088
1843	948	1868	2298
1844	994	1869	2398
1845	827	1870	2737
1846	809	1871	2682
1847	766	1872	2799
1848	767	1873	3072

Source: Annual Report and Minute Books of the Glasgow Eye Infirmary 1824 - 1873.

References:
1. *only functional for 7 months of the year*
2. *moved to College Street*
3. *moved to Charlotte Street*

TABLE XLI: Number of Patients Dismissed Each Year from the Glasgow Eye Infirmary, at Charlotte Street and Berkely Street 1874 - 1886

Year	Patients Dismissed from Charlotte Street	Patients Dismissed from Berkely Street	Total Dismissed
1874	2975	670	3645
1875	2625	1551	4176
1876	2313	2439	4752
1877	2738	2912	5650
1878	2978	2905	5883
1879	3376	3175	6548
1880	2520	3503	6023
1881	3352	4047	7399
1882	4283	5316	9599
1883	4401	5437	9838
1884	4440	5142	9582
1885	4459	4947	9406
1886	3392	4753	8145

Source: Annual Reports of the Glasgow Eye Infirmary 1874 - 1886

TABLE XLII: Number of Patients Dismissed Each Year from Certain Eye Injuries at the Glasgow Eye Infirmary 1837-1873

Year	Types of Injury						
	Inflammation of eye through injury	Burns of Eyeball	Wounds of Eyeball	Bruises of Eyeball	Foreign bodies in eyeball & Appendages	Specs on Cornea	Total
1837	35	-	16	-	-	38	89
1838	41	-	26	-	-	32	99
1839	64	8	37	-	-	39	148
1840	46	5	15	7	2	46	121
1841	49	3	14	2	-	36	104
1842	62	9	24	6	-	59	160
1843	54	2	12	9	1	45	123
1844	38	10	18	-	2	44	112
1845	38	10	26	-	4	37	115
1846	57	13	29	-	4	43	146
1847	56	8	24	10	2	39	139
1848	93	7	30	9	7	35	181
1849	52	10	32	-	1	27	122
1850	98	13	30	-	4	64	209
1851	92	27	41	-	6	32	198
1852	94	18	42	26	-	35	215
1853	107	14	36	-	11	38	206
1854	116	15	33	-	9	40	213
1855	193	16	57	-	8	72	346
1856	85	16	38	-	21	55	215
1857	134	50	11	-	14	75	284
1858	116	42	15	-	21	-	194
1859	92	41	16	-	15	-	164
1860	106	60	26	-	27	64	283
1861	91	54	24	-	34	96	299
1862	106	54	26	-	35	87	308
1863	138	38	26	-	34	72	308
1864	153	17	47	-	33	56	306
1865	137	41	71	-	41	105	395
1866	130	41	92	-	32	133	428
1867	102	40	91	-	39	54	326
1868	158	27	51	-	33	109	378
1869	138	32	90	-	44	78	382
1870	213	27	57	-	53	63	413
1871	234	38	112	-	59	35	478
1872	175	32	99	-	101	65	472
1873	149	35	51	-	107	44	386

Source: Annual Reports and Minute Books of the Glasgow Eye Infirmary 1837 - 1873.

TABLE XLIII: Number of Patients Dismissed Each Year from Certain Eye Injuries from the Glasgow Eye Infirmary at Charlotte Street and Berkely Street: 1874 - 1886

Year	TYPES OF INJURY: Inflammation of the eye through injury			Burns of eyeball			Wounds of eyeball			Foreign Bodies in eyeball & appendages			Foreign Bodies within eyeball			Specs on cornea			Total injuries		
	C	B	T	C	B	T	C	B	T	C	B	T	C	B	T	C	B	T	C	B	T
1874	84	38	122	40	5	45	124	14	138	97	76	173	-	-	-	43	12	55	388	145	533
1875	25	106	131	5	12	17	10	40	50	4	98	102	-	-	-	70[1]	32	102	114	288	402
1876	87	160	247	11	31	42	43	56	99	74	118	192	-	-	-	73	66	139	288	431	719
1877	72	204	276	20	23	43	58	33	91	67	144	211	-	-	-	103	78	181	320	482	802
1878	142	207	349	16	13	29	53	43	96	65	154	219	-	-	-	88	73	161	364	490	854
1879	131	203	334	9	32	41	56	57	113	72	122	194	-	-	-	98	50	148	366	464	830
1880	106	212	318	29	46	75	37	80	117	114	184	298	-	-	-	89	59	148	375	581	956
1881	123	214	337	21	39	60	44	56	100	193	240	433	-	2	2	81[2]	46	127	462	597	1059
1882	97	239	336	35	73	108	54	121	175	189	369	558	-	4	4	97	74	171	472	880	1352
1883	89	316	405	52	52	104	42	128	170	163	399	562	-	2	2	93	62	155	439	959	1398
1884	53	517	570	14	70	84	37	156	193	129	102	231	-	9	9	143	-	143	376	854	1230
1885	305	467	772	14	61	75	53	122	175	161	117	278	-	6	6	-	-	-	533	773	1306
1886	64	334	398	35	52	87	86	90	176	240	292	532	4	6	10	-	-	-	429	774	1203

Source: Annual Reports of the Glasgow Eye Infirmary 1874-1886.

References:
C – *Charlotte Street*
B – *Berkely Street*
T – *Total*
1 – *Includes 14 wounds of cornea and 4 burns of cornea*
2 – *Includes 2 wounds of cornea*

number of cases attended which had been caused by accidents in public works. For example, in 1846 it was said that there were 122 cases of industrial accident whereas from Table XLII, the number of injury cases totalled 146, a discrepancy of 24. In 1854 nearly 200 cases of injury from public works were stated to have occurred, whereas the figure in Table XLII is 213. It would thus seem likely that the figures in the Table tend to be slightly on the high side. A much larger discrepancy is seen, however, in 1848, when it was said that there were about 140 cases of industrial injury whereas the Table shows 181. This was an unusual year in many respects as the 1849 report, commenting on the industrial accidents, wrote:

> "Many of the unemployed operatives who were last year engaged in breaking stones, lost one or both eyes from injuries which the wearing of a simple wire-gauze shade might have averted." [1]

As the number of patients treated at the Infirmary fluctuated greatly, Table XLIV shows the cases dismissed due to the injuries as a percentage of the total cases dismissed. This has been graphed in Figure I, together with information on the output from Clyde shipyards between 1864 and 1886, as it would be expected that in periods of greatest industrial activity there would have been more injuries from chips of metal and molten liquids. However, there appears to be little correlation between the two sets of figures. Negative correlation can be observed in two periods: when output fell between 1864 and 1866 the percentage of eye injury cases at the Infirmary rose dramatically and when output increased between 1880 and 1883 the percentage of injuries fell. Information on other industries, especially mining accidents, is necessary before conclusions can be drawn.[2]

[1] 23rd Annual Report of the Glasgow Eye Infirmary 13th January 1847; 25th Annual Report 11th January 1849; 31st Annual Report 9th January 1855 HB 3/3/1 (GHB).

[2] Also as will be seen later, from 1868 some eye injuries were treated at the Glasgow Ophthalmic Institution.

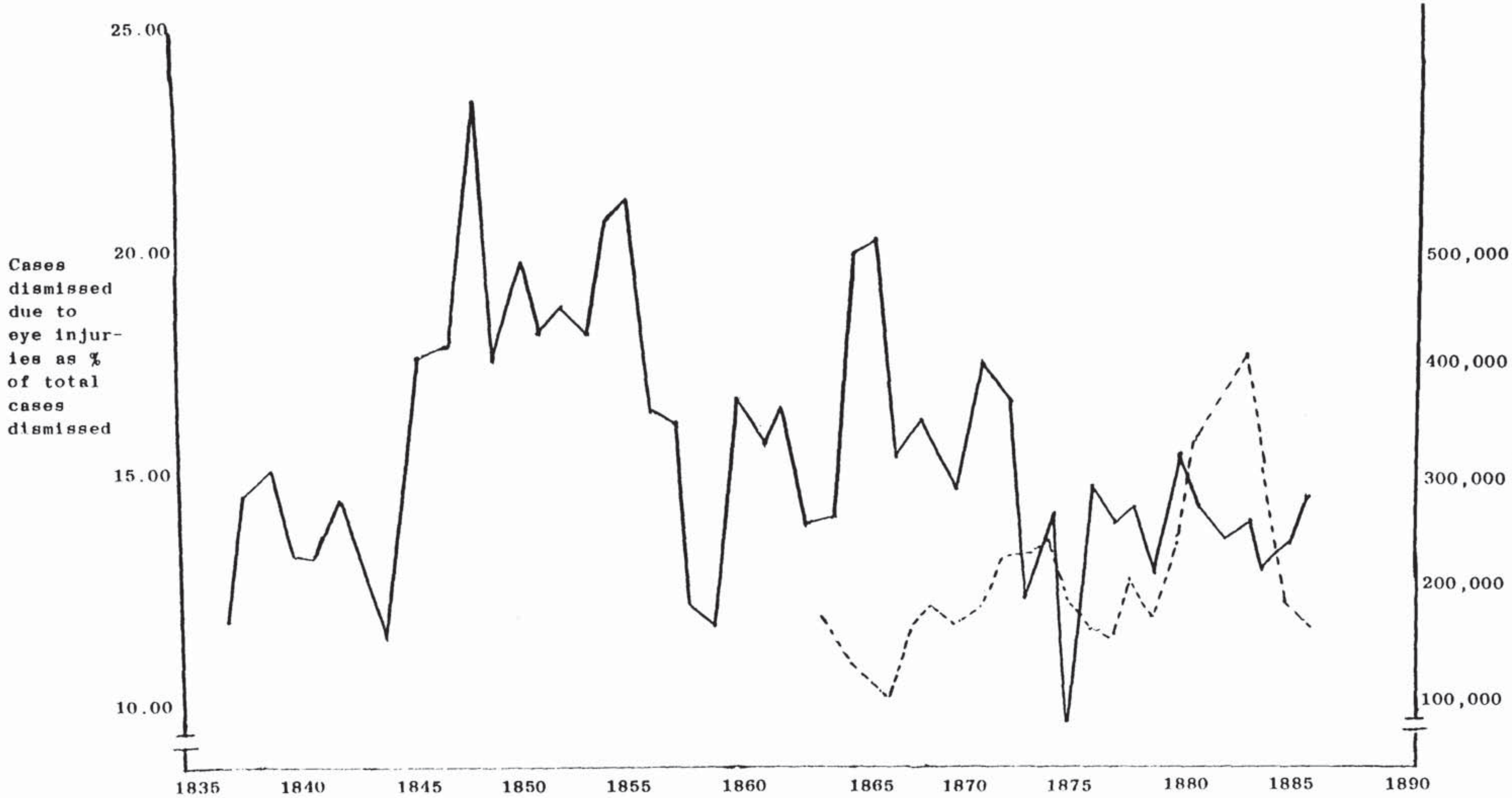
TABLE XLIV: Cases Dismissed due to Injuries of the Eye as a Percentage of Total Cases Dismissed from the Glasgow Eye Infirmary 1837 - 1886

Year	Cases of Eye Injuries Dismissed as a % of Total Cases Dismissed	Year	Cases of Eye Injuries Dismissed as a % of Total Cases Dismissed
1837	11.68	1862	16.79
1838	14.78	1863	13.96
1839	15.32	1864	14.08
1840	12.53	1865	20.13
1841	12.32	1866	20.83
1842	14.57	1867	15.61
1843	12.97	1868	16.45
1844	11.27	1869	15.93
1845	13.91	1870	15.09
1846	18.05	1871	17.82
1847	18.15	1872	16.86
1848	23.60	1873	12.57
1849	17.73	1874	14.62
1850	20.25	1875	9.63[1]
1851	18.89	1876	15.13
1852	18.93	1877	14.19
1853	18.09	1878	14.52
1854	20.44	1879	12.68
1855	21.54	1880	15.87
1856	17.09	1881	14.31[2]
1857	16.53	1882	14.08
1858	12.02	1883	14.21
1859	11.34	1884	12.84[3]
1860	16.93	1885	13.88[3]
1861	15.72	1886	14.77[3]

Source: Annual Reports and Minutes of the Glasgow Eye Infirmary 1837 to 1886

References:
1. 10.11% - if wounds and burns of cornea are added.
2. 14.34% if wounds of cornea added.
3. In these years, there was some changes in the classification of disease making it more difficult to extract injury cases.

FIGURE I: Graph to Show Cases Dismissed due to Injuries of the Eye as a % of Total Cases Dismissed from the Glasgow Eye Infirmary 1837-1886, with Output from the Shipbuilding Yards on the Clyde 1864-1886



KEY: ——— Cases dismissed due to injury of the eyes as a % of total cases dismissed
----- Fluctuations in output from the Clyde Ship Yards

SOURCE: Annual Reports and Minutes of the Glasgow Eye Infirmary 1837-1886
Clyde Shipbuilding from Old Photographs (1975)

From 1896, pathological reports were made on eyes removed through injury:[1]

TABLE XLV: Number of Eyes sent for Pathological Examination 1896-1902 at the Glasgow Eye Infirmary

Year	Total sent	Removal due to accident	As % of total	Removal due to disease	As % of total
1896	98	60	61.22	38	38.78
1897	72	50	69.44	22	30.56
1898	105	76	72.38	29	27.62
1899	140	92	65.71	48	34.29
1900	127	86	67.72	41	32.28
1901	142	100	70.42	42	29.58
1902	127	86	67.72	41	32.28

TABLE XLVI: Number of Eyes sent for Pathological Examination due to Accidents in public works and other causes 1897 - 1902

Year	Total sent	Accidents in Public Works	As % of total	Other Accidents	As % of total
1897	50	42	84.00	8	16,00
1898	76	58	76.32	18	23.68
1899	92	70	76.09	22	23.91
1900	86	54	62.79	32	37.21
1901	100	75	75.00	25	25.00
1902	86	50	58.14	36	41.86

TABLE XLVII: Some of the Causes of Industrial Accidents in Public Works requiring the removal of an eye, as seen from the Patholoical Reports 1896 - 1902

<table>
<tr><th>Year</th><th>Blow from Chip of Metal</th><th>Blow from Chip of Stone</th><th>Blow from Chip of Coal</th><th>Blow from Chip of Glass</th><th>Blow from Chip of Wood</th></tr>
<tr><td>1896</td><td>24</td><td>-</td><td>-</td><td>2</td><td>5</td></tr>
<tr><td>1897</td><td>17</td><td>6</td><td>-</td><td>5</td><td>-</td></tr>
<tr><td>1898</td><td>43</td><td>6</td><td>4</td><td>5</td><td>-</td></tr>
<tr><td>1899*</td><td>36</td><td>7</td><td>7</td><td>2</td><td>2</td></tr>
<tr><td>1900</td><td>28</td><td>-</td><td>6</td><td>16</td><td>-</td></tr>
<tr><td>1901</td><td>43</td><td colspan="2">5</td><td>13</td><td>7</td></tr>
<tr><td>1902**</td><td>20</td><td colspan="2">8</td><td>12</td><td>5</td></tr>
</table>

Source: All three tables drawn from the pathological reports contained in the Minute Book and Annual Reports of the Glasgow Eye Infirmary, Minute Book No. 4 HB 3/1/4 (GHB).

Ref.: * 1899 also lists six cases resulting from severe burns by hot metal, lime &c., and three cases following the effects of explosions in mines or quarries.

** 1902 also lists three cases from splashes of molten metal and two destroyed from the point of a pick axe.

1 An interestingpoint to arise from the data of causes of injury for which eyes had to be removed (unrelated to industrial cases) is the number of injuries put down to using a fork to untie shoelaces with 1 in 1898, 2 in 1899, 3 in 1900 and 3 in 1902.

In 1897 there was an engineers' strike and lockout. The hospital maintained the decrease in eyes removed that year (72 as opposed to 98 in 1896) was not influenced by the strike. However, Table XLVII would rather seem to indicate that the engineers' strike and lockout did have some effects for the number of injuries caused as a result of blows from chips of metal was greatly reduced in comparison with the number of injuries from this source in 1896 and 1898.

The Glasgow Eye Infirmary was not the only place in Glasgow where workmen could seek relief for injuries to eyes. The Opthalmic Institution was founded in 1868 by Dr J R Wolfe at 65 Bath Street, Glasgow. The rooms there were limited, and with financial help from certain eminent free churchmen, the Institution was moved in 1870 to 146 West Regent Street. These premises also proved inadequate and in 1872 a final move was made to 126 West Regent Street. The relationship between it and the Glasgow Eye Infirmary was initially strained. There had been some discussion concerning amalgamation, especially when the Eye Infirmary moved into the west end of the city in 1874, but neither side could come to an agreement. Instead, the Opthalmic Institution amalgamated with the Royal Infirmary in 1892, become the Eye Dispensary Unit.[1]

The founder of the Institution, Dr J R Wolfe,[2] was a rather outspoken character and he dominated the policy decisions of the hospital. In November 1876 he was joined by two assistants, one of whom was Dr Niven Cluckie who later played an important role in the setting of the Greenock Eye Infirmary and the Dumbarton Eye Dispensary.[3] Like the Glasgow Eye Infirmary, the Institution was always open to

1 W J B Riddell *The Glasgow Ophthalmic Institution 1808-1968 (1968).*

2 Dr Wolfe devised a new method of operating on cataracts, caused by injury, which he lay before the Ophthalmological Congress of 1872. It proved a great aid to industrial victims. He also introduced the transplantation of membranes from animals in certain cases of burns from hot metal or from explosions in mines. Minute Book Ophthalmic Institution GH B6/1/65; *Glasgow News* 1879 March 11th.

3 Minute Book of the Glasgow Ophthalmic Institution 1876 14th December GH B6/1/65 - (Glasgow Royal Infirmary Historical Museum Collection Card 47).

attend to accident victims, many coming from the surrounding mining districts as well as the engineering and shipbuilding yards.[1] The numbers attending increased steadily and in 1877, 3663 patients were treated:

> "A large proportion of those who had been treated had been injured in the course of their ordinary employment, and it was the more necessary that they should receive speedy relief that they were generally the bread-winner of their families."

It was said in that year that upwards of 450 cases were operated on for accidents resulting from public works. On the whole, though, the annual reports of the Glasgow Ophthalmic Institution give little indication of the number of industrial victims treated. In 1878, 3522 patients were dealt with, of which 327 were operated on for accidents of an industrial nature. Similarly, in 1879 the figures were 3683 and 300 respectively but this does not give an accurate picture since not all cases admitted from industrial injury would necessarily involve operations. Moreover, no real comparison can be made with the figures for the Glasgow Eye Infirmary for these years (as seen in Table XLIII) which are for all injuries.[2]

The only other breakdown of accident figures from the Institution is for the year 1892,[3] when a full Table of injuries and burns resulting from accidents at work is given. (Table XLVIII).

[1] Ibid.; *Glasgow Herald* 1878 March 12th; Report of them coming from mining districts in 25th Annual Report 1894 - Annual Reports of Glasgow Ophthalmic Institution GH B6/1/66 (Glasgow Royal Infirmary Historical Museum Collection Card 49).

[2] Minute Book GH B6/1/65; *Glasgow News* 1879 March 11th; 1880 March 9th. Some patients may well have attended both the Eye Infirmary and the Ophthalmic Institution as shown by the case of a shepherd, John Stewart, who received a splinter of stone in his eye whilst repairing a stone wall, case noted in the minutes for 1880 June 3rd over a query of fees.

[3] From 1894 the Annual Reports do indicate how many of the in-patients were suffering from injury which were as follows:

Year	Total In-Patients	Number of them who were injury cases
1894	453	73
1895	444	65
1896	405	52
1897	476	51
1898	692	63
[illegible]	722	77
		85

TABLE XLVIII: Cases of Injuries and Burns treated at the Ophthalmic Institution in Glasgow in 1892 which were the result of employment

Nature of Injury	Number Treated
Wounds and Burns of the Eyelid	14
Wounds and Burns of the Conjunctiva	34
Wounds and Burns of the Cornea	57
Wounds and Burns of the Sclerotic	8
Traumatic Cataract	33
Hernia Iridis (Traumatic)	15
Hyphaema	2
Extensive Injury necessitating removal of the eye	11
Foreign Bodies on the Conjunctiva of Cornea	88
	262

Source: 24th Annual Report of the Ophthalmic Institution 1893 (GH B6/1/66).

It is interesting to note that the total number of cases was 262, whereas in 1877 it was claimed that there had been upwards of 450 operations alone on victims of accidents at work. The total number of patients treated had also fallen from 3663 in 1877 to 3179 in 1892. It may well be that the opening of the Eye Infirmary in Greenock had taken away some of the prospective patients.

The Greenock Eye Infirmary was the result of the Ferguson Eye Bequest made in 1865. Ferguson was a merchant and sugar refiner who left £6,000 for an eye infirmary to be set up in Greenock. However, it was not until late in 1879 that the terms of the will were implemented, the Eye Infirmary opening its doors to patients in Greenock in August 1880. The surgeon in charge was Dr Niven Cluckie, who had been appointed at a salary of £100 per annum. The Infirmary began life in rented rooms but a new Eye Hospital was begun in 1892 and completed for opening on 4th August 1894. Most of the money for its construction was donated by Mr Anderson Rodger, a shipbuilder from Port Glasgow. The new hospital also treated ear, nose and throat patients.[1]

[1] Dr A M K Barron 'Eye Infirmary shuts down after 85 years' *Greenock Telegraph* 1979 4th August.

In the first year of operation, that is 2nd August 1880 to 31st August 1881, 2920 patients were treated, of which over 60% (1792) were adults:

> "A considerable number of these had sustained eye injuries in public works, and after treatment were able to return home. Engineers, boiler makers, caulkers, riveters, stone masons and labourers formed the great majority of the cases so treated." 1

As seen from Table XLIX, the number of patients treated at the Infirmary generally fluctuated between two and three thousand. Although the majority of patients came from Greenock itself, a considerable number came from Port Glasgow and Gourock. Several also came from the areas of Helensburgh and Dumbarton across the Clyde.[2] The decrease in patients in 1885 and 1886 was explained by the fact that both the shipbuilding yards and the foundries had cut down their labour force.[3]

Dr Cluckie gave very detailed annual reports in which he frequently made reference to the number of workmen arriving at the hospital with injuries sustained at work. For example, in 1887 he wrote:

> "I would again respectfully direct your attention to the number of serious accidents to the eye. I am almost daily consulted by workmen who are either suffering from past or present injuries to their eyes, caused by the want of some protection, such as wire gauze goggles while at hazardous work. There are at present 10 or 12 such patients under treatment at the Hospital, and so recently as yesterday a young man from Port Glasgow presented himself with such a severe wound in the eyeball from a

1 1st Annual Report 1881 AC2/2/1 Ferguson Eye Infirmary Annual Reports 1881-94.

2 For example for the year ending 31st August 1881, of the 2920 patients - 1568 came from Greenock, 821 Port Glasgow, 189 Gourock, 13 Inverkip, 11 Dunoon, 10 Kilmalcolm, 290 from elsewhere; For the year ending 31st August 1882 of the 3283 patients ; 1865 came from Greenock, 841 Port Glasgow, 164 Gourock, 25 Helensburgh, 25 Dunoon, 19 Dumbarton, 18 Inverkip, 15 Kilmalcolm, 13 Rothesay, 298 elsewhere; 1st and 2nd Annual Reports 1881 and 1882 AC 2/2/1.

3 5th Annual Report 1885 AC2/2/1; 6th Annual Report 1886 AC2/2/1.

large chip of steel entering it, that, although the steel was immediately removed, no hope can be entertained of restoring sight to the injured eye, which might have been saved if some form of eye protector had been used." [1]

TABLE XLIX: Total Number of Patients Dismissed Each Year from the Greenock Eye Infirmary 1881 - 1902

Year Ending 31st August	No. of Patients Dismissed	Year Ending 31st August	No. of Patients Dismissed
1881	2920	1892	3023
1882	3283	1893	3039
1883	3084	1894	2844
1884	3159[1]	1895	3151[2]
1885	2833	1896	3260
1886	2003	1897	3098
1887	2040	1898	3254
1888	2380	1899	3344
1889	2430	1900	3463
1890	2312	1901	3023
1891	2646	1902	3641

Source: Annual Reports of the Ferguson Eye Infirmary 1881-1894 (AC2/2/1); Annual Reports of the Ferguson Eye Bequest 1895-1911 (AC2/2/2).

Refs.: 1. *The actual report initially says 3167 patients treated but from subsequent tables it appears rather to have been 3159.*

2. *Although for this year, ear, nose and throat patients were treated at the hospital, the report from this section of the infirmary was kept separate and the figures in the Table are just for patients to the eye unit. This is also true for 1896 to 1902.*

Many of the accidents were caused by chips of metal but the more serious injuries were due to sparks of boiling lead, red hot metal or acids. Some examples of cases entering the hospital were given in 1896; such as a riveter who had a large piece of steel removed from his vision, thus partially restoring sight; another riveter whose vision had been destroyed by being struck with a red hot rivet, the eye having to be removed; and a railway engine driver whose eye was destroyed by the bursting of the steam gauge in the

[1] 7th Annual Report 1887 AC2/2/1.

engine and therefore had to have it taken out.[1]

As well as case notes, Dr Cluckie gave a breakdown of the injuries and diseases treated in the hospital in the annual reports; unfortunately, however, there is no consistency in the method in which this was done. An attempt to put his data regarding injury into order has been made in the following Tables (L, LI and LII) but the conclusions that can be drawn from them are very limited. For example, the figures given for operations of removing foreign bodies from certain parts of the eye does not correlate with the numbers given for those suffering from this cause in the list of injuries treated. It would be quite acceptable if the number of operations was less than the total number of injury cases recorded butfor 1883, 1884 and 1891 the actual number of operations performed was larger. Another oddity in the Table is that in the year 1892 288 patients appear to have been suffering from foreign bodies in the cornea or sclerotic, the greatest number in any year set out in the Tables, yet there were just nine recorded operations for the removal of foreign bodies from the sclerotic and none recorded for the cornea. In the same year, equally strange, is the absence of anyone suffering from injuries to the cornea, whereas in the four previous years there had been over two hundred such cases.

Even more doubt is thrown on the value of the Tables by the fact that in certain years, namely 1883, 1894, 1896 and 1989, Dr Cluckie did actually record the number of workmen treated for injuries caused at work. For these years he stated that 651, 325, 732 and 1506 workmen respectively were treated for injuries caused at work.[2] From the injuries recorded in Tables L and LI, the corresponding figures are 477, 368, 732 and 1126. With the discrepancies

[1] 14th Annual Report 1894 AC2/2/1; 16th Annual Report 1896 AC2/2/2.

[2] 3rd Annual Report 1882 AC2/2/1; 14th Annual Report 1894 AC2/2/1; 16th Annual Report 1896 AC2/2/2; 18th Annual Report 1898 AC2/2/2.

TABLE L: Number of Patients Dismissed Each Year from Certain Eye Injuries at the Greenock Eye Infirmary 1882 - 1892

Type of Injury	Year										
	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892
Injuries of Eyeball from blows, fragments of metal, etc.	203	186	182	-	-	-	-	-	-	-	-
Opacity, Blood Effusion, blows on eyeball	31	19	10	-	-	-	-	-	-	-	-
Injuries to Eyelids	30	-	-	13	6	10	18	22	37	21	54
Foreign Bodies in Eyelids	-	-	-	8	9	6	12	13	7	4	10
Burns to Eyelids	-	-	-	16	10	4	8	10	14	11	8
Foreign Bodies in Orbit	-	3	6	3	4	1	3	2	2	1	2
Foreign Bodies in conjunctiva	41	25	30	14	11	14	16	9	-	9	12
Foreign Bodies in cornea/sclerotic	250	209	215	251	120	100	113	186	132	238	288
Injuries to cornea	-	35	60	290	100	84	231	272	239	240	-
Foreign Bodies in Iris	-	-	-	3	2	3	8	5	2	2	23
" " Vitreous	-	-	-	5	4	8	6	9	15	3	8
" " in lens	-	-	-	5	3	4	8	14	7	4	7
TOTAL	555	477	503	608	269	234	423	542	455	533	412

Source: Annual Reports of the Greenock Eye Infirmary 1882 - 1892.

TABLE LI: Number of Patients Dismissed Each Year from Certain Eye Injuries at the Greenock Eye Infirmary 1893-1902

Type of Injury	Year									
	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
Injuries to Eyelids or Eyeballs from chips of metal, burning red hot metal, etc.	318	122	109	732	578	731	873	838	842	888
Specs of dust or 'fires'	283	246	374							
Burns	-	-	-	-	34	59	-	46	-	65
Injuries Causing Temporary Loss of Sight	-	-	-	-	173	-	-	-	-	-
Injuries Generally	-	-	-	-	-	336	251	186	-	-
TOTAL	601	368	483	732	785	1126	1124	1070	842	953

Source: Annual Reports of the Greenock Eye Infirmary 1893-1902

TABLE LII: Operations at the Greenock Eye Infirmary 1882 - 1892

Type of Operation	Year										
	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892
Removal of Foreign Bodies from eyelids	-	-	-	5	9	7	10	9	12	23	43
Wounds stitched of eyelid	-	-	-	-	-	10	14	11	21	12	18
Removal of foreign bodies from orbit	-	3	4	3	1	4	2	2	4	1	3
Removal of foreign bodies from conjunctiva	43	51	39	16	8	8	14	18	11	7	12
Removal of foreign bodies from cornea	201	230	273	145	100	82	61	71	116	256	-
Removal of foreign bodies from sclerotic	7	11	18	13	4	6	4	2	6	5	9
Removal of foreign bodies from iris	-	-	-	2	1	3	-	7	3	1	3
Removal of foreign bodies from lens	-	-	-	1	2	3	5	10	3	2	6
Removal of foreign bodies from anterior chamber	2	3	5	2	3	4	3	3	1	3	8
Removal of foreign bodies from vitreous	-	-	-	4	2	5	3	5	2	2	6
SUB TOTAL	253	298	339	191	130	132	116	138	179	312	108
Other operations	274	290	331	375	298	311	346	370	342	260	357
TOTAL	527	588	670	566	428	443	462	508	521	572	465

Source: Annual Reports of the Greenock Eye Infirmary 1882-1892 thus being in both directions, (and with one year the figures corresponding) it is impossible to see any clear connection between the injury cases recorded in the Tables and the numbers suffering industrial injury to the eye, unlike the data for the Glasgow Eye Infirmary where, in the years when checks were possible, the figures were consistently slightly higher.

As was remarked earlier, some of the patients attending the Greenock Eye Infirmary came from across the Clyde, from Helensburgh and Dumbarton and on June 21st 1892 delegates from the various Accident Fund Societies in the town of Dumbarton met at the Leven Ship Yard to consider the possibility of getting Dr Cluckie to attend at Dumbarton one day a week. Representatives at the meeting were from Messrs. Denny & Co., Dennystown Forge Company, Hardie and Gordon, A McMillan & Sons, Mr Paul & Co. and Wm. Denny Bros. The idea of trying to get medical attendance at Dumbarton had arisen at the annual meeting of the Leven Ship Yard Accident Fund Society when the motion was passed unanimously. Dr Cluckie agreed to the suggestion and the dispensary commenced work on 28th September 1892. It was open every Wednesday afternoon, serious accident cases and those needing major operations being sent to Greenock. At the time no other town in Britain of a similar size had such facilities.[1]

The number of patients treated each year is shown in Table LIII:

[1] Minutes, Dumbarton Public Eye Dispensary Minutes 1/1; 1892 June 21st; September 28th; 8th Annual Report 1900 Dumbarton Public Eye Dispensary Reports 2/3.

TABLE LIII: Total Number of Patients Dismissed Each Year from the Dumbarton Eye Dispensary 1893 - 1900

Year ending in September	Number of Patients Dismissed
1893	938
1894	896
1895	887
1896	908
1897	832
1898	789
1899	812
1900	703

Source: Annual Reports of the Dumbarton Eye Dispensary.

Although the annual reports give some idea of the breakdown of the diseases and injuries treated, the same problem occurs as with the Greenock material, namely that the classification is not consistent from year to year and hence, it is not possible to extract fully the numbers treated for industrial accidents. The only year for which Dr Cluckie provided the actual number of workmen treated for wounds and burns resulting at work was 1896, when the figure was 110.[1] This was 12.11% of the total patients (908) dismissed from the dispensary that year, which compares favourably with the information for the Glasgow Eye Infirmary (Table XLIII).

Although the data from the various eye hospitals[2] is inconclusive as to the exact number of injury cases arising from industrial causes, the general impression is that there was considerable risk of damage to the eye from working in the shipbuilding yards or in the engineering and foundry trades. It is also clear that there was great concern

[1] 4th Annual Report 1896 Dumbarton Public Eye Dispensary Minutes 1/1 "One workman had a piece of steelweighing 3 grains removed from the interior of the eye with vision restored, one patient had a large piece of steel removed from the eyelid, which had been embedded for 8 years."

[2] There was also an eye infirmary at Paisley which was opened in June 1888. Two medical attendants were appointed. They were, Consulting Surgeons Drs Donald and A H Richmond, Consulting Physicians Drs Crawford and Orr (of Johnstone), Surgeon Occulist Dr Cluckie. (From correspondence with the Archivist of the Greater Glasgow Health Board University of Glasgow).

about the problem in the area and efforts were made to provide relief for the sufferers. Perhaps the most fitting conclusion comes from Dr Cluckie himself, in his 1899 Report on the Dumbarton Public Eye Dispensary, when he wrote:

> "Of the 38 patients sent to Greenock Eye Infirmary 17 had the eye removed owing to the serious nature of the injury and to prevent loss of sight in the sound eye. It is most painful to me to be called upon to treat a workman's eye, and on examination to find, that with all our improved electro magnet and X-rays apparatus for the removal of pieces of steel from the eye, that the eye has been so seriously injured as to place it beyond the power of human skill to restore vision. The fact that seven workmen each lost an eye during the year and in several of the cases the injury caused impairment of vision in the healthy eye, leads me again to call your attention to the many serious eye accidents which occur every year in the shipyards and public works, and which might be prevented by the regular use of wire goggles during the hazardous work.
>
> Apart from the great calamity of a workman of losing one of his eyes in the performance of his daily work, he is not only morally bound to use some protection, but his employer in his own interests should insist on his employee taking all necessary precaution to protect his eye from injury. It has become a serious financial question with employers, the permanent injury of their workmens' eyes and how far they are liable under the Employers Liability Act for the loss of an eye. A trifling injury to one eye may ultimately cause total loss of vision in both eyes.
>
> The loss of an eye to a workman, I value at not less than £250. If the injury causes blindness in both eyes which fortunately is a rare occurrence, then the workman is rendered helpless for life and compensation of not less than £1,000 is a reasonable sum." [1]

[1] 7th Annual Report 1899 Dumbarton Eye Dispensary Minutes 1/1.

CONCLUSION

It is a truism that the period studied was one of massive change in Britain and that advances in techniques of industrial manufacture were central to this. The aspects of this change which are of significance to this study are the enormous growth in industrial output under the emerging factory system and the rapid urban growth consequent upon the unprecendented rise in population. In the earlier age of crafts and proto-industry (often practised on a part-time basis) the health and safety of operatives was hardly a topic that could have made much impression on the national consciousness. The noxious effects of intensive and changing techniques of production on workers' health between 1780 and 1900 have been discussed in the foregoing pages together with the extent to which they were acknowledged and understood and steps taken to remove, isolate or otherwise treat the cause.

In the introduction, four factors were discussed as influencing health in the work environment - physical, chemical, biological and psychosocial factors. Hazards under each of these categories have been observed as being present in the 19th century although the full potential of these dangers was not always appreciated. Several of the industrial hazards discussed, for example, dust, were not new to the period but were intensified by the increasing scale of production and new work patterns. The case of the Sheffield grinders illustrates the transition from small workshops to large factories, where the operatives were not only placed in closer proximity to each other but hours of work became more regular and possibly longer thereby increasing the level of exposure to the hazards of the trade.

Other hazards were new to the period, being caused by the expanding range of chemicals and compounds in industrial use, and the new systems of production introduced. Some examples of the new diseases discussed are 'phossy jaw' caused by the use of phosphorus in matches, cancerous growths suffered by shale oil workers and those in related trades, and caisson disease experienced by those constructing bridge piers at depth.

The growth in awareness of health and safety issues between 1780 and 1900, however, was to a large extent concentrated on the chemical and biological factors influencing the work environment, less attention being given to physical factors save in the case of major accidents or as, for example, in caisson disease where the incapacity of the men after working in compressed air was too obvious to be ignored. The emphasis on the observable and sensational is hardly surprising for, in one sense, the study and prevention of industrial disease and accidents in the 19th century was one segment of the whole spectrum of the study of longevity and mortality which was more particularly associated with the public health movement. Infantile mortality was high and the chances of surviving childhood in order to take up employment thereby lessened. Smith (1979) has shown that about one quarter of the recorded deaths from the 1840's to the end of the 19th century in England and Wales were of infants under one year and almost half of all deaths were of children under five.[1] The causes of death were infantile diarrhoea brought about by artificial feeding, whooping cough, measles and smallpox. Infectious diseases were rampant throughout the period and rapid urban growth with the associated problems of poor housing, inadequate sanitation and polluted water exacerbated the risks to public health. Moreover, the nutritional value of the diet of much of the population, for the greater part of the 19th century, increased the risk of the spread of infectious diseases.

[1] Smith (1979), pp65-128.

Not surprisingly, industrial diseases and accidents (with certain exceptions) did not loom large in the minds of the public or the medical world and only attracted attention if there was an obvious correlation between early mortality and occupation; if the disease had a disabling effect preventing a person from pursuing employment; if it greatly disfigured the body and was not merely discomforting; if it produced considerable financial loss to the employer; or if the hazard was transmitted to the final product and thus affected the consumer. The psychosocial or stress factors, so much discussed today, exacerbated by the factory system with its long hours, often monotonous work patterns and stricter time discipline, were not identified and any improvement in working conditions in this respect were indirectly arrived at by the movement to reduce working hours. It could be argued that management, by not understanding stress factors, wrongly blamed certain sectors of the workforce for being neglectful and careless and afforded them little sympathy when accidents occurred.

As seen in the introduction, the emphasis of the contemporary philosophy of health and safety at work is on preventative measures - substitution, isolation, exhaust ventilation, personal protection and personal hygiene. Attempts at all these approaches were made in the 19th century but in a piecemeal fashion rather than systemically. After an initial discussion on the nature of the problem and its causes (although some issues such as miners' nystagmus went little further) the first preventative measures adopted were usually improved hygiene. Here the emphasis was on personal cleanliness and improved sanitation, accompanied sometimes by modifications in ventilation. In some situations, protective clothing, spectacles or masks were provided. These preventative measures were adopted partly because they were the simplest and cheapest methods to put into practice and also because there was a clear connection with the wider interest in public health. By emphasising personal hygiene and devolving responsibility for wearing (and sometimes for providing) protective devices to the operative, employers could exert a further element of control over the workforce which was legitimised by the philosphy of self-help. Substitution, where it occurred, was more often the result of improved technology to increase production rather than a conscious effort to improve safety although the Society of Arts was responsible for setting up a premium to encourage experimentation to find a harmless substitute for lead in pottery glaze.

Industrial safety was considered to be a distinct issue. Virtually the sole preventative measure enforced by law was the fencing of certain aspects of machinery. Today safety aspects are part of the initial design features of machinery wheras inthe 19th century engineers were initially only concerned with designing a machine to perform a given operation efficiently; only in the second half of the century, after the 1844 and 1956 Acts requiring millgearing and machinery identified as dangerous to be fenced, did engineers begin to include fencing and guards in the original design. Accidents with machinery were considered to be the fault of the individual rather than the situation, and there were no studies of causes nor education on the question of safety ehos as there is today. It is in the light of 20th century knowledge of psychosocial factors in the work environment that many of the 19th century accidents can be interpreted. Without knowledge or understanding of the influence of stress factors on accidents, there was little likelihood of a more positive approach to accident prevention. Any action in the 19th century was the response to an immediate problem rather than developing any more comprehensive understanding of the nature of accidents and their prevention.

The question of the awareness of and attitudes to health and safety issues has arisen throughout the thesis. Gersuny (1981) talks of a conflict situation between employers and employees, with protection being desirable to the employee but a cost to the employer. But there are many examples of employers introducing safety measures on their own initiative and at their own expense (for example in some of the white lead works). Moreover, in the case of the Redditch grinders, the operatives resisted the introduction of fans because of the possible reduction in wages, an indication that conflict could arise from pressure exerted upwards as well as downwards and that, at least in the short-term, operatives could object to safety measures.

We can observe, as the 19th century progressed, a change in the attitude of the governing classes to questions of health and safety at work, due perhaps partly to the extension of the franchise and paralleled by changes of attitude in other spheres. The early 19th century may be seen as a period of individualism, with emphasis on the entrepreneurial ideal, self-help and an attitude of laissez-faire. A reflection of this can be seen in the importance attached to personal hygiene and the wearing of protective devices as a means of combatting industrial hazards rather than employers endeavouring to suppress those hazards at source.

As MacDonagh (1958) has pointed out, over the century these views were tempered by humanitarian considerations and the influence of the philosophy of Utilitarianism (that society should aim for the greatest good for the greatest number of persons). Government intervention to protect the weak in society on the matter of industrial conditions was seen as legitimate. The first categories of operatives to receive some protection at work were children and women but further Government action protected individuals engaged in dangerous occupations and enforced minimum standards, for example the Special Rules issued for White Lead works in 1883. The process was assisted in the later stages, as MacDonagh has pointed out, by the existence of a permanent element in the executive (i.e. the Factory Inspectorate) whose purpose was not only to enforce existing factory legislation but to propose new areas for government control. By the end of the period under study, Government intervention on its own initiative on health and safety issues was being accepted as the norm.

Thus although it may be argued that occupational diseases cannot be clearly distinguished from other causes of disablement and death until such medical phenomena as early deaths from cholera, infectious diseases and tuberculosis had been controlled, it is clear that during the period 1780 to 1900 there was knowledge of occupational disease and that this knowledge not only grew but became systemized being more firmly science-based. Moreover, with the increasing collection of statistical data by the Registrar General, by the Medical Officers of Health and by certain doctors (like Greenhow), information on industrial hazards became widely disseminated. A comparison of the average life expectancy and mortaltiy per 1,000 for the total population with comparable figures for selected trades, demonstrated that certain occupational groups were more liable to suffer from one form of disease than another. It seems reasonable to explain these differences by reference to the trade followed rather than to any environmental or social factors. The latter would be expected to affect the population in general. Dr Greenhow's 1860 and 1861 studies of lung diseases are illustrative of this point. Longevity increased over the period but as the study of Sheffield demonstrates, when causes of death of a selected trade are analysed, a predominance of one kind of illness could be found which was not common to the general population. Moreover, the average age at death was lower than for other trades or the population as a whole.

However, although understanding may have extended, knowledge of prevention and treatment tended to be limited to ideas which had been advanced by those researching the cause, and which had not been tested to a significant extent by practical application. One of the many examples is the disease of miners' nystagmus, where the discussion and research was into the causes of the disease, but the only treatment suggested was leaving the employment or to attempt to improve general health and nutrition or to administer iron and strychnine.

The period 1780 to 1900 was one in which problems of occupational health and safety were heightened. It was, however, a period in which the relative forces were coming together which made a consideration of the question possible. Medical knowledge was expanding, the attitude of Government was changing and, together with it, society's acceptance of centralisation of legislation; workers were becoming organized and in a better position to demand improved working conditions; employers were more aware that a healthy workforce was beneficial to production; and advances in science and technology meant that it was becoming possible to experiment with new production methods which would eliminate some of the dangers. There was no systematic approach to health and safety at work and problems were encountered and solved in an ad hoc fashion, but the foundations were laid for future developments, with a recognization of many of the principles (if only in a primitive way) of today's approach to the subject. From an awareness amongst a few medical men and other individuals of the problems of health and safety at work in particularly dangerous occupations in 1780, occupational health and safety had become a branch of medicine (if only small) by 1900, with its own textbooks (especially Thackrah, 1831 and Arlidge, 1892) and series of books and pamphlets on specific health risks. For approximately 60 years it had been a subject of concern in Parliament with various enquiries into the conditions prevailing in certain trades and the subsequent Factory and Mines Acts. Employers and employees were beginning to consider health and safety as a central question in production and certain issues, such as the conditions of white lead workers and lucifer match makers, were widely publicized being taken up by the national press. Thus the seeds of a science of health and safety had been sown which has grown enormously in this century and which in the last decade, in particular, has been unified and systematised.

APPENDICES

APPENDIX 1: Acts of Parliament passed between 1780 and 1900 which relate to Health and Safety at Work

a) Factory Acts

1802 An Act for the Preservation of the Health and Morals of apprentices and others, employed in cotton and other mills, and cotton and other factories.

42 Geo III c73

1819 An Act for further provisions for the regulation of cotton mills and factories, and for the better Preservation of the Health of Young Persons employed therein.

59 Geo III c66

1820 An Act to amend an Act of the last session of Parliament, to make further provision for the regulation of cotton mills and factories, and for the preservation of the Health of Young Persons employed therein.

60 Geo III c5

1825 An Act to make further provisions for the regulation of cotton mills and factories for the better preservation of the health and young persons employed therein.

6 Geo IV c63

1829 An Act to amend the law relating to the employment of children in cotton mills and factories.

10 Geo IV c51

1829 An Act to amend the law relating to the employment of children in cotton mills and factories.

10 Geo IV c63

1831 An Act to repeal the laws relating to apprentices and other young persons employed in cotton factories and in cotton mills, and to make further provisions in lieu thereof.

1 & 2 Gul IV c39

1833 An Act to regulate the labour of children and young persons in the mills and factories of the UK.

3 & 4 Gul IV c103

1834 An Act to explain and amend an Act of the last session of Parliament forregulating the labour of children and young persons in the mills and factories of the UK.

4 & 5 Gul IV cl

1844 An Act to amend the laws relating to factories

7 & 8 Vict c15

1845 An Act to regulate the labour of children, young persons and women in print works.

8 & 9 Vict c29

1846 An Act to amend two clerical errors in an Act of the last session for regulating the labour of children, young persons and women in print works.

9 & 10 Vict c18

1846 An Act to declare certain ropeworks not within the operation of the Factory Acts.

9 & 10 Vict c40

1847 An Act to limit the hours of labour of young persons and females in factories.

10 & 11 Vict c29

1847 An Act to amend the law as to the school attendance of children employed in print works.

10 & 11 Vict c70

1850 An Act to amend the Acts relating to labour in factories.

13 & 14 Vict c54

1853 An Act to further regulate the employment of children in factories.

16 & 17 Vict c104

1860 An Act to place the employment of women, young persons and children in bleaching works and dyeing works under the regulations of the Factories Act.

23 & 24 Vict c78

1861 An Act to place the employment of women, young persons and children in lace factories under the regulation of the Factories Act.

24 & 25 Vict c117

1862 An Act to prevent the employment of women and children during the night in certain operations connected with bleaching by open air process.

25 & 26 Vict c8

1863 An Act to amend the Act for placing the employment of women, young persons and children in bleaching works and dyeing works under the regulations of the Factories Act.

26 & 27 Vict c38

1864 An Act for the extension of the Factory Act.

27 & 28 Vict c48

1864 An Act for extending the provisions of the Bleaching and Dyeing Works Act, 1860.

27 & 28 Vict c98

1867 An Act for the extension of the Factory Acts.

30 & 31 Vict c103

1867 An Act for regulating the hours of labour of children, young persons and women employed in workshops; and for other purposes relating thereto.

30 & 31 Vict c146

1870 An Act to amend and extend the Acts relating to factories and workshops.

33 & 34 Vict c62

1871 An Act to amend the Acts relating to factories and workshops.

34 & 35 Vict c104

1874 An Act to make better provisions for improving the health of women, young persons and children employed in manufactures, and the education of such children, and otherwise to amend the Factory Acts.

37 & 38 Vict c44

1878 An Act to consolidate and amend the law relating to factories and workshops.

41 & 42 Vict c16

1883 An Act to amend the law relating to certain factories and workshops.

46 & 47 Vict c53

1888 An Act to amend the Factory and Workshop Act 1878.

51 & 52 Vict c22

1889 An Act to make further provisions for the regulation of Cotton Cloth Factories.

52 & 53 Vict c62

1891 An Act to amend the law relating to factories and workshops.

54 & 55 Vict c75

1895 An Act to amend and extend the law relating to factories.

58 & 59 Vict c37

1897 An Act to give power to make regulations with respect to cotton cloth factories.

60 & 61 Vict c58

b) Mines and Quarries Acts

1842 An Act to prohibit the employment of women and girls in mines and collieries, to regulate the employment of boys, and to make other provisions relating to persons working therein.

5 & 6 Vict c99

1850 An Act for the inspection of coal mines in Great Britain.

13 & 14 Vict c100

1855 An Act to amend the law for the inspection of coal mines in Great Britain

18 & 19 Vict c108

1860 An Act for the Regulation and Inspection of mines.

23 & 24 Vict c151

1862 An Act to amend the law relating to coal mines.

25 & 26 Vict c72

1872 An Act to consolidate and amend the Acts relating to the regulation of coal mines and certain other mines.

35 & 36 Vict c76

1872 An Act to consolidate and amend the law relating to metalliferous mines.

<u>35 & 36 Vict c77</u>

1875 An Act to amend the provisions of the Metalliferous Mines Regulation Act, 1872, with respect to annual returns from mines.

<u>38 & 39 Vict c39</u>

1881 An Act to amend the law relating to the use of gunpowder in certain stratified ironstone mines.

<u>44 & 45 Vict c26</u>

1886 An Act to amend the Coal Mines Regulation Act, 1872.

<u>49 & 50 Vict c40</u>

1887 An Act to provide for the fencing of Quarries.

<u>50 & 51 Vict c19</u>

1887 An Act to consolidate with amendments the Coal Mines Act 1872 and 1886, and the Statified Ironstone Mines (Gunpowder) Act 1881.

<u>50 & 51 Vict c58</u>

1891 An Act to amend the Metalliferous Mines Regulation Act, 1872, in its application to the Isle of Man.

<u>54 & 55 Vict c47</u>

1894 An Act to provide for better regulations of quarries.

<u>57 & 58 Vict c42</u>

1894 An Act to amend the provisions of the Coal Mines Regulation Act, 1887, with respect to check weighers.

<u>57 & 58 Vict c52</u>

1896 An Act to amend the Coal Mines Regulation Act 1887.

<u>59 & 60 Vict c43</u>

1900 An Act to prohibit child labour underground in mines.

<u>63 & 64 Vict c21</u>

c) Other Acts relating to Health and Safety

1788 An Act for the better regulation of chimney sweeps and their apprentices.

28 Geo III c48

1834 An Act for the better regulation of chimney sweepers and their apprentices and for the safer construction of flues.

4 & 5 Gul IV c35

1840 An Act for better regulations of chimney sweepers and chimneys.

3 & 4 Vict c85

1860 An Act to amend the law concerning the making, keeping and carriage of gunpowder and compositions of an explosive nature and concerning the manufacture, sale and use of fireworks.

23 & 24 Vict c139

1863 An Act for the regulation of bakehouses.

26 & 27 Vict c40

1864 An Act to amend and extend the Act for the regulation of chimney sweepers.

27 & 28 Vict c37

1871 An Act for the safekeeping of petroleum and other substances of a like nature.

34 & 35 Vict c105

1875 An Act to amend the law with respect to manufacturing, keeping, selling and importing gunpowder, nitro-glycerine and other explosive substances.

38 & 39 Vict c17

1875 An Act for further amending the law relating to chimney sweepers.

38 & 39 Vict c70

1878 An Act for the prevention of accidents by threshing machines.

41 & 42 Vict c12

1879 An Act to regulate the employment of children in places of public amusement in certain cases.

42 & 43 Vict c34

1880 An Act to extend and regulate the liability of employers to make compensation for personal injuries suffered by workmen in their service.

43 & 44 Vict c42

1882 An Act to make better provision for inquiries with regard to boiler explosions.

45 & 46 Vict c22

1883 An Act to amend the laws relating to explosive substances.

46 & 47 Vict c3

1886 An Act to limit the hours of labour of children and young persons in shops.

49 & 50 Vict c55

1888 An Act to continue the Employers Liability Act 1880.

51 & 52 Vict c58

1890 An Act to amend the Boiler Explosions Act 1882.

53 & 54 Vict c35

1892 An Act to amend the law relating to the employment of young persons in shops.

55 & 56 Vict c62

1893 An Act to amend the Shop Hours Act 1892

56 & 57 Vict c67

1894 An Act for providing for notice of and inquiry into accidents occurring in certain employments and industries.

57 & 58 Vict c28

1894 An Act to make better provisions for the regulation of chimney sweepers.

57 & 58 Vict c51

1895 An Act to amend the Shop Hours Act, 1892.

58 & 59 Vict c5

1895 An Act to make provisions for public inquiry in regard to fatal accidents occurring in industrial employments or occupations in Scotland.

58 & 59 Vict c36

1897 An Act to amend the law with respect to compensation to workmen for accidental injuries suffered in the course of their employment.

60 & 61 Vict c37

1897 An Act to extend the age under which the employment of young persons in dangerous performances is prohibited.

60 & 61 Vict c52

1897 An Act for the prevention of accidents by chaff cutting machines.

60 & 61 Vict c60

1899 An Act to provide for seats being supplied for the use of shop assistants.

62 & 63 Vict c21

1900 An Act to extend the benefits of the Workmen's Compensation Act 1897, to workmen in agriculture.

63 & 64 Vict c22

APPENDIX 2: White Lead Works - examples of rules and regulations

a) From 1883 White Lead Poisoning Communications to the Secretary of State, with Report by the Chief Inspector of Factories (C 3516), pp8-10.

Alexander Redgrave's Report Copies of rules and regulations enforced in some White Lead Works. The first two are from well conducted works, the second two from totally inadequate ones.

No. 1

Rules and Regulations to be observed by men and women employed at the ...... White Lead Works.

1. That each man or woman before starting work at any stove or rollers, receive from the foreman or bath superintendent one overall suit or slip, head cloth and respirator; and each woman when working at stoves to take off all her own clothes, when flannel combinations with oilskin petticoats will be provided in addition to the above.
2. That each man or woman working at any stove, rollers, or white bed, before going to breakfast, dinner or home, must put off their overall suit; brush every particle of lead dust from their clothes; wash in the lavatory; take care to clean their nails thoroughly; wash their feet in the large cistern; and use soap, towels, nail, tooth and clothes brushes which are provided by the firm..
3. Smoking and tobacco chewing strictly prohibited during work hours.
4. That no person is allowed to wash or dress in the dining area.
5. That each woman must have a bath once a week; and each woman working at the stoves to have a bath after finishing her day's work, but to wash her hands and feet thoroughly before going into the bath.
6. That no man or woman enter the dining room to take any meals without attending rule 2.
7. That all men and women wash out their mouths before taking food or drinking anything.
8. That all men and women go the foreman before leaving work, and after washing, to get a glass of "treacle beer"; and those men and women working at stoves to get at the same time a dose of salts.

9. Before commencing to strip the white bed, the foreman to see that the lead is well watered, and the gangway outside stacks and leading to rollers be constantly watered to keep down the dust.

10. The medical attendant will call at the works one day a week between 12 and 1 mid-day to see each woman, and it is requested that they will answer all questions and carry out his instructions.

11. In case of any man or woman not feeling quite well, it is requested that they will at once, either send to the doctor's, or a message to the works, when a doctor will call to see them. No charge is made for either medical attendance of medicine.

12. Salts are always kept at the works, and anyone can have a dose by applying to the foreman or bath superintendent.

A communication from the firm shows how insistent they are even on minute details.

"Most of the women assist either in setting or drawing a stove once a week (refer to rules, 1, 2, 5). After their work is over they partially undress before going into the wash-house. They first gargle their throat with treacle beer, then wash their arms, lower part of their legs and feet; after which they each have a tepid bath. After coming out of the bath they wash their heads in warm distilled water, and lastly brush their teeth. If by chance any of the women have not worked in a stove they are not compelled to wash their heads. If a woman shirks her bath during the week, the next times she comes to work, the foreman orders her to have a bath that afternoon, and if she does not then have it, she is not permitted to work again until she does."

No. 2

Rules and Regulations to be observed by men and women employed at the ..... White Lead Works.

1. That each man or woman before commencing work at any stove, rollers or white bed, received from the bath superintendent one overall suit, head cloth, respirator, gloves and high-topped boots.

2. Smoking at all times strictly prohibited.

3. That each man or woman working at any stove, rollers or white bed, before going to breakfast, dinner or home must:

    1st put off their overall suit and give it to the bath superintendent;
    2nd brush every particle of lead dust from their clothes;

3rd thoroughly wash in the lavatory, and be particular that no dust remains underneath the fingernails;

4th thoroughly wash the feet in the large cistern, and use soap, towels, brushes &c, which are provided by the firm.

4. That no person on any account is allowed to wash, dress or leave any clothes in the dining room, all clothes to be left in the cloak room.

5. That each woman must bathe once a week and oftener if inclined, and further, that every person must wash in the lavatory before bathing.

6. That no man or woman enter the dining room to take any meals without attending to rule 3.

7. That all working at the stoves and rollers will receive, at 10am and 4pm, the men 1 pint and the women ½ pint of beer.

8. That at 11.50am the stove and roller women thoroughly wash themselves; they must then wash out their mouths with acidulated water, and go to the laboratory and drink one glass of milk.

9. That the women working at the rollers and white beds receive twice a week a teaspoonful of "specially prepared sulphate of magnesia" mixed in water, those drawing stoves will receive one teaspoonful when finished.

10. That any man or woman breaking any of these rules or disobeying the bath superintendent will be instantly dismissed from the work.

<u>No. 3</u>

No printed rules - reply to circular.

"We beg to inform you, in reply to your communication, that the chief precautions which we rely upon for preserving the health and comfort of the persons employed in our white lead works, are to provide them with hot and cold waterbaths and every other necessary for cleanliness, and also with a superintendent whose duty it is to see that these precautions are strictly observed.

No woman is allowed to take food until the attendant is thoroughly satisfied that she is perfectly clean and free from any adherent pigment. A spacious dining room is provided and all the food is cooked on the premises by an attendant specially provided for that purpose, and before the women are permitted to partake of it they are inspected.

The women who work in the stoves, where their liability to inhale the dust of the white lead is greatest, are provided with overalls, which are thoroughly beaten and freed from dust after use. Head coverings *are also provided, but the women, as a rule, will not use either these or respirators, as the coverings heat the head too much and cause perspiration and irritation, and the respirators are troublesome.*

The women always have access to drink, weakly acidulated with sulphuric acid, and sulphuretted hydrogen baths were provided for them, but as the sulphuretted hydrogen had the effect of blackening the skin, we were unable to induce them to use them habitually."

<u>No. 4</u>

No rules exhibited in the works - reply to circular.

"1. *We provide unlimited drink, composed of lemons, sugar, sulphuric acid and water.*

2. *We provide towels, soap, hot water and in addition, when working at the stoves, we find slips for women, and trousers and jackets for men.*

3. *Respirators are provided, but workpeople will not, as a rule, use them; we also have a bath fixed for the use of the workpeople with hot and cold water, but we could not prevail upon them to use it.*

We have 3 men and 2 women who have been in the works over 25 years, 2 men and 3 women over 10 years, and many between 5 and 6 years. We should be happy to carry out any suggestion for the benefit of the workpeople but we consider that cleanliness and sulphuric acid drinks to render lead innocuous are the two important points."

At No. 3 no notice is taken of anyone ill with regard to medical treatment, at No. 4 sent to hospital or infirmary to which the firm are subscribers. In one, washing facilities passable, the other troughs full of white lead as the women washed the slips in the troughs for washing hands and faces rather than in the tub. No supervision to prevent this dangerous habit.

b) <u>The Factory & Workshop Act 1883 46 & 47 Vict c53</u>

The Schedule White Lead Works.

Conditions of obtaining Certificate.

1. The stacks and stoves in the factory must be efficiently ventilated.

2. There must be provided for the use of the persons employed in the factory sufficient means of frequently washing hands and feet, with a sufficient supply of hot and cold water, soap, towels and brushes.

3. There must be provided in addition, for the use of women employed in the factory, sufficient baths, with a sufficient supply of hot and cold water, soap, towels and brushes.

4. There must be provided for the use of the persons employed in the factory (but not in any part of the factory where any work is carried on) a proper room for meals.

5. There must be provided for every person working at any task an overall suit with head covering, and for every person working at any white-bed a respirator or covering for the mouth and nostrils and head covering, and for every person working at any dry stove or rollers an overall suit with head covering, and a respirator or covering for the mouth and nostrils.

6. There must be accessible to all persons employed in the factory a sufficient supply of acidulated drink.

c) Factory and Workshop Act 1891 54 & 55 Vict c75

Special Rules - White Lead Works.

Duties of Occupiers

They shall provide sufficient bath accommodation for all men and women employed.

They shall provide dressing-rooms, lavatories, and a cloak-room, in which the ordinary clothes of all workers are to be kept apart from their working clothes.

They shall arrange for a weekly visit by a doctor, who shall examine every worker individually, and who shall enter the result of each examination in the proper register.

They shall cause such a register to be kept, and shall have entered in it the date when each worker commences and leaves employment and the date when each employee takes a bath.

Duties of Superintendents and Persons in Charge of Departments

They shall cause each man or woman to take a bath at least once a week and to wash in the lavatory before bathing.

They shall deliver to the persons employed the articles of clothing which are required to be worn and they shall see that they are put on. At the end of every day's work, they shall collect and have thoroughly washed all those which have been used in the stoves, and those which have been used in other departments once a week.

They shall see that the general lavatory is thoroughly cleansed and supplied with clean towels after evey meal.

They shall have the dressing-rooms, baths, and w.c.'s brushed and cleansed daily.

They shall not allow any of the workers to leave any clothes in the dining room, or their ordinary clothes in any work-room.

They shall see that the supply of hot and cold water, soap, brushes, and towels is sufficient in the bath-room and lavatories.

They shall see that there are kept in close proximity to the workers in each department washing conveniences and a sufficient supply of sulphuric acid drink, or other approved sanitary drink, and they shall cause the people to take it.

They shall set apart and cause to be entered in a notice affixed in each department a period of at least 10 minutes in addition to the regular meal times, for washing immediately before each meal time, and also before the end of the day's work, and they shall see that it is observed.

They shall see that at the doctor's weekly visit the proper entries are on each occasion made in the register.

Upon any person complaining of being unwell, they shall, with the least possible delay, give an order upon the doctor; and upon any person desiring medicine, they shall give a dose of the prescribed medicine kept at the works.

Managers &c shall report immediately to the firm any instance which comes under their notice of any worker neglecting the regulations herein after mentioned.

They shall examine all persons going out of the works, and shall not allow them to leave unless they are properly cleansed from lead.

<u>As to Persons Employed</u>

Each man or woman before commencing work in any of the following departments shall wear as follows, having received the same from the person in charge:-

White Bed	One overall suit, women inside the white-beds to wear respirators also, but the 'carrier' not.
Washing and Crushing	One overall suit, 'roller' women to wear respirators also.
Grinding	One overall suit.
Setting Stoves	One overall suit and head covering.

Drawing Stoves	One overall suit, head covering and respirator.
Paint Mixing	One overall suit and respirator.

Each man or woman working at any white-bed, or in setting or drawing stoves, or in the washing and crushing, grinding, or paint mixing departments before going to breakfast, dinner or home, or before entering the dining-room for any purpose whatever, must:-

Put off the overall suit &c, and give the same to the person in charge, or leave it in the clothes room.

Brush every particle of lead dust from his clothes.

Thoroughly wash the face and hands in the lavatory, and be particular that no dust remains underneath the finger-nails. If not wearing stockings and boots, thoroughly wash the feet.

Each man or woman must bathe at least once a week, and must wash in the lavatory before bathing.

Each man or woman must receive and drink, at such times as maybe stated in a notice affixed in the factory, such sanitary drinks as may be prescribed in such notice.

Every white-bed must be adequately watered on removal of boards, and all trays of corrosions shall be well saturated with water before passing through the rollers.

No person shall smoke or use tobacco in any workplace or room. Respirators - these may be pieces of flannel or knitted wool, covering nostrils and mouth.

Prescribed medicine.

<u>The following departments to be specially ventilated</u>:

1. Washing and Crushing.
2. Grinding in water.
3. Paint (grinding in oil).
4. Drawing stoves. No cask or other receptacle to be filled except under ventilators.

Her Majestys Chief Inspector of
Factories

APPENDIX 3: Regulations issued by the Borough of Bradford to prevent Woolsorters' Disease 1880

(As printed in the Report of the Chief Inspector of Factories and Workshops for the Year Ending 31st October, 1880 (C 2825) Alexander Redgrave's Report, pp36-37).

1st That all Van Mohair, Camel's hair, and Persian wool, mohair locks, and all damaged wools are noxious and must be dealt with before sorting. If a sorter considers any wool damaged he is to call for the decision of the foreman.

2nd That all average mohair, Cape Hair, peleton and alpaca are to be sorted as usual (damaged excepted).

3rd That in dealing with 'noxious wools' before a bale is opened, it shall be steeped in water for a sufficient period to saturate it. In case the covering does not freely admit the water, it shall be opened so as to do so. In the event of any difference of opinion as to saturation being complete, the sorter may call for the decision of the foreman.

4th That after the bale has been in the water the necessary time, the hair or wool shall be placed in a sud of hot water and washed, then passed through rollers, partly dried, and sorted while still damp as early as possible after washing. The heat of the water to be 100 to 120 degrees.

5th That sorting rooms shall be well ventilated; the floors swept daily, the walls and ceilings swept once in three months, and thoroughly cleansed; and the walls lime washed with lime mixed with carbolic acid once in twelve months.

6th That no bale of wool shall be stored in the sorting room, save under special arrangement as to ventilation and cubical open area, and no wool, hair or other material shall be kept in the said room so as to interfere with the proper ventilation thereof.

7th That no meals shall be taken in the sorting room or food kept there. Also, that provision be made for the sorters to wash in or near to the sorting room.

APPENDIX 4: The Sheffield Trades

a) Causes of death of Sheffield Grinders 1861

(From the Superintendent Registrar for Sheffield - 1861 Mortality Returns for the Borough of Sheffield).

Occupation	Age	Registered Cause of Death
Grinder	55	Rheumatism & Diarrhoea
Grinder	37	Chronic Pneumonia
Grinder	47	Disease of Lungs
Grinder	23	Phthisis
Grinder	25	Phthisis
Grinder	43	Disease of Lungs
Grinder	51	Disease of Lungs
Grinder	22	Bronchitis
Grinder	20	Phthisis
Grinder	44	Pulmonary Consumption
Grinder	53	Spasm of Heart
Grinder	60	Grinders' Disease
Grinder	40	Dropsy
Grinder	37	Phthisis
Grinder	68	Chronic Bronchitis
Grinder	39	Grinders' Disease
Grinder	60	Phthisis
Grinder	48	Chronic Disease of Lungs
Grinder	57	Fever
Scissor Grinder	59	Bronchitis
Scissor Grinder	39	Phthisis Pulmonalis
Scissor Grinder	21	Fever, Congestion of Lungs
Scissor Grinder	58	Bronchitis
Scissor Grinder	23	Epilepsy
Scissor Grinder	49	Phthisis
Scissor Grinder	41	Phthisis
Scissor Grinder	50	Phthisis
Scissor Grinder	59	Asthma
Razor Grinder	46	Emphysema, Bronchitis
Razor Grinder	44	Phthisis
Razor Grinder	17	Phthisis
Saw Grinder	44	Inflammation of Lungs
Saw Grinder	28	Phthisis Pulmonalis
Saw Grinder	58	Consumption
Saw Grinder	51	Phthisis
Saw Grinder	63	Phthisis
Saw Grinder	60	Fractured Arm
Edge Tool Grinder	38	Phthisis
Edge Tool Grinder	20	Struma Phthisis
Wool Shear Grinder	53	Disease of Lungs
Shear Grinder	38	Pleuro Pneumonia

Occupation	Age	Registered Cause of Death
Scythe Grinder	44	Phthisis
Spring Knife Grinder	42	Phthisis
Table Blade Grinder	72	Bursting of a blood vessel
Table Knife Grinder	68	Chronic Bronchitis
Table Knife Grinder	42	Disease of Lungs
Table Knife Grinder	56	Disease of Lungs
Table Blade Grinder	68	Strangulated Hernia
Table Blade Grinder	20	Phthisis
Table Blade Grinder	60	Bronchitis
Table Blade Grinder	37	Phthisis
Table Blade Grinder	34	Disease of Heart
Blade Grinder	41	Disease of Heart
Pen Blade Grinder	36	Hanged himself
Pen Knife Grinder	21	Erysepelas
Pen Blade Grinder	57	Cancer of the Tongue
Pen Blade Grinder	67	Paralysis
Pen Blade Grinder	41	Cerebrites
Pen Blade Grinder	44	Phthisis
Pen Blade Grinder	59	Decay of Nature
Pocket Blade Grinder	49	Hepatitis
File Grinder	37	Grinders' Disease
File Grinder	43	Cirrhosis
File Grinder	54	Chronic Bronchitis
File Grinder	42	Bronchitis
File Grinder	40	Haemoptysis
Fork Grinder	49	Chronic Bronchitis
Fork Maker	55	Disease of Heart
Fork Grinder	58	Bronchitis
Needle Grinder	27	Phthisis
Needle Grinder	35	Grinders' Disease

b) Case Histories taken from *B.M.J.* 1857 April 11th, pp294-295 J C Hall

"Case 1

Adriel Shaw, pen and pocket blade grinder, was admitted under my care at the Sheffield Public Dispensary, February 20th, 1857. He complains of great difficulty of breathing, cough and expectoration. He has always ground on the wet stone, but states that 'razor grinders have worked in the same hull with him', and added, 'there is no fannie in my room, nor about our wheel'; he went to the trade at the age of 14; before that he worked as a cabinet-maker. He came from the country to Sheffield. His father is a gardener; he is living, aged 40, his mother died of thoracic consumption. He has slight haemoptysis three years ago, but took no notice of it; it has frequently recurred, and he is always attacked with it after 'racing' a stone. He began to feel very short of breath six months ago: he now feels very weak, and can take hardly any exercise. He is thin; the chest measures thirty inches, and expands only to thirty and a quarter inches; there is considerable dullness under each clavicle; a loud blowing sound is heard under the right nipple, and a peculiar creaking sound under the left. The expectoration under the microscope, exhibited pus and mucus-cells, enveloped blood-corpuscles, cells containing pigment, and particles of grit dust.

Case 2

John Gosney, aged 31, scissor-grinder (dry), was admitted March 12th, 1857. He first went into the wheel when nine years old. He has had attacks of shortness of breath, at intervals, for years, but got on fairly till about a year ago, when he was seized with profuse haemoptysis, and he has never been well since. He complains of cough, great shortness of breath, and states that he feels 'as if a wire had been drawn round his chest'. The chest measures thirty-three inches, and does not reach thirty-three and a half inches when he attempts to take a deep inspiration. The chest is generally flat; there is considerable depression under each clavicle; beneath the right clavicle the respiratory murmur cannot be heard; on the left side a few moist clicks may be heard very distinctly about two inches below the clavicle. The sputa under the microscope appeared to be pus and mucus cells; one or two bits of bronchial columnar epithelieum could be seen, and several pieces of the elastic tissue forming the areolae of the air vesicles were distinctly visible; also some particles of grit and steel.

Case 6

Frederick Clark, aged 19, a razor grinder (dry), was admitted September 18th, 1854. The disease had made considerable progress; he had been in the wheel from an early age. He has had cough and great difficulty of breathing for several years: he states that' he has occasionally spit blood'; his dyspnoea is aggravated on the slightest exertion; there is oedema of the feet and ankles: the clavicles are prominent, and there is a deep hollow between them and the upper ribs; the respiration is feeble on the left side, and a series of clicking crepitations may be heard during both the respiratory movements: there is a cavity of considerable size at the upper part of the right lung. He died on the 1st November. No post mortem examination was permitted.

Case 7

James Hodgkinson, aged 21, a table-blade grinder (for the most part wet) consulted me, April 4th, 1857. He has a pale pasty looking face; he stands 5 feet 3½ inches, and weighs 8 stone 7 lbs. His mother is living aged 55; his father, a table blade grinder, died of the grinders' disease at 39, and his grandfathers, on both sides, died of the grinders' complaint. 'Does not think consumption was ever in his family.' He went to the wheel at the age of 13, and has been in it ever since. He has felt a dryness in his throat for a long time, and has been 'a bit out of wind when going up hill, but nothing to mean anything': he has got worse the last few weeks, and 'the dry cough begins to trouble him very much'. He works mostly wet; the bolsters of the table-knives are *ground dry. He suffers very much from dust when they 'race' the stones, which fills the hull with dust. He has never spit blood. His chest measures thirty-four inches, expands to thirty-five inches; fairly formed; movements better on the left than on the right side; slight dullness under each clavicle; the respiration is harsh; the expiratory murmur is prolonged on the right side; and, three inches under the clavicle, a slight blowing sound can be heard. I give this case as illustrative of the earliest symptoms of the Sheffield grinders' disease. By abstaining from work a few weeks, under appropriate treatment, this man will recover; at any rate, for a time."*

c) Factory and Workshop Act 1895 58 & 59 Vict. c37

Section 25 First Schedule

Regulations to Grinders in Tenement Factories

1. Board to fence the shafting and pulleys, locally known as drum boards, shall be provided and kept in proper repair.
2. Hand rails shall be fixed and the drums kept in proper repair.
3. Belt guards, locally known as scotchmen, shall be provided and kept in proper repair.
4. Every floor, which is constructed after the commencement of this Act, shall be so constructed and maintained as to facilitate the removal of slush and all necessary shoots, pits, and other conveniences shall be provided for facilitating such removal.
5. Every grinding room or hull, which is established after the commencement of this Act, shall be so constructed that for the purposes of light grinding there shall be a clear space of three feet at least between each pair of troughs and for the purposes of heavy grinding there shall be a clear space of four feet at least between each pair of troughs and six feet in front of each trough.
6. The sides of all drums in every grinding room or hull shall be closely fenced.
7. Except in pursuance of a special exemption granted by the Secretary of State, no grindstone shall be run before any fire place or in front of another grindstone.
8. No grindstone erected after the commencement of this Act shall be run before any door or other entrance.

GLOSSARY OF SOME OF THE MEDICAL TERMS USED IN THE TEXT

Acute	*Any illness which has a sudden onset and runs a relatively severe and short course is called acute. (The opposite is chronic).*
Amaurosis	*Blindness; in particular that kind of blindness which is caused by disease of the optic nerve, the brain or the retina, so that the blind eye looks outwardly normal.*
Ankylostomiasis	*A skin eruption caused by hookworm.*
Anthracosis	*The grey or black colour changes seen in the lungs of miners (and found in varying degrees in most city dwellers) due to the inhalation of coal dust and soot.*
Anthrax	*Infectious disease caught by man from infected animals, also known as woolsorters' disease and malignant pustule.*
Asthma	*A disease of the respiratory system which produces difficulty in breathing.*
Bronchitis	*Inflammation of the bronchi or air passages of the lung.*
Bursa	*A natural space containing a little fluid situated in fibrous tissue at a point where there is constant pressure or friction. Such bursae can become inflamed through pressure, e.g. housemaids' knee.*
Byssinosis	*Lung disease found in cotton and flax workers and caused by dust.*
Caisson Disease	*'The Bends' - found in persons working in compressed air in caissons and who return too quickly to normal atmospheric pressure.*
Chimney Sweeps' Cancer	*Cancer of the scrotum.*
Chronic	*An illness lasting over a long period of time, as opposed to acute, which signifies something sudden.*
Cirrhosis	*Development of fibrous tissue in an organ with consequent scarring, hardening and loss of function. The term is usually used in conjunction with cirrhosis of the liver.*
Conjunctiva	*The thin transparent membrane covering the front of the eye.*
Cornea	*The transparent part of the eyeball which lies over the pupil and iris.*

Cyanosis	*Blueness of the skin*
Dermatitis	*Inflammation of the skin*
Dyspnoea	*Difficulty of breathing*
Emphysema	*Enlargement of the air vesicles of the lungs.*
Erysipelas	*Local feverish disease, causing deep red colour of the skin.*
Fibrosis	*The formation of fibrous or scar tissue in place of normal tissue which has been destroyed by injury, infection or deficient blood supply.*
Furuncle	*Boil, tumour.*
Grinders' Disease	*A disease of the lungs*
Haemoptysis	*The spitting up of blood from the respiratory system.*
Impetigo	*Mattery pustules, with much inflammation and swelling.*
Lichen	*Dry raised pimples.*
Melanosis	*Abnormal development of black pigment in tissue.*
Necrosis	*The death of a small part of the tissue, especially mortification of the bones.*
Nystagmus	*A condition in which the eyeballs show an involuntary rapid movement from side to side, or less commonly, up and down, or a rotary motion which is a combination of the two.*
Oedema	*Swelling due to passage of fluid in excess through the walls of the blood or lymph vessels into the tissue spaces.*
Ophthalmia	*Inflammation of the eye or the conjunctiva.*
Orbit	*The bony socket in the skull that contains the eye.*
Peritonitis	*Inflammation of the peritoneum. (The membrane which covers the inner walls of the abdominal cavity and the organs contained within it.)*
Phthisis	*Wasting. Because it so often used to accompany pulmonary tuberculosis, the word phthisis was frequently used by the profession as a synonym for the disease.*
Plumbism	*Lead poisoning.*
Pneumonconiosis	*Occupational disease of the lungs caused by various dusts.*

Psoriasis	*Common skin disease causing red scaly spots and patches.*
Sclerotic	*Membrane coating eye around iris. (White of the eye).*
Silicosis	*Lung disease caused by silica dust.*
Tuberculosis	*Disease affecting most tissues of the body marked by tubercles and the presence of a characteristic bacillus (pulmonary tuberculosis-consumption).*
Woolsorters' Disease	*Anthrax.*

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