INTERNATIONAL LABOUR OFFICE

OCCUPATION

AND

HEALTH

ENCYCLOPAEDIA OF HYGIENE, PATHOLOGY
AND SOCIAL WELFARE

Volume I

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PREFACE

In the brief introduction which the collaborators in this Encyclopaedia of Industrial Hygiene *have written for their work, the origins of the publication are clearly stated.*

In 1919 the International Labour Conference at Washington requested the International Labour Office " to draw up a list of the principal processes to be considered as unhealthy ". But it was impossible in practice to draw up such a list, at least in a complete or final form, on account of the number and complexity of the operations which in some aspects could be considered unhealthy, the continuous evolution of industrial technique which does away with causes of disease in one direction while giving rise to fresh possibilities of disease in another, and the indefinite character of the conception of " unhealthiness " which varies at different times and in different countries.

These considerations led to the idea of substituting for the list of unhealthy processes requested by the Conference, a sort of encyclopaedia which would analyse from the triple point of view of the work to be done, the worker employed, and the environment in which he worked, the various tasks involved in human labour, the properties of the substances dealt with, the operations involved in handling and working up these substances, the possible sources and carriers of intoxication and disease, the statistical data on the effects as far as known, the symptoms, the diagnosis, the therapeutic and prophylactic treatment, and the protective legislation already in existence.

It was a difficult task, and one which was bound to be open to the reproach of being neither complete nor final. But how could it be otherwise ? No one can hope to fix once for all something which is living, evolving, progressive. Although, as was mentioned above, the evolution of technical practice in industry may create new dangers for the worker every day, yet the progress of this same technique and of industrial hygiene may, on the following day, do away with certain existing dangers, which must, notwithstanding, be recorded and analysed in this work. One of the virtues of this work is just the fact that it is not final. It seizes one moment in social life and

in the progress of industrial hygiene, but it requires to be kept constantly up to date precisely because it is a scientific as well as a practical work.

This is its dual nature, as it is that of every piece of research undertaken by the International Labour Office, the strict purpose of which is to make science the servant of practical action. This Encyclopaedia *is not a work of pure propaganda; it never sacrifices scientific objectivity to the ideas which the authors naturally have at heart. On the other hand, it is not purely a treatise on medicine or hygiene; it claims no originality in the treatment of the various questions; it does not claim to be an exhaustive study; on each subject it merely gives a summary of the existing position of science, with figures taken from statistics for the sake of example and not in support of any argument. It has tried to keep a middle path between a purely scientific work intended for the expert, and a popular manual. It is meant to supply workers, employers, their organisations, and practising doctors with the information necessary to enable them to discover, combat, and prevent occupational diseases, the economic consequences of which are as harmful to production as their social consequences are to the world of labour.*

In carrying out this plan it has been the privilege of the International Labour Office to have the collaboration during the last few years of eminent experts who have taken part in the compilation or the supervision of the Encyclopaedia. *The International Labour Office takes this opportunity of expressing its sincere and warm gratitude to them. They must, however, have already found the first and greatest recompense for their work in the work itself. Each of them is an apostle as well as an expert in his own country. All are living illustrations of the fine, comprehensive definition of "social medicine" given by Pieraccini: "Social medicine purifies, if one may say so, the work of doctors; its programme and its essence are purer and more homogeneous; it removes doctors from contact merely with individuals and makes them benefactors of the whole human race".*

The International Labour Office, in collaborating with these scientists for some years, has obtained a clearer consciousness of the scope of its mission. The Preamble to Part XIII of the Peace Treaty included among the urgent tasks of the Office the protection of workers "against sickness, disease and injury arising out of their employment". The signatory States, in agreeing to this statement of principle, seem to have accepted the dictum of Lord Beaconsfield, that the health of the people is the most important of all problems. The Office has put at the disposal of those concerned a statement as to the actual position of science and has conveyed to the legislator the elements of physiology and physio-pathology necessary to him for setting up a code of industrial health; by collecting and concentral-

ing this information in one work, and thereby increasing its range and appeal, the Office is continuing the work of those who, since the inception of "large-scale" industry, have endeavoured to protect human life, openly or insidiously menaced by new technical processes.

The fact that the Office was able to secure the collaboration of a good number of these persons is the best proof of its international utility. For many years before the war, the studies of social savants had led to the partial and more or less sporadic introduction of legal protection for the worker against the harmful consequences of his employment. But this edifice, like so many others, was still incomplete and on an insecure basis, so that it was overthrown, if not actually swept away, by the torrent of war. The willing workers on the original building found numerous obstacles in their path when they tried to resume their work, and especially to reunite the bonds of international collaboration. The Office is proud to think that it may perhaps claim the merit of having provided for the first time since the war the means and habit of intellectual co-operation, *irrespective of frontiers, for the welfare of all. And it is just because this work was for the welfare of all, and for the protection of human health, that the Office rejoices in the resumption of this co-operation, and in its share in bringing it about.*

The Introduction to this Encyclopaedia *bears the motto of Ramazzini:* Medici munus plebeios curantis est interrogare quas artes exerceant — *"The duty of a doctor attending the common people is to enquire what trades they practice". The old practitioner knew well that a knowledge of the patient's trade might be a valuable factor in arriving at a diagnosis. This simple practical piece of advice throws a strong light on industrial civilisation. It is only when dealing with the "common people" that the doctor must think of their occupation. There are numerous sources of disease which do not affect the privileged classes of society, but only that class which Saint-Simon called "the most numerous and the poorest" and which nevertheless by its work gives rise to all wealth, all progress, and all happiness. For a long time this work, which is indispensable to the prosperity of the community, brought the worker nothing but physical, intellectual and moral poverty. But the conscience of the modern world has been awakened to this monstrous social paradox. Too much misery lies behind humble daily tasks; they lead to too much physical, and hence also moral, suffering. "We live", says Pierre Hamp, "on the sufferings of others. Everyone makes life a torment for some of his fellow-men. How many people earn their living pleasantly? All do so in unpleasant and often intolerable conditions. To love one's occupation is to be happy, but where are the occupations which one can love?"*

In ancient societies, dangerous and disagreeable tasks were

reserved for criminals. Fourier, for all his fertile imagination, dared not foresee that the progress of industrial technique would one day lead to the suppression of unhealthy or dangerous occupations: he reserved filthy or dangerous work for his "small gangs". Nowadays the problem is entirely different: the conscience of modern society realises that occupational diseases should not be reserved for certain persons, but that they should be made to disappear. The origins and the causes are now known, and all that is wanted is will and organisation. There are plenty of other sufferings and plenty of other infirmities to which mortals are exposed. As Puccinotti has said: "Life must be preserved for labour, and labour must be made harmless to life". Work must be healthy if it is to be pleasant and agreeable and if some of the causes of that "unrest" which, as Part XIII of the Peace Treaty says, is "so great that the peace and harmony of the world are imperilled" are to be done away with.

It is hoped that this modest work which the International Labour Office has prepared by patient toil and now offers to the judgment, and still more for the service, of workers, employers, and society as a whole, may contribute its share to realising this high ideal. The efforts of its editors have been directed towards rendering science a guide to practical action. This aim will have been achieved if the work appears to be an indispensable part of that edifice, the erection of which will be the next task: the international code of hygiene and industrial health.

ALBERT THOMAS.

INTRODUCTION

Medici munus plebeios curantis est interrogare quas artes exerceant.

RAMAZZINI.

ORIGIN OF THE WORK

During the First International Labour Conference, which met at Washington in October 1919, the Commission on Unhealthy Processes adopted the following resolution:

> " It should be referred to the International Labour Office to draw up a list of the principal processes to be considered as unhealthy. "

The Commission admitted, however, that it felt embarrassed by the absence of any definition of what constituted an " unhealthy process ".

On the proposal of one of the delegates, the Conference recommended that the Health Section (the creation of which within the International Labour Office was then contemplated) should be entrusted with the work of drawing up the list in question, since such work was naturally one of its functions. "So far as the injurious processes are concerned it is not primarily a case of investigating main principles. As a rule, it is the detailed examination of how to apply particular precautions to varied and different industries, and that means an examination of a great mass of statistics and analysing chemical and medical data. "

For some years the question of unhealthy industries has atttracted the attention of experts and even of public opinion, which has demanded legislative action, sometimes international action, on lines likely to produce the best possible results both for industry and for the worker himself. Such action for the diminution, and in some cases the entire abolition, of all serious occupational dangers is a worthy task, but cannot but be slow, since unhealthy occupations are very numerous and often very complicated. Although certain industries cannot for the time being be made completely innocuous, the progress of modern science and technique enables far-sighted employers, conscious of the advantage to be gained therefrom by industry, to adopt measures and new processes which tend to make dangerous processes less dangerous. It should not be forgotten, however, that scientific progress leads to the discovery or creation of products and processes which, when adopted in industry, are often a source of new dangers to the worker. Unfortunately, occupational risks do not lurk only in the raw materials, in the finished product,

or in by-products, but are often concealed in intermediate manufacturing operations and are only detected by the experts when disease has already attacked the worker.

The expression "Prevention first" is often heard. That is all very good, but in order that adequate and complete prophylaxis may be organised, it is first necessary to examine the patient, know the disease, its etiology, its pathogenesis, its symptoms, its evolution, and, above all, its extent in the strata of society affected — in this case amongst the working classes. Without this preliminary knowledge, there can be no question of prevention.

Earlier Efforts

Even before health experts considered the question of drawing up lists of unhealthy processes (see, for example, Layet's work, published in 1875), legislators had contemplated similar lists, though from a different point of view. Such lists of undertakings classified as dangerous, unhealthy, or obnoxious are more concerned with the nuisances and dangers which such undertakings may involve for the neighbourhood (e.g. smells, smoke, fumes, waste water, danger of fire or explosion) than with the health of the workers in the factory itself. Later, under pressure of public opinion, legislators were compelled to draw up a list of the processes on which the employment of children, women, or young persons should be prohibited, or only permitted under certain conditions.

It is impossible to refer here to all the pioneers in industrial hygiene and pathology who dealt with this question, or all the treatises on the subject [see article "Occupational Diseases: Historical Review"]. It will be sufficient to mention some of the "lists of industrial poisons".

The earliest to appear were the list drawn up at the instigation of the International Association for Labour Legislation and those published on their own initiative by certain scientists; for example, that drawn up in 1908 by Sommerfeld in collaboration with Oliver and Putzeys (Jena, Fischer, 1908) and revised in 1910 by Fischer (Frankfort-on-Main, Aug. Weisbrod), and Sommerfeld's later list of 1910 (Jena, Fischer). More recently there have been the lists of Müller, of Zurich (1919), of Kober and of Wadsworth (in Kober and Hayhurst's treatise on industrial hygiene), the pamphlet of the Metropolitan Life Insurance Company (New York, 1921), that of the Bureau of Labour Statistics (U. S. Department of Labour, Bulletin No. 206, Washington, 1922), the pamphlet drawn up by Dr. Robertson, of the Industrial Health Division of the Australian Ministry of Health (Melbourne, 1922), and finally, *Industrial Diseases: Rapid Reference Manual for the Use of the Medical Profession*, arranged by C. T. Graham-Rogers, M. D., Inspector of Factories, New York State Department of Labour, Division of Industrial Hygiene (1924). The Industrial Poisons Committee (Chemical Section) of the National Safety Council of the United States submitted to the 1924 Annual Congress a study entitled *Summary of Present Practice in Industrial Poisoning Prevention*. In 1925 there appeared the second edition of the *Aerztliche Merkblätter*, dealing with occupational poisoning and injuries resulting from chemical substances, edited by the Association

of Factory Doctors in the German Chemical Industry (Verlag Springer, Berlin).

The lists, which were at first confined to giving in tabular form the data concerning industrial poisons (e.g. industries and processes in which poisoning may occur; mode in which poison enters the system; symptoms; special measures), have little by little been extended to include all other causes of disease, such as temperature, compressed air, humidity, dust, infection, etc. This logical and necessary development of the lists shows clearly that the term "unhealthy" is not limited to its former restricted sense, which only covered poisons.

Scope of Present Volume

In these circumstances, and for other reasons which need not be urged here, the compilation of an international list such as that contemplated by the Washington Conference becomes extremely difficult, not to say impossible. It may be considered that the most practical solution would be the preparation of national lists drawn up by each country separately; but at the same time it is the function of the International Labour Office to collect and publish all information which will enable experts and the authorities concerned to learn what has been done and suggested in this field in the various countries. Such information, which would be the objective result either of a permanent investigation in the various States Members of the International Labour Organisation or of data drawn from published works and carefully checked [1], is of the utmost interest to manufacturers, workers, medical inspectors and industrial experts, medical practitioners, experts, etc.

Acting in accordance with the spirit, if not the letter, of the Washington resolution, and in agreement with its Correspondence Committee on Industrial Hygiene, the Office decided to interpret the

[1] The treatises on occupational diseases and industrial hygiene of Pieraccini, Loriga, Carozzi, Giglioli, Ranelletti, Ferrannini, for Italy; of de Mosny, Sergent, Balthazard, etc., for France; of Hope, Hanna and Stallybrass, Oliver, Prosser White, etc., for Great Britain: of Weyl, Rambousek, Lehmann, Gottstein, Schlossmann and Teleky (Vol. II. of *Treatises on Social Hygiene*, 1928), of Chajes (1929), etc., for Germany; of Löwy, for Czechoslovakia; of Hejermans, for the Netherlands; of Kober and Hayhurst, Alice Hamilton, etc., for the United States; the reports of the proceedings of national and international congresses on occupational diseases and hygiene; of original articles appearing in technical periodicals: *Journal of Industrial Hygiene* (*Great Britain and United States*); *Public Health Reports*, the *American Journal of Public Health*, the *Industrial Doctor* (United States); *La Medicina del Lavoro, La Rassegna di Previdenza Sociale* (Italy); *Zentralblatt für Gewerbehygiene* (Germany); *Zeitschrift für Gewerbehygiene* (Austria); *Annales d'Hygiène publique, industrielle et sociale* (France); *Bulletin de l'Inspection médicale du Travail* (Belgium); *Bollettino del Lavoro e della Previdenza* (Italy); *Higjena Pracy* (Warsaw); *Gigiena Besopastnost i Patologia Truda* (Russia), etc.; the medical press of various countries, etc.; the theses; the chapters dealing with the factor "work" in treatises on special subjects; the treatise by Oppenheim, Ullman and Rille on skin diseases of occupational origin (Verlag Voss, Leipzig, 1926); the treatise on toxological chemistry by Kober (Germany), by Ogier and Kohn-Abrest (France), etc.; the treatises on diseases of women, diseases of the eyes, etc.; the most important publications on technology and industrial chemistry, etc.

word "unhealthy" in the widest possible sense, so that in addition to toxic, infectious, and parasitic causes of disease the articles cover all other causes capable of endangering the health and life of the workers.

Scheme of Compilation

The series to which this forms an introduction deals therefore with three main groups of questions:

(1) The work.

(2) The worker.

(3) The environment.

The *work* is analysed into its constituent elements, such as materials, industries, trades, and causes of disease (chemical, biological, etc.). Each article is prepared on a uniform plan, which in the case of causes of disease includes the following subdivisions: chemistry or biology; sources of poisoning or of infection; uses of the dangerous product; its mode of action; statistics; symptoms; diagnosis; method of detection in the environment or the individual; prevention; legislation; bibliography.

Industrial technique is described in the order of the operations involved, showing in each case the peculiar dangers involved and the requisite preventive measures. The scope of the technical descriptions is determined, on the one hand, by the nature of the unhealthy conditions and, on the other, by the preventive measures employed or prescribed by legislation.

Among the numerous and often detailed statistics in the possession of the Office, those have been selected which are the most recent and deal with the essential facts.

In general, the figures selected are restricted to absolute figures or relative values cited by authors or factory inspectors, without any attempt being made to interpret or compare these. The statistical methods followed being very varied, the number of workers engaged in a given factory visited or exposed to a given risk being unknown, it would be highly imprudent to analyse these figures with a view to arriving at any conclusion whatsoever. On the other hand, these figures represent nevertheless an interesting aspect of the question or an indication which deserves to be brought to the attention especially of those desirous of engaging in the study of any given problem.

The subdivision "Dangers" describes the characteristic forms of disease in each industry. In cases of the more important forms of poisoning the reader is referred to the special article on this poison; for example, in the article on "Hair Cutting" a reference will be found to the article on "Mercury Poisoning". In the paragraph headed "Pathology" the reader is given an account of the morbid forms noted amongst workers engaged on the processes in question. Similarly, as regards legislation, a brief summary, is given of measures for the protection of women, young persons, and, where such exist, of adult men, with information as to provisions on the notification and compensation of industrial diseases, special legislation, etc.

The *worker* is considered in relation to the products with which, and the environment in which, he works. The object of the articles

on the physiology and pathology of the various organs and systems, personal and collective hygiene (including medical or social welfare within the factory), etc., is mainly to recapitulate the data given under the headings of industries and causes of disease. They are, to some extent, a more complete review of problems which could not be dealt with in detail in the technical articles (e.g. an article on the eye summarises the various diseases of that organ encountered in the various industries).

Under *environment* fall general studies on subjects such as atmosphere, premises, heating, lighting, removal of dust, gas and fumes, humidification, etc. Sanitary accommodation (cloak-rooms, lavatories, privies, etc.) is dealt with in a single article entitled "Personal Hygiene". These studies, based on data furnished by up-to-date industrial hygiene, are treated separately with a view to avoiding repetition.

Limitations

Every effort has been made to make as complete a statement as possible on each subject, but obviously it is very difficult, for example, to classify the dangers which threaten the worker in their order of gravity: there are too many factors involved, even in a single country. This is an essentially national question, indeed, in some cases a local one, which cannot be taken into account here.

In fact, the same industry, the same process even applied in two different factories, though these may be for instance in the same town, will exert different effects on the health of the workers in accordance with the special conditions under which the work is carried out (workrooms, varying methods of work, up-to-date plant or otherwise, health supervision, etc.).

It is equally difficult to make a distinction between definitely established facts and data which may seem doubtful or inaccurate. In each individual case enquiries are made of qualified experts on any point which, on revising the articles, the members of the Correspondence Committee on Industrial Hygiene think doubtful. After this consultation, the Office takes the final decision that it thinks proper. It should nevertheless be emphasised that all the data published, although the result of the most detailed research and of information collected with the utmost care, cannot be considered as final.

The hygienic and health conditions dealt with in the various articles must not be considered as the result of a permanent enquiry at present conducted by the Office. They merely represent the results of investigations conducted by experts or by factory inspectors in the most varied localities and also at very different dates. Obviously these results are neither comparable one with another, nor can they be regarded as a "photographic" representation of the present state of the industry in question, and still less that of any one factory in particular, which could have no ground whatsoever for imagining that the conditions as stated in the articles might imply criticism of its methods.

It has been said that science is revolutionary. Like matter, it is always in process of transformation; therein lies its great strength and its *raison d'être*. Science lives only because it doubts, because

it refuses to accept as fixed and final the truths enunciated even by the most eminent authorities. In science there exists no authority which can settle a question finally, putting one party in the right and the other in the wrong. This being so, in preparing the *Encyclopaedia* the custom of placing in parentheses after a statement of opinion the name of the author responsible therefor has been generally followed.

The section dealing with "legislation", which is as up-to-date as possible, is not intended of course to include all legislative measures on any given subject, but merely seeks to give the most characteristic or important provisions as examples. Similarly, in the "bibliographies" at the end of each article there are only mentioned the most recent and important works, which will enable the reader to refer to general bibliographies on the subject. In this connection it may be recalled that the Office publishes quarterly a very detailed *Bibliography of Industrial Hygiene* classified by subject and by author.

It was further decided to illustrate certain parts at least of this publication (e.g. articles dealing with industries and hygiene) with photographs, sketches, diagrams, plans, etc., showing recent innovations and improvements. The work is completed by a series of cross-references and an alphabetical table of contents which will facilitate readers' enquiries.

The publication, therefore, will have neither the systematic form of a list nor the scope of a large treatise on hygiene; its only object is to furnish as wide and accurate information as possible on questions which are of daily occurrence in the world of labour, in connection with hygiene, pathology, and medical aid.

In order not to make the work too voluminous, it has been thought well to condense the articles, though without sacrificing any essential matter, in effect to adopt a somewhat telegraphic but nevertheless clear and intelligible style. The technical and medical sections in particular are made neither too concise for the uninitiated to understand them, nor so detailed as to be unintelligible except to one or two experts, who in any case are already acquainted with the subject or could look it up in other documents.

Medical men will no doubt note omissions in the various articles and sections on occupational diseases (especially in the data relative to morbid anatomy and therapeutics). These omissions are deliberate, since the work is intended not solely for doctors, who can, if necessary, find the information they require in any medical handbook, but also, and above all, for workers, manufacturers, and their organisations. The chief object is to disseminate as widely as possible the information required for the detection of occupational diseases, to indicate the steps to be taken for their cure and prevention, and to lay down general principles for the better protection of the workers.

Expert Collaborators

In view of the extensive knowledge and experience required for this publication, and of the responsibility assumed by the Office in preparing and issuing it, it has been judged essential, in drawing up the plan of work and in drafting certain articles, in addition to enlisting the aid of the members of the Correspondence Committee on

Industrial Hygiene, to appeal to certain of the foremost experts in the various countries who were considered as being particularly fitted to write one or other of the articles.

The articles written by collaborators or by the Health Service are submitted for consideration to the members of the Correspondence Committee on Industrial Hygiene and to experts in the particular subject. The final text of each article has been drawn up on the basis of the information and suggestions received by the Service.

Each article has been signed by the author of the original report. The signature replaces the formula adopted in the brochure edition: " According to an original report by....., revised by the Correspondence Committee on Industrial Hygiene of the International Labour Office ". Where the original text has been prepared by the Hygiene Service under the responsibility of Professor L. Carozzi, Chief of the Hygiene Service, it is marked thus***. This sign replaces the above-mentioned formula.

The work appeared at first in the form of separate brochures. The present edition in volume form contains many modifications and additions rendered necessary by subsequent discoveries, new conceptions and observations furnished by science and technology subsequent to the publication of certain articles. It may therefore be said that this volume represents a new, revised and extended edition of the work already published in pamphlet form.

The Office takes this opportunity of acknowledging the valuable assistance given by Dr. Legge, formerly Senior Medical Inspector of Factories in Great Britain, and by Professor E. L. Collis, University College of South Wales and Monmouthshire, Cardiff, in the preparation of the English translation of the articles, a task which, in view of the many technical terms employed, was one of unusual difficulty and responsibility.

Like the pamphlets, the volume appears in the two official languages of the Office, English and French.

List of Collaborators[1]

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[1] The names of the members of the Correspondence Committee on Industrial Hygiene and the Safety Committee of the International Labour Office are preceded by an asterisk.

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Contents of Volume I

List of Articles in Volume II

the mayor, which must be renewed every week. The Californian law enjoins that no child under at least 16 years of age can be employed in a studio unless duly authorised and after medical examination carried out by a medical man in the Child Welfare Service. These examinations are made every three months. Children taking part in film production must not be employed more than eight hours a day, including lessons lasting four hours given by a qualified teacher, paid, but not selected, by the studios. Employment of children before 8 a.m. and after 5 p.m. is prohibited.

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Asbestos

French: *Amiante, Asbeste, Pierre à coton.* — German: *Asbest, Amianth, Bergflachs.* — Italian and Spanish: *Amianto.*

CHEMICAL PROPERTIES

Asbestos is a brilliant filamentous mineral, oily to the touch, white, silvery grey, greenish or bluish. Its density is 2.3-2.9. Its chemical composition consists, according to its origin, of calcium silicate and magnesia or of a magnesia silicate accompanied by quantities of iron, more or less extensive. Analysis of different varieties of asbestos reveals a silica content of 40-50 per cent. — 41.2 in Canadian asbestos, 41.8 in Siberian asbestos, and 51.1 in the African variety — while oxide of magnesia varies between 2.3 (African) and 41.7 (Canadian), oxide of iron between 2.52 (Canadian) and 35.8 (African). In Siberian asbestos there is besides 16.39 per cent. of alumina. When cut up it presents a silky cotton-like form which lends itself easily to weaving. It is incombustible, prevents heat loss, is a thermic and electric insulator and is not attacked by most acids.

Of the three different mineral varieties known by the name of asbestos, it is serpentine asbestos or chrysolite and hornblende asbestos which are the most commonly used; the first of these is the most sought after variety. Industrial asbestos is chiefly derived from Canada, Russia, Italy, and the Transvaal.

TECHNOLOGY

Extraction involves two distinct operations: (1) quarrying of the asbestos-bearing rock, generally mined in open quarries or, in countries having a severe winter climate, in galleries; (2) separation of the asbestos from the surrounding rock. The rock is cut in terraces, sometimes reaching a depth of some 150-200 ft. Quarrying is more economical and effective than underground work even despite exposure to weather. Drilling and blasting are engaged in as in ordinary stone quarrying. The mineral got from the quarry is rough sorted, different grades being chosen for length of fibre and sent to "cobbing sheds" where dressing is carried out. This consists of separating the abestos fibres from the surrounding rock and may be done (*a*) by hand — the stone being broken by a small sledge hammer and the fibre thrown thereafter into one box and the waste into another — or (*b*) by machine ("mills").

Hand separation ("picking and sorting") is not difficult since the fibres lie in layers more or less loosely attached to the rock and can frequently be picked off with the fingers; but hand dressing is not thorough and the waste material from the cobbing tables contains much fibre, the further utilisation of which represents large profits to the mine, and these fine pickings have to be dressed mechanically. They are passed after drying to crushers where they are broken by successively finer-set rollers and further reduced by cylindrical fiberisers and the cyclone machine, which reduces them to fine powder. The cotton-like fibres come to the surface and are mechanically withdrawn by suction. The pulverised rock and ground asbestos are then separated by passing them through a shaking screen. In some mills the particles of iron present are taken up by strong electric magnets. The crude fibre on separation from the waste rock resembles mineralised wool. The asbestos is graded according to the length of fibre on a series of cylindrical screens. It is then carded and packed in sacks and placed on the market in bulk.

INDUSTRIAL USES

The uses to which asbestos is put are very varied. The long fibres are used in the textile industry for the manufacture of cloth, braid, rope, theatre curtains, decoration, upholstery, hangings, and for finishing pistons for steam engines. The shorter fibres together with an agglomerating agent are used in the manufacture of felt, paper, cardboard, varnishes, covering agents (especially for strong

rooms), cements, rubber tyres for automobiles and bicycles. Asbestos is also used as an electrical insulator for covering electric wiring for high and low pressure currents, in the manufacture of tiles, planks, panelling and exterior coverings for buildings, mattresses, heat insulating gloves, firemen's clothes, laboratory equipment, porcelain, balls for gas fires (made of fireclay and asbestos), etc.

Dangers and Hygiene

The worker engaged on the extraction and manufacture of asbestos is constantly exposed to danger from dust, more especially, however, in the operations of spinning and weaving.

The baneful influence of the dust in relation to the production of tuberculosis is brought out in the *Annual Report of the Chief Inspector of Factories for England and Wales for 1910*, which records 5 deaths from tuberculosis amongst 40 workers engaged in an asbestos weaving factory, where the most dangerous process was revealed to be the weaving of asbestos mattresses composed of bags of woven asbestos filled with short asbestos fibre. They were placed on a table and beaten out flat by a man with a wooden flail, which process occasioned the production of much dust. Women sewed the mattresses into sections using asbestos threads and as they worked beside the beaters they also of necessity inhaled much dust.

Towards the beginning of 1924 a fatal case of poisoning by asbestos dust was reported at Rochdale (England). The victim was a woman who had been employed in an asbestos factory. A post-mortem examination revealed death as due chiefly to a fibrosis of the lungs due to the inhalation of mineral particles and in part to tuberculosis. A microscopic examination of the lungs and of dust samples taken from three different workshops of the factory revealed the same black particles present in each, alike in form and dimensions.

Another fatal case was studied in 1927 by Cooke and Hill (Great Britain).

A striking example of the noxious property of asbestos dust is instanced by the following case: in an asbestos spinning and weaving factory (Calvados) there were 40 deaths in the five years 1890-1895. The mortality rate decreased considerably with the installation of a good system of local ventilation over the carding machines. (See also article "Tuberculosis".) In an asbestos weaving factory in Saxony the workers complained of headaches and loss of appetite. These affections were caused by fumes given off by a rubber solution with which the asbestos cloth had been coated to eliminate dust.

An investigation carried out in Canada in 1911 revealed that hygienic conditions were greatly improved as a result of the adoption of an effective system of ventilation. Nevertheless, a local doctor with long experience stated that respiratory troubles, and in particular tuberculosis, were of very frequent occurrence amongst asbestos workers.

Rambousek drew attention to the risk of lead poisoning during the weaving of asbestos when a thread of lead is added to the weft, as is sometimes the case.

Marked frequency of chronic conjunctivitis with hypertrophy of the rims of the pupils has also been noted amongst the asbestos workers of the Island of Cyprus. The workers in question were chiefly engaged in grinding, screening, and packing the asbestos in sacks.

The weaving of asbestos has only developed importance during the last twenty years. Now that it is widely practised the application of local exhaust systems during such processes as that above described is called for. All processes from extraction onwards unquestionably involve a considerable hazard, and American and Canadian life insurance companies generally refuse asbestos workers on account of the assumed deleterious conditions in the industry.

The lack of more accurate and detailed data in medical literature regarding this industry in its various branches, including the utilisation of by-products, is to be deplored in view of the self-evident importance of asbestos dust as a predisposing cause of pulmonary tuberculosis, more especially since the rapidly-increasing development of industries utilising asbestos adds greatly to the urgency of studying the conditions with a view to their amelioration.

All provisions already described for withdrawal of dust should be enforced in this industry.

Legislation

In *Italy* boys under 15 and girls under 21 years of age are excluded from workshops where dyeing and weaving of asbestos are engaged in, unless effective

means are taken to prevent the diffusion of dust throughout the atmosphere.

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Ashes, Cinders

French: *Cendres.* — German: *Aschen.* — Italian: *Ceneri.* — Spanish: *Cenizas.*

Ashes present problems from the point of view of industrial hygiene, not only when cinders from hearths are in question (dangers from hot dust, presence of certain products, etc.), but especially when they are employed for special purposes. Thus, for instance, treatment of goldsmiths' ash by lead may cause injury by reason of the metallic dust which it liberates.

Hygienic measures assure covering of any openings giving on to the public streets, thorough ventilation of the workshop, the installation of hoods for the furnaces and cupels connected to the chimney by a strong exhaust. If the treatment is effected by means of mineral acids, application of measures of protection against toxic fumes is required, viz. condensation of lead fumes. Noisy machinery should be isolated, and measures applied for evacuation of residues and the protection of workers from the heat and glare of the furnaces.

Pearl ash from combustion of organic material, such as shoots of vine, wine lees, vinasse from beetroot, etc., is composed of impure potassium carbonate and its treatment liberates sharp, piquant, thick, and disagreeable fumes and injures vegetation in the neighbourhood. Factories should be erected at a long distance from dwelling houses and calcination should be effected in closed ovens. Gases and fumes should be led to special hearths or requisite measures taken for their destruction. The chimney must be a very high one. It would be advisable to collect the incandescent mass of carbonate of potassium in a special apparatus so constructed that the gases can be led to the hearth or into apparatus where they can be burnt. Hoods should be installed above the evaporation boilers. The water should be led to a sewer: the residues require fairly frequently to be removed and can be utilised as manure.

By the expression "dust shot with a lead content" is meant the impure oxides which form on the surface of each bath containing lead or lead alloys. This scum or black dross is removed as it forms and is often put aside on the floor, where it becomes mixed with other substances. In appearance it resembles ashes, hence the French expression "*cendres de plomb*".

Kelp ash is lixiviated for the extraction of the salts of potassium. The ash is got by burning different kinds of sea-weed known as kelp or wrack and thrown up on the seashore. Dried in the sun, they are thereafter reduced to ashes in furnaces lined with refractory bricks. The product of combustion "kelp ash" is in the form of a solid compact block, from which the salts of potassium are extracted. The blocks are then ground and put into special apparatus for gradual dilution with water. The solution is concentrated in iron boilers and poured into vats where, after cooling, the potassium chloride is deposited in crystals, which are then subjected to purification.

Hygienic precautions to be recommended are impermeable flooring, cement walls to the height of one metre, hoods provided above the boilers to draw off the fumes to the chimney, all openings to the public highways to be kept closed, and neutralisation of the water used before it enters the sewers.

The Recommendation adopted at the International Labour Conference at Washington (1919) regarding the protection of women and children against lead poisoning demands the exclusion of women and young persons under eighteen years of age from work involving manipulation, treatment, and reduction of ashes containing lead.

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Asphalt

(Mineral Pitch, Hard Bitumen)

French: *Asphalte, Poix minérale, Bitume.* — German: *Asphalt, Erdpech, Erdharz.* — Italian and Spanish: *Asfalto.*

Earth and rocks impregnated with bitumen are called asphalt. In mineralogy, however, the name asphalt is also given to bitumen in a free state. It is highly important to distinguish between these two products. Asphalt is generally in the form of fine grained rock, black or dark brown in colour according as it is more or less