The occupational diseases : their causation, symptoms, treatment and prevention / by W. Gilman Thompson.

Contributors

Thompson, W. Gilman 1856-1927.

Publication/Creation

New York ; London : D. Appleton, 1914.

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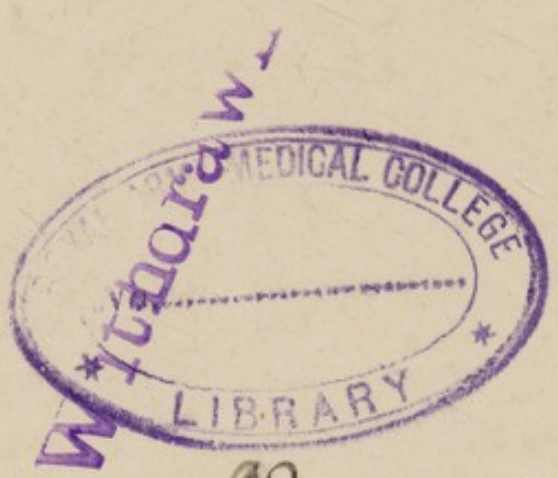
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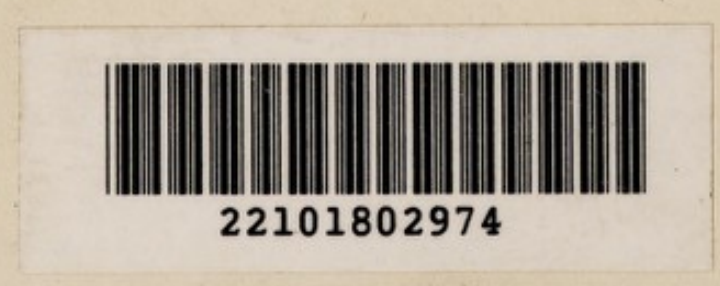
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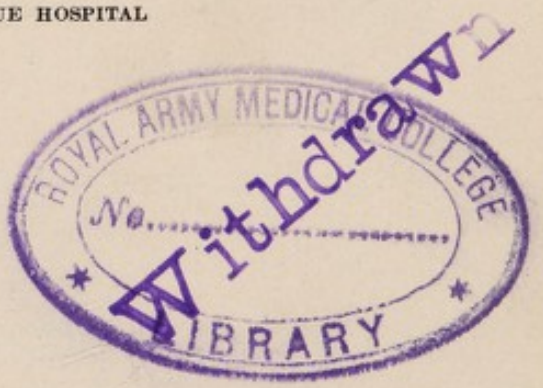
THEIR CAUSATION, SYMPTOMS TREATMENT AND PREVENTION

BY

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PREFACE

This work, which is the first of its kind to be published in this country, is designed primarily for physicians interested in the subject of the Occupational Diseases of Modern Life, and also as a guide for students of social economics, social service workers, insurance actuaries, and those whose special interests deal with problems of labor legislation, or with workers in the chemical, textile, and many other manufactures or trades in which the health of the workman is closely related to problems of efficiency and humanitarian effort.

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INTRODUCTION

Many valuable monographs have been published of recent years in this country on various general and special phases of the occupational diseases, notably by Drs. George M. Kober, Alice Hamilton, C. F. W. Doehring, Graham-Rogers, George W. Price, Frederick L. Hoffman, John B. Andrews, and by Mr. Edward T. Davies, Mrs. Linden W. Bates, and others whose work is given full recognition in the following text. Yet, in the Memorial on Occupational Diseases sent to the President of the United States in June, 1910, by the First National Conference on Industrial Diseases, the statement is made that "practically all the standard works of reference on occupational diseases are by English or Continental authorities. There is no modern treatise on the subject by an American authority on industrial hygiene."

To supply in some measure this lack, the present work has been undertaken, particularly with the aim of meeting the needs of American practitioners of medicine, as well as those whose industrial or philanthropic interests require a comprehensive summary of the nature and prevalence of the occupational disease hazards as they obtain in this country.

It has come to pass that in complex modern civilization the evolution of new machinery and apparatus, new varieties of food and drink, new occupations and habits of life—in a word, of the entire social environment—has been accompanied by the employment of new poisons in the mechanical arts, new poisons of inhalation, new uses for the muscles, new strains of the nerves, and new stress of

the mind. Many of these factors operate most insidiously, others more acutely, but, sooner or later, tend to injure the structures of the body or alter its activities in a manner to produce what fairly may be regarded as definite occupational diseases or disorders, many of which affect longevity and mortality in very striking degree.

Almost all these diseases of occupation are preventable, and this aspect of the subject is one which in some phase or another concerns the whole community; for it presents a legislative aspect, a practical business side, and a humanitarian interest. Legislators should concern themselves with restrictive legislation; manufacturers, with practical efforts to preserve the health of their employees; experts in hygiene should devise means for prevention or relief, and physicians and social workers should coöperate in obtaining much needed data on which to base a rational policy of prevention.

In the hospitals and dispensaries of New York City, with its varied industries and large foreign population, is a wide field for the study of this subject. The writer, in the course of many years' connection with the visiting staffs of the New York, Presbyterian, and Bellevue Hospitals, and with the Cornell University Medical College Dispensary, has had exceptional opportunities for practice among such occupational diseases, particularly those which are represented in the metal manufactures and the industries which give origin to many disorders of the circulatory, respiratory and nervous systems.

The occupational diseases are not new diseases from the ultimate pathological standpoint. The arteriosclerosis or chronic nephritis produced by lead poisoning, for example, does not differ from that due to alcoholism or other toxic causes, nor does the bone necrosis of phosphorus poisoning differ from necrosis of other origin. Nevertheless, in the grouping of symptoms, in their mode of onset and progress, as well as in their etiology, the diseases caused by industrial

hazards may fairly be regarded as new to medical science, and hence the justification for their independent classification and description.

The subject of occupational diseases appeals to many interests, medical, scientific, economic, sociologic, philanthropic, insurance and legislative, and is just beginning in this country to command the attention and receive the study which its importance to the community demands; for there are few manufactured articles of necessity, comfort or adornment which may not, in their production, have been associated with possibilities of industrial poison or disease hazard. Clothing, tools, household utensils, buildings, conveyances, in fact practically all the complex manufactured products of modern civilization, afford abundant illustrations from time to time of risks to health and life where the unskilled or uninstructed workman is permitted to deal with toxic substances or to be exposed to deleterious environment.

It is quite true that many processes of manufacture will always involve risk to health, as many trades necessarily involve risk to limb or life. One cannot handle white lead without risk of disease, just as one cannot use dynamite without risk of injury. Yet, in each case, the workman has the right of warning against the hazard, the right of such protection as modern scientific knowledge affords, and should have the right of compensation when disabled as a result of the lack of such warning and protection. It is easy to estimate the result of bodily injury or award a fixed rate of compensation for the loss of a life, but it is far more difficult to estimate the insidious and progressive effects of occupational disease, and the resulting loss of time or the suffering and misery not only of the workman, but of his family, which such disease entails. On the other hand, it is easy to exaggerate the hazards of particular industries, some of which are very serious but very infrequent, whereas others are not very serious but very frequent.

These, then, are the problems upon which it is the aim of this book to throw light, it is hoped without exaggeration and in a spirit of fairness to employer and employee alike. In addition to full explanation of the etiology of the occupational diseases, their pathology, prevention and treatment are discussed at length. Extensive tables of classification are introduced and illustrations have been added wherever they might amplify the text.

In presenting statistical data, although foreign sources have not been neglected, the aim has been in every instance in which they were obtainable to draw upon American reports in preference.

For granting the use of a number of the illustrations, special acknowledgment is made to the courtesy of Drs. John B. Andrews, Secretary of the American Association for Labor Legislation; George W. Price, Secretary of the New York State Factory Investigating Commission; William C. Hanson of the Massachusetts State Board of Health; Alice Hamilton of the Illinois State Commission on Occupational Diseases; John A. Fordyce, William Burton, and J. S. Haldane; the American Iron and Steel Institute; the Illinois State Factory Inspection Commission; the *American Labor Legislation Review;* the Illinois Steel Company; Brown Brothers, photographers, and *Rauch und Staub.* Other acknowledgments are made in the text.

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THE OCCUPATIONAL DISEASES

PART I

HISTORY, CLASSIFICATION, GENERAL PATHOLOGY AND ETIOLOGY

I. GENERAL STATEMENTS

DEFINITIONS

The occupational diseases may be defined as maladies due to specific poisons, mechanical irritants, physical and mental strain, or faulty environment, resulting from specific conditions of labor.

Such maladies may be acute or chronic. They may be the cause of instant death, more or less prolonged invalidism, and incapacity for further work, or may lay the foundation for other diseases of equal or greater hazard.

They arise from a great variety of poisons, irritating substances, and exposure to unusual physical conditions. They are, for the most part, the outcome of conditions of modern life whereby new combinations of substances are constantly being employed in the arts and manufactures. Also, special uses of nerves and muscles are called for in the operation or control of machinery, and special strains result from lack of variety in work, concentration, and the haste involved in competition or "speeding up." In other cases, diseases arise from the general environment of the workman or from the abuse of foods and alcoholic and other beverages in connection with his special employment.

In addition to the diseases derived primarily from hazardous occupations are others of importance, notably tuberculosis and pneu-

monia, which readily assail those whose constitutions have been undermined by exposure to deleterious substances and environment.

Broadly speaking, then, the occupational diseases may be due to:

(1) Poisonous or irritant foreign substances which enter the body;

(2) Conditions associated with methods of work;

(3) General unhygienic conditions surrounding the workman.

In a general survey of the subject of industrial diseases there are three factors to be considered, namely: (1) the manufactory, (2) the worker, and (3) the worker's home.

(1) The *manufactory* includes the problems not only of the special hazardous substances employed, but the conditions of cleanliness, ventilation, temperature, light, hours of labor, monotony of work, etc.

(2) The *worker* presents the problems of individual physique, age, sex, previous health and resistance or individual immunity. Besides these are the habits of the workman, especially as to the abuse of alcoholic beverages, his personal cleanliness, intelligence and willingness to adopt prescribed precautions.

In determining the effect of metal poisons especially it is necessary to discount the possible influence of alcoholism and syphilis as factors in producing arteriosclerosis and chronic nephritis.

(3) The *worker's home* may be so poor, ill-kept and ill-ventilated, and his food so insufficient that certain diseases may arise from such deleterious influences rather than from the conditions of actual employment.

SYNONYMS

The occupational diseases have been variously called "industrial diseases," "diseases of modern life," "diseases of dangerous trades," "maladies of professions and occupations," and "diseases of environment."

HISTORY

Occupational Diseases in Foreign Countries.—The study of occupational diseases is no new subject, and two centuries ago Bernadini

Ramazzini published a treatise in Padua, Italy, on tradesmen's diseases entitled "De Morbis Artificum Diatriba, 1713."

In the early part of the nineteenth century the gradual substitution of steam for water power in manufacture made it possible to multiply machinery and subdivide labor so that women and children could be employed in many industries not previously open to them, and to assemble workmen upon a scale unattempted before. With this industrial revolution began many of the occupational hazards which have been constantly increasing with the discovery of new industrial processes.

Since that early time those foreign countries in which the subject has received most attention, and in which the greatest educational and legislative advance has been made, are Germany, England, France and Italy. In Holland, Denmark, Sweden, Switzerland and Austria, also, considerable attention has been given to many branches of the subject. In Germany state inspection and control have been very far advanced, and many valuable scientific studies of trade disease hazards have been made. Hygienic institutes and museums abound, where the industrial diseases receive due share of recognition. In Frankfort-on-the-Main a new Institute for Industrial Hygiene was inaugurated in 1910, and there are others in Vienna, Budapest, Berlin, Munich and elsewhere.

In England, owing largely to the activities of Sir Thomas Oliver, M.D., much has been accomplished in Parliamentary investigation, control and compulsory notification by physicians of many industrial diseases, notably those arising from lead and phosphorus, pottery making, textile works, caisson boring, and a variety of the more hazardous dust-yielding occupations.

In 1906, the British Parliament first classed certain of the occupational diseases with industrial accidents for compensation under the Workmen's Compensation Act; and the list of diseases now includes twenty-four, having been increased from a list of six. In addition to the above-mentioned diseases it now includes the following: poisoning by nitro-derivatives of benzin (dinitro-benzol, anilin, and others), carbon disulphid, nitrous fumes, nickel carbonyl, arsenic, lead, and African boxwood; chrome ulceration, eczematous

ulceration of the skin produced by dust, or caustic or corrosive liquids; ulcerations or epitheliomatous cancer of the mucous membranes of the nose and mouth produced by dust, ulceration of the skin, or of the corneal surface of the eye, due to pitch, tar or tar compounds; scrotal epithelioma; nystagmus (a miner's malady); miner's beat hand; miner's beat knee; acute bursitis over the elbow (miner's beat elbow); inflammation of the synovial lining of the wrist joint and tendon sheaths; glanders; compressed air illness.

Under the Compulsory Notification Act compensation damages were awarded in 1908 for the following numbers and varieties of cases:

DISEASE	CASES
Lead poisoning	421
Anthrax (wool carding)	23
Chrome ulceration	20
Eczema	19
Arsenic poisoning	15
Compressed-air illness	10
Nitro and amido-derivatives of benzin poisoning	10
Ankylostomiasis	6
Epithelioma	6
Mercury poisoning	3
Phosphorus poisoning	1

Since that time in one year damages were awarded in over 2,000 cases of occupational diseases arising from ten of the hazardous substances enumerated by Parliamentary act.

Germany also has made marked progress in employers' liability acts which, in many instances, cover pecuniary responsibility for diseases, as well as accidents, acquired in dangerous trades.

In France, in addition to the prohibition of the use of poisonous phosphorus, a notable achievement has been the partial control of lead poisoning by substitution of zinc oxid in the making of much of the white paint that is used. Industrial Museums of Safety containing illustrations, models, charts, diagrams and materials of

various sorts, illustrative both of occupational accidents and diseases and their mode of production, have been established in fourteen of the larger European cities (*See* Figs. 1 and 2), nearly all of which are supported by the state. In 1906 was held the first International

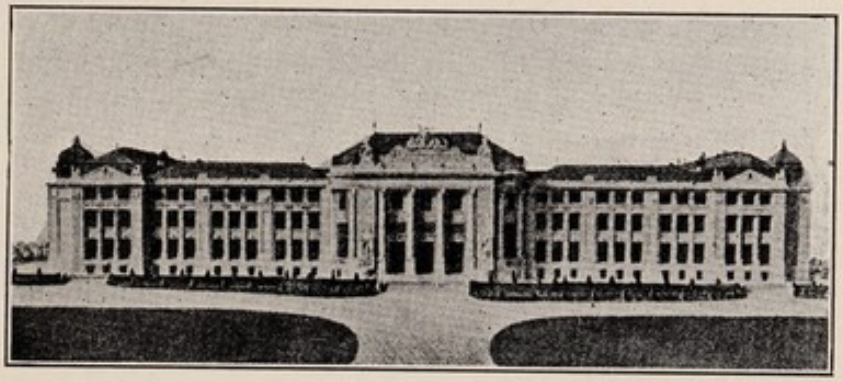


FIG. 1.—BERLIN MUSEUM OF SAFETY. Founded in 1904. Maintained by the State.

Congress on Industrial Diseases. To Italy, however, belongs the credit of establishing the first and thus far the only hospital for the exclusive study and treatment of the industrial diseases. This institution is so important as to merit detailed description, which is given on page 8.

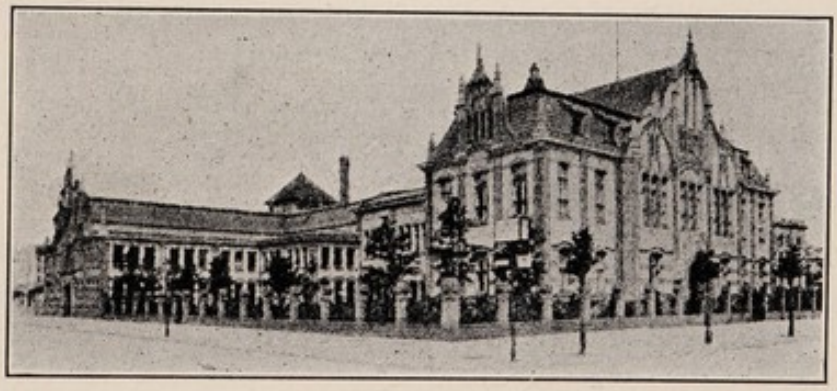


FIG. 2.—VIENNA MUSEUM OF SAFETY. Founded in 1909. Maintained by the State.

Occupational Diseases in the United States.—In this country it is only within a very short time that any collective or authoritative study has been made of the occupational diseases or has any comprehensive and restrictive legislation been suggested to mitigate their

manifold evils such as were shown by the result of the recent Diamond Match Congressional investigation, which excited such widespread interest. The Census Bureau has lately issued a partial classification of one hundred and one diseases of hazardous occupations under which death returns or other statistics should be grouped. The States of Illinois and New York have established special commissions to investigate the problems of the occupational diseases in greater detail.

In 1907, the Massachusetts State Board of Health exhibited in Boston a series of ninety photographs illustrative of occupational disease hazards, which were again presented at the Sixth International Congress on Tuberculosis in 1908.

The United States Bureau of Labor, in *Bulletin No. 86,* 1910, published a translation of a list of industrial poisons prepared for the International Association for Labor Legislation by Dr. Thomas Sommerfeld, Sir Thomas Oliver, M.D., and Dr. Felix Putzeys. This list, lately revised in Germany, has been translated and published as *Bulletin No. 100,* May, 1912, by the United States Bureau of Labor. It comprises brief notes on forty-nine poisons only.

June, 1910, was signalized by the meeting in Chicago of the first National Conference on Industrial Diseases, and in a memorial sent to President Taft by this Conference it was stated that there occur annually in the United States 13,400,000 cases of sickness among artisans and craftsmen, many of which are attributable to occupation hazards, involving a total annual economic loss of nearly three-fourths of a billion dollars. A second meeting of this Conference under the auspices of the American Association for Labor Legislation was held at Atlantic City in June, 1912, and at a joint meeting with the Section on Hygiene and Public Health of the American Medical Association valuable summaries were presented of different phases of the occupational diseases. A noteworthy feature of this meeting was the presentation, in coöperation with the New York State Factory Commission, of a pictorial and diagrammatic exhibit of many of the hazardous trades. It is intended to organize this exhibit as a "traveling exhibit," after the manner of those so successfully employed in the anti-tuberculosis campaign.

In 1907 the Massachusetts State Board of Health presented a similar pictorial exhibit in Boston, illustrating hazardous conditions in textile and other industries. The States of Massachusetts, Ohio, New York, New Jersey, Wisconsin, Illinois and Minnesota are collecting photographs and charts upon a large scale illustrating industrial disease hazards.

In New York City is a small but instructive Museum of Safety, where models and illustrations are gathered of appliances for prevention of accidents to workmen, and within the year this museum has begun a collection to illustrate the causes of occupational diseases as well, such, for example, as samples of the dust inhaled by the grinders of meerschaum pipes, makers of files, etc. For this purpose it has imported a duplicate of the Sommerfeld collection of noxious trade dusts, etc.

Among the States which have lately become active in gathering data upon the occupational diseases and which, through their labor bureaus, factory commissions and boards of health, have issued bulletins upon special occupational conditions investigated, are Illinois, Massachusetts (since 1904), Minnesota, New Jersey, New York, Wisconsin and Connecticut.

A number of independent organizations have established committees for the study of the occupational diseases. Such, for example, are the New York Academy of Economic and Social Science and the New York branch of the American Chemical Society.

In November, 1911, I organized in New York City an informal committee with the object of studying the occupational disease situation, both local and general, and especially for coöperating with the State Labor Bureau in furtherance of its investigations. This committee was composed of experts in industrial chemistry, medicine, mortality statistics, and employers' liability, labor legislation, social service, the science of economics, and philanthropic service; and this method of organization may be recommended to those desiring to pursue the study of the occupational diseases in other large centers of industry. The committee was subsequently absorbed by the New York Association for Labor Legislation as its official committee on the occupational diseases. This committee has already gathered

much valuable material with a view to formulating prophylactic legislation and extending a campaign of education regarding industrial disease hazards.

In September, 1912, the International Congress of Applied Chemistry, meeting in Washington, devoted a part of its meetings to a discussion of the metal poisons in the trades, and at the same time and place the International Congress on Hygiene and Demography discussed various phases of the occupational diseases as they occur in different States.

Among the intensive investigations of industrial diseases already made in this country which are especially noteworthy are the admirable study made in Illinois by Dr. Alice Hamilton on the subject of lead poisoning; that by Mrs. Lindon W. Bates on mercury poisoning in the felt hat industry in New York and New Jersey; that by Dr. Emery R. Hayhurst on brass poisoning; that by Dr. W. C. Hanson on dusty trades in Massachusetts; those by Dr. Graham Rogers on the industry of potteries, bakeries, calico printing, and the cloak-making trade; and that upon phosphorus poisoning in the match industry by Dr. John B. Andrews, which later led to such brilliant results in prohibitive legislation by Congress. The latter investigator has also contributed a valuable study of lead poisoning in New York State.

All these recent activities are proof that the subject of the occupational diseases is at last receiving in this country the thorough scientific, statistical and critical study which its great importance commands.

THE MILAN HOSPITAL AND CLINIC FOR OCCUPATIONAL DISEASES

The Milan hospital and dispensary for the study of occupational diseases, operated in connection with a large institute of research having a staff of twelve investigators, is the first complete institution of the kind anywhere established. It was inaugurated April 10, 1910, and in the first eighteen months of service treated 415 hospital and 2,400 dispensary cases, among which were 136 of chronic lead poisoning, 71 occurring in painters.

The institution, under the direction of Prof. L. Devoto, is admirably appointed, and every detail as to treatment, diet, physical examinations and clinical laboratory tests is well carried out. The building contains a library of all publications relating to occupational diseases; a museum of chemical products, dusts, and all hazardous materials used in industries; chemical and physical lab-

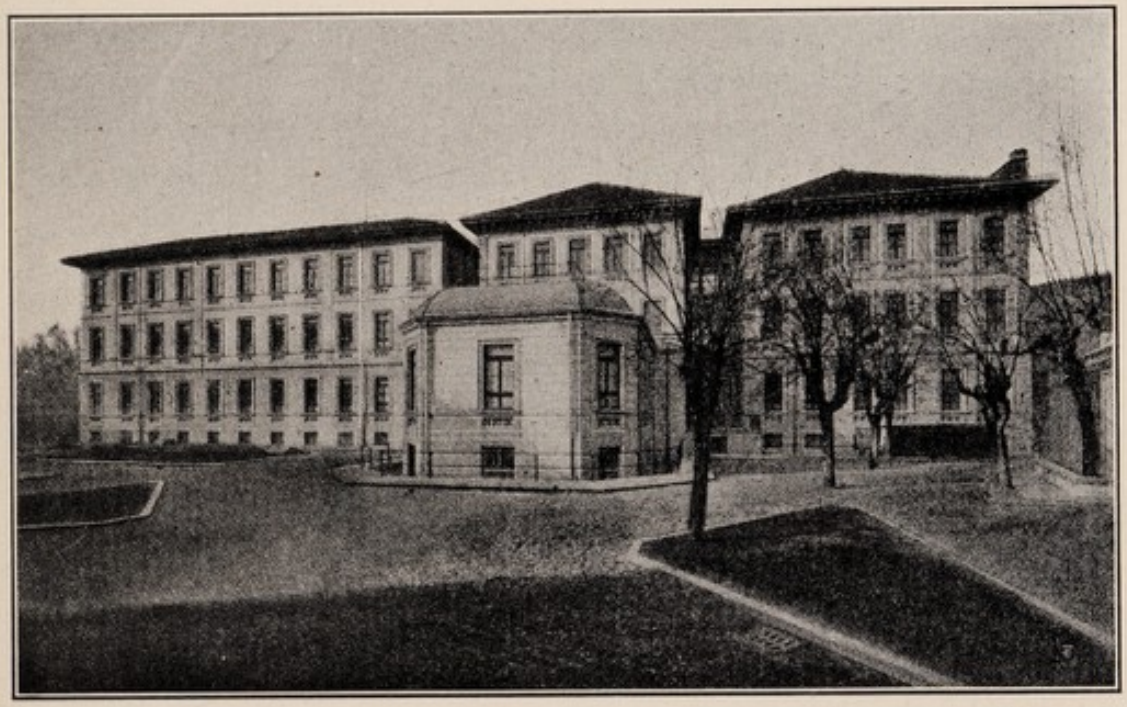


FIG. 3.—MILAN HOSPITAL AND CLINIC FOR OCCUPATIONAL DISEASES. Opened March, 1910. Amphitheater and Laboratories in the Center.

oratories; and six clinical wards with a capacity of twelve beds each, with additional isolation rooms, making the total hospital capacity eighty beds. There are a large dispensary and a pathological department with laboratories and a lecture hall. There are rooms for animal experimentation, X-ray photography, physiological chemistry, clinical microscopy, calorimetry, etc. Apparatus is installed for the study of electro-cardiograms, hydraulic pressure, analysis of the explosive and other toxic gases, air analysis, microspectroscopy, microphotography, ergography, etc.

Among the functions undertaken by this institution are the visiting in their homes of artisans affected by industrial diseases who may be unable to attend the clinic; the instruction of the fami-

lies and friends of industrial workers in hygiene and the recognition and avoidance of special occupational hazards; the publication and distribution of leaflets of instructions; the holding of popular conferences to discuss occupational hazards; the instruction of students in special courses of occupational hygiene, diagnosis, laboratory analysis, occupational diseases of the circulatory, respiratory, osseous, nervous and cutaneous systems, and of the eyes; radiography and occupational diseases transmissible from animals to man, the relationship of tuberculosis, syphilis and alcoholism to occupational diseases, and the duties of the physician in relation to such diseases. The construction of a similar hospital and institute for occupational diseases, with a capacity of 300 beds, is being planned in Budapest, and one is very much needed in this country.

MORBIDITY STATISTICS

Many of the occupational disease data reported at the present time are based upon antiquated observations, to which nothing new has been added for many years, and a fine opportunity is open for the more scientific study of these diseases in the light of modern diagnostic methods. This is especially true in regard to the results of inhalation of respiratory irritants in relation to the ultimate acquisition of tuberculosis; for it is primarily through the point of view of the modern study of tuberculosis rather than that of occupation that many facts have been brought to light.

The first National Conference on Industrial Diseases held in Chicago in 1910, adapting to the United States the sickness insurance of the German industrial population, sent a memorial to the President calling for controlling legislation and estimating that there were in this country in 1910,

13,400,000 cases of sickness among the
33,500,000 men, women and children engaged in gainful occupations in the United States, representing
284,750,000 days of sickness, and
$366,107,145 loss in wages.

Of course not all of these cases of sickness were due in any manner to occupation, for they include such diseases as typhoid fever and influenza and many others which are in no sense occupational; for such figures mean that more than one-third of all men, women and children employed are ill on an average of almost a month out of each year. To anyone familiar with modern factory conditions it is apparent that such data are misleading and based on wrong premises; for there are very many factories in which the tally books show an almost clean bill of health for a year. If this is true in many factories, it would raise the average of illness in others so high as to put them out of commission if these wholesale statistics were accurate. They may serve in a sensational manner to influence legislation, but are of little use from a scientific point of view. It is well known that there are, unfortunately, no accurate morbidity or mortality statistics recorded for the entire United States, and to compute over thirteen million cases of illness from the few accurate data here and there obtainable is purely guesswork and is scarcely in the interest of scientific knowledge. Most of the statistical estimates heretofore made of workingmen's illness are mixed with industrial accidents on the one hand and with ordinary non-occupational diseases on the other. As a matter of fact, it is often extremely difficult to determine proper limitations. For example, an epidemic of influenza may attack the employees in a certain factory. Some will acquire the disease who were in previous good health, others may acquire it because anemia, overwork and like conditions resulting directly from their occupation combine to lessen their resisting power. Others may acquire it because their alcoholic habits, poor food or unhygienic home conditions have similarly reduced their resisting power. Others, again, may remain immune despite adverse conditions. The net result, however, is so many cases of illness among so many workmen, but it is manifestly unfair to take this net figure of cases of illness as an indication that the occupation is especially hazardous. Occupational disease statistics should be confined to those diseases which are distinctly and solely due to occupation, and should not include the factors of home environment, undesirable habits,

etc., except in separate discussion. In many cases, as, for example, with lead poisoning, this can be done readily, but as yet such data in other industries do not exist on a scale which warrants gross estimates of all the occupational diseases in this country.

In this book an attempt has been made to recite all the varied symptoms which may possibly occur in each of the more important industries. But I would warn against the exaggerated conclusion that these symptoms are universal, or in many cases even frequent. In fact, in many cases they are so infrequent as sometimes to fail of proper interpretation as to their etiology. Far from implying that the health of the industrial workers of the country as a whole is deteriorating, it is distinctly improving in very many industries in which the risks to health and its safeguards are constantly being better understood. Nevertheless, there is still a vast amount of preventable and, therefore, unnecessary illness, and it is only through better understanding of all the possible hazards that further improvement is to be attained. Some industrial diseases, like some industrial accidents, are bound to occur among the millions of industrial laborers of the country; for one cannot handle poisons, as one cannot handle explosives, without incurring risks. But watchfulness, training and instruction as to the possible dangers involved are as important in the one case as the other, and hence the reason for grouping them collectively for reference and study, for upon such foundation only can permanent progress in prevention be made.

Morbidity statistics are constantly varying with the varying conditions of industries. For instance, the morbidity from lead poisoning in typesetting and pottery glazing has, in the past decade, steadily diminished, owing to improved industrial conditions; but in the storage battery and automobile painting industry a serious new field for it has arisen.

The relative proportion of the occurrence of the industrial diseases as compared with each other is difficult to determine in other than the most general terms. In the yearly report for 1910 of the Royal Industrial Commission of Sachsen-Meiningen the relative number of cases was found to vary as four to one, those furnished by textile industries ranking as four, the stone and pottery indus-

tries as two, and as one each the chemical industry, leather and similar stuffs, and wood industries. This research, however, referred only to ninety-one establishments, obviously not an exhaustive basis for comparison.

Some idea may be obtained of the relative predominance of different types of disease among industrial operatives from the following table of 1,925 cases collected in the Milan Clinic, in 1910-1911, by L. Carozzi, and published in "Il Lavoro" (1911, vol. iv, nos. 19-21).

DISEASE SYSTEM	NO. OF CASES	PER CENT.
Blood (oligemia, etc.)	243	12.6
Respiratory (general)	361	18.8
Tuberculosis	235	12.3
Circulatory	113	5.8
Digestive	325	16.9
Muscles and joints	51	2.6
Cutaneous	169	8.7
Renal	190	9.8
Nervous	138	7.3
Plumbism	100	5.2
	1,925	

MORTALITY STATISTICS

Some highly dangerous trades may produce immediate fatal effects, but do not give rise to chronic ailments; such, for example, is the effect of using in a confined space shellac dissolved in wood alcohol. Other trades may possess both the danger of immediate death and also give rise to chronic poisoning, depending on the quantity of poison absorbed; such, for example, are trades in which illuminating gas constitutes the hazard, as in working in sewers into which it has escaped. Other trades, again, may produce serious incapacitating lesions which become progressive after the workman has left the trade. In such cases the mortality may appear lower than is the actual fact, because in a statistical enumeration only the men still employed in the trade are taken account of.

Hence, some of the most dangerous trades may have an apparently lower mortality than those in which the danger acts more insidiously, or as compared with the mortality of those who do not work in trades. For example, workers in lead, arsenic or mercury may quit their trade and die some time afterward as a result of the industry, their places being filled by healthy workmen who lower the rates of both morbidity and mortality in those trades.

For these reasons great care must be exercised in accumulating statistics to determine the duration of the hazardous employment and the subsequent career of the workmen who have left it. Frederick L. Hoffman, statistician of the Prudential Life Insurance Company, stated at the First National Conference on Industrial Diseases, June 10, 1910:

"The most serious impairment of all statistical investigations of this kind results from the effect of occupation selection, or the elimination of those who have been impaired as the result of occupational activity in unhealthful trades and who subsequently find employment elsewhere. The tendency of modern times is rather to increase this impairment of statistical investigation into morbidity and mortality because increasing intelligence on the part of industrial workers suggests, at an earlier date than formerly, a change of employment for the purpose of physical betterment."

The National Bureau of Labor gives the mortality rate among workmen in the dusty trades as follows:

FATAL CASES PER 100 WORKERS		
Class of Employment	*Tuberculosis*	*Pneumonia*
Workers in metallic dust....	28	17.4
" " mineral dust.....	25.2	5.9
" " mixed dust.....	22.6	6
" " animal dust.....	20.8	7.7
" " vegetable dust...	13.3	9.4
" " non-dusty trades.	11.1	4.6

In a recent longevity table issued from the Registrar-General's office of England and Wales, comprising males between 25 and 65

years of age, and based upon the unit of 1,000, the ratio for the following classes of occupation was:

Filemakers	1,810
Plumbers, painters and glaziers	1,120
Printers	1,096
Fishermen	845
Ministers	533

Workmen in general were shown to live less than half as long as the leisure class.

In the United States census returns of 1909 (page 30), covering the 18 States comprised in the "Special Registration Area," there were reported 86 deaths from chronic lead poisoning, and, under the vague heading, "other occupational and chronic poisonings," without further specification, were 140 deaths of males and 127 of females, making a grand total for the year of 353 cases of deaths from chronic occupational poisoning. Acute poisonings are not specified in detail, but deaths from "poisonous gases and other accidental poisonings" (exclusive of suicide cases, which are separately classed) are given as a total of 3,616. How many of these were of occupational origin is guesswork. That this list is an understatement there can be no doubt in the present rudimentary condition of statistical data in this country; for many deaths are classed under "pneumonia" and other general diseases in which the primary or underlying cause of death was undoubtedly some occupational poisoning. I know of at least three deaths from acute lead poisoning in smelting works which were returned by physicians under other diseases, and a case of fatal methyl alcohol poisoning from using shellac dissolved in wood alcohol which was returned as "epilepsy." After all, the total direct deaths from occupational poisonings are always numerically insignificant in comparison with the morbidity figures from the same cause, and with the number of patients who would not have died from pneumonia, nephritis, tuberculosis and other general diseases but for the foundation of serious lesions of occupational origin.

Further illustrations of the difficulty of drawing really useful conclusions from mortality statistics are furnished from the Special Registration Area returns in the United States Census of 1908, *Bulletin 104*. Here it is shown that out of every 100 deaths of occupied males, 25 to 34 years old, 30.9, or nearly one-third, were caused by pulmonary tuberculosis. With this figure as a standard for comparison, tuberculosis deaths in selected industries were as follows:

Compositors and printers	49.2
Boot and shoemakers	44.1
Bookkeepers	41.9
Tailors	41.2
Barbers	40.1
Farmers	25.6
Miners and quarrymen	5.3

From such a table one might infer that miners and quarrymen, as compared with compositors and printers, lead a charmed life as far as tuberculosis is concerned, but later in life the death rate for compositors and printers lessens by comparison with that of the other trades. Moreover, as stated in the Census, "It does not follow that the death rate from tuberculosis of the lungs is in reality lower among miners and quarrymen, for example, than among printers. The very high ratio of deaths from accidents (62.1 per cent.) of miners and quarrymen would greatly reduce the *relative* importance, but not necessarily the absolute death rate, of tuberculosis for this occupation, as compared with the printers, who have only a low ratio (7.3 per cent.) from external causes."

In other words, if a miner 25 or 30 years of age is killed by an explosion he is not going to die a lingering death from tuberculosis. In the absence of an autopsy, it cannot be affirmed that he had no tuberculosis. Again, if he be not killed, but maimed by accident, he may seek other employment, and still be tuberculous. The compositor leads a life of less vigorous exercise, largely sedentary, and has certain temptations as to drink, etc., which do not beset the miner in like degree.

This illustration is given merely in protest against the lax quotation of mortality statistics which perhaps may be reversed in the next decade of life, or completely offset by other conditions of employment than appear from a bald statement of figures.

Physicians in this country have not yet acquired the habit of properly reporting deaths from industrial poisoning, and either omit reference to the particular trade entirely, giving only some immediate cause of death, such as pneumonia, or state the trade in such general terms that no conclusions of value are to be drawn. For example, to give the occupation as "glass worker" conveys little or no information, for the man might be a glazier with lead poisoning, a cutglass grinder with pneumonoconiosis from emery dust, or a glass blower with emphysema.

General mortality statistics compiled for the state of Massachusetts for a period of 42 years which comprise all workers of or over 25 years of age illustrate to some extent the relative harmfulness of trades, but conditions of industry have changed so much in this period that such figures can have only very limited value. These figures are quoted as follows:

MORTALITY BY CLASSIFICATIONS OF OCCUPATIONS

Occupations	*No. of Persons*	*Average Age at Death*
Females in trades	7,387	39.10
Trainmen, teamsters, soldiers, etc	10,776	39.36
Indoor sedentary workers	28,459	45.43
Indoor active workers	28,208	48.80
Sailors, etc., on the ocean	12,394	48.57
No special trades	43,716	49.06
Business men (indoors)	27,098	49.60
Outdoor and active workers	17,371	51.34
Professional men	8,306	52.13
Cultivators of the earth	46,182	66.29
	229,897	51.82

Hoffman states: "Estimating the death rate among American wage-earners at only 10 per 1,000, and applying this rate to the 33,500,000 wage-earners estimated for the year 1910, there occur annually 330,500 deaths among them, and of this number certainly one-fourth are due to diseases or accidents more or less preventable."

CLASSIFICATION

In order to establish a satisfactory classification of the occupational diseases and the industrial hazards which give origin to them, it is necessary to agree upon a standard nomenclature which may prove not only of scientific value, but constitute a working basis for such remedial legislation as may prove desirable. The authority for such nomenclature and classification is properly vested in the United States Bureau of the Census, which, being a national institution, is better fitted for this work than the local municipal or state boards of health or labor bureaus. Agreement as to uniformity among the latter would obviously involve much time and discussion, with probably less satisfactory ultimate results.

The Bureau of the Census already furnishes a generally accepted classification of the causes of death from ordinary diseases and includes a number of causes of death from occupational diseases, about one hundred of which are enumerated in the *Mortality Statistics Bulletin No. 108,* 1909, page 33. But this list does not include diseases which are non-fatal nor all of those which frequently are fatal. It is understood, however, that the Bureau of the Census is at present coöperating with the Committee of the American Medical Association on the Nomenclature and Classification of Diseases, and it is to be hoped that they will find time to include in this work the formulation of a complete classification of the disease hazards and deleterious substances which are causatively related to the industrial diseases—irrespective of mortality statistics.

In the absence which exists at this time of a complete and authoritative classification of the occupational diseases as they obtain in this country, the classification herewith submitted is intended as a convenient working basis merely, and must be subject to much future revision as knowledge of the subject increases.

There is an enormous number of cases of chronic invalidism which produce greater or less incapacity for work and lay the foundation for many fatal diseases not primarily caused by occupation, but which are engrafted upon constitutions enfeebled by harmful trades. Thus, the polisher of glazed pottery may not die of the immediate effects of plumbism or of inhalation of flint or other sharp dust particles, but his arteries, kidneys or lungs may become so damaged that he almost inevitably dies if exposed to the germs of pneumonia or tuberculosis. Such a case should be classified as follows:

(1) Major occupation: potter.
(2) Detailed hazard: lead poisoning, or dust inhalation (specifying the variety of dust), as the case may be.
(3) Immediate cause of death: pneumonia or tuberculosis.
(4) Contributing cause of death: arteriosclerosis, nephritis, or pneumonoconiosis.
(5) Degree of alcoholism or of chronic non-toxic maladies present.
(6) Age and sex.
(7) Duration of employment.

Whereas the occupational diseases do not differ in their ultimate pathological changes from the ordinary medical diseases as grouped in medical textbooks (with very few exceptions), they might be grouped in the conventional manner as diseases of the

(1) Blood
(2) Circulatory system
(3) Respiratory system
(4) Digestive system
(5) Nervous system
(6) Muscular system
(7) Bones
(8) Cutaneous system
(9) Urinary system
(10) Special sense organs

Such grouping, however, does not serve the essential purposes of emphasizing their peculiar etiology, and merely differentiates occupational diseases from the occupational surgical accidents and injuries. It is, therefore, desirable to adopt a brief general classification comprising (A) the main groups of harmful substances, (B) the harmful conditions of environment, and (C) the special injuries to the tissues and organs of the body arising from such substances, environment, or other conditions of labor. This brief classification is submitted as follows:

General Classification of Occupational Diseases and Harmful Substances

A. *Harmful Substances:*
   1. Metallic poisons
   2. Toxic gases, vapors, and fumes
   3. Toxic fluids (acids, alkalies, dyes, petroleum products, etc.)
   4. Irritant dusts and fibers
      (a) Insoluble inorganic dusts
      (b) Soluble inorganic dusts
      (c) Organic dusts and fibers
   5. Organic germs (anthrax, glanders, etc.)
   6. Miscellaneous irritants

B. *Harmful Conditions of Environment:*
   1. Air compression and rarefaction
   2. Excessive humidity
   3. Extreme heat and cold
   4. Excessive light (electric, X-ray, etc.)

C. *Occupational Injuries:*
   (Medical)
   1. Injuries to the blood
   2. Injuries to nerves, muscles and bones
      (Strain, fatigue, cramp, faulty positions, "occupational neuroses," blows, vibrations, pressure, etc.)

3. Injuries to the eyes
4. Injuries to the ears
5. Injuries to the mouth, nose and throat
6. Injuries to the skin

Under these major headings may be grouped practically all of the irritant substances, yet certain difficulties arise even in this elementary arrangement. For example, lead, which of course would be classed as a simple metal poison, is also, when heated, to be ranked among the toxic fumes, and again, in the form of filings, as a soluble inorganic dust. As this applies to many of the other metals, to repeat them all under each subheading would be cumbersome. Phosphorus, for instance, is a metalloid; yet it is as a toxic fume that it works such havoc, and it had better be classed with the latter.

Furthermore, the names of many substances may convey no intimation of their special hazards. For example, whether ferrosilicon be classed among the metals as containing iron and traces of arsenic, or in solution as a liquid, since by itself it is non-toxic, neither of these groups would suggest its real hazard, which consists in the accidental access of water, producing the combination arseniuretted hydrogen gas that has cost many lives, especially on ships in which the ferrosilicon was being transported.

For such reasons it would seem best to class each substance primarily in the major group, which its most common form and use suggest, and, when its common name conveys no idea of the hazard, to indicate the latter in parentheses. Thus ferrosilicon might be grouped under toxic metals, and a parenthesis should follow, reading "arseniuretted hydrogen gas, on hydration."

The attempt to name pulmonary fibrosis in accordance with its etiology is entirely unnecessary, as the lesion is the same, no matter what may have been the original irritant. Thus coal miner's phthisis has been called "anthracosis," that of iron or steel-workers "siderosis," of flint-workers, "chalicosis," of clay-workers, "aluminosis," and even that of tobacco-workers has been given the ridiculous

name, "tabaccosis." The nomenclature of the occupational diseases is complex enough without such unscientific additions.

A harmful substance may produce a single disease, as steel dust may cause knife-grinder's phthisis, or pneumonoconiosis. More often, especially if the substance be soluble, it may produce a variety of diseases or lesions. For example, chronic lead poisoning may cause arteriosclerosis, cardiac hypertrophy (compensatory), chronic nephritis, chronic anemia, encephalitis, or neuritis. Mercury may cause not only bone necrosis, but anemia, and a series of grave nervous and mental disorders. Similarly, a harmful condition of environment may beget a single lesion, as when electric light injures the eye, or it may cause a variety of diseases, as in the case of extreme heat and humidity. Obviously, therefore, a classification based upon the disease alone is less complete than one based upon the etiological factors as above given.

Another method of approaching the subject is by grouping the hazardous trades. While this serves a certain purpose, it is open to many objections. In the first place the number of hazardous trades is exceedingly numerous and constantly increasing, whereas the toxic substances and conditions of harmful environment are fairly definite and understood. There are, for example, fully 150 distinct trades in which lead in some form constitutes the essential hazard.

Secondly, the particular trade may give rise to varied diseases, either because of the combination of substances used, as in brass poisoning (brass being an alloy of copper and zinc with traces of lead), or because the work in the trade itself is so subdivided. For instance, a workman classed merely as a "potter" may be employed in glazing or polishing and acquire lead poisoning; or, as in the Limoges works in France, he may be a grinder subject to inhalation of silica dust, and may acquire fibroid phthisis and subsequently tuberculosis; or as a molder he may be exposed to constant humidity and may suffer from rheumatism or chronic bronchitis. Obviously, to class him solely as a "potter" supplies information so incomplete as to be almost useless. Other terms are still more ambiguous. For example, a "hatter" may be engaged in the non-hazardous occupation

of selling hats, may be a maker of straw hats, associated either with no hazard or with the minor one of using some bleaching substance or inhaling straw dust, or may be a man who is employed in making felt hats. This latter industry is so subdivided that the man may rank as a blocker, blower, pouncer, flanger, curler, shearer, stiffener, singer, trimmer, coner, dyer, dryer, feeder, hardener, mixer, welter, or finisher. In about half of these labors he would be subject to no hazard whatever, as, for instance, if he be a curler or finisher; but if he be a fur-cutter, "maker" or sizer he is very susceptible to bronchial irritation and liable to add to the tuberculosis mortality. If, on the other hand, he be a pouncer, he is almost certain to acquire chronic mercurial poisoning and sooner or later to become wholly incapacitated for work, and he may possibly die as a result of his labor. In the wool industry a workman may be a sorter, picker, dyer, scourer, carder, slubber, crabber, napper, loom fixer, comber, fuller, sizer, warp dresser, etc. To specify all the subdivisions of labor in a complex industry is to accumulate a catalog of many thousands of technical terms and easily to become lost in a maze of phraseology. It is precisely in this understanding of technical work that physicians as a body need education, for upon them must devolve the collection of disease data, if such data are to be confirmed by accurate diagnoses. It is not customary, as yet, to give systematic instruction in medical colleges upon occupational diseases. Most of the standard textbooks on medicine refer to scarcely a half dozen of the industrial poisons, such as lead or arsenic, and the literature of this topic adapted for use in this country is scattered mainly in isolated monographs and a few brief journal articles.

Hospital and dispensary statistics are for the most part so lacking in this detailed information as to the exact nature of the workman's employment as to make it exceedingly difficult to collect comprehensive data as to the extent and distribution of occupational hazards; yet, if legislative control or educational preventive measures are to be inaugurated, it is of prime importance that such data be collected upon a truly scientific basis.

Before a standard classification of occupational diseases is

adopted, attention should be given to the educational needs of the situation. A classification which is too elaborate may fail of its chief purpose, which is to interest physicians in this important humanitarian, scientific, and legislative work, i. e., the control and mitigation of the occupational disease hazards. It is desirable, therefore, to furnish physicians and employers with a simple general classification, after the form outlined in this article, and to supplement it with a more elaborate classification to be supplied to special investigators in hospitals and dispensaries, or to those who have access to the study of large groups of cases. It is clearly undesirable that hasty or unfair legislation, based on insufficient data, should be enacted, and it is therefore of the greatest importance that physicians everywhere enter into hearty coöperation with the state authorities in the collection of accurate statistics which shall be of true scientific value.

As an aid to meet the educational requirements of classification in New York State, I have furnished the State Labor Bureau with a brief general classification of occupational hazards and harmful substances, to be printed on the backs of the notification blanks required by law to be sent to each physician. I also furnished a more elaborate classification which is printed in small booklet form and is designed for distribution to hospitals and dispensaries, social service workers, and all physicians who will take interest enough to gather special data. As far as possible this classification is arranged in four parallel columns, headed respectively, "Harmful Substance," "Industry Where Prepared or Used," "Mode of Entrance into Body," "Diseases or Symptoms." This list, considerably amplified, is reproduced in the Appendix.

A similar list comprising fifty-four poisons of hazardous trades has recently been published in Germany by the International Association for Labor Legislation and translated by Dr. William H. Rand for publication in *Bulletin No. 100* of the United States Bureau of Labor (May, 1912).

For my own use and that of my assistants in hospital and dispensary work, I have designed history cards with headings calling for classified data, one set for the metal poisons, another for the dust

and fiber irritants, etc. From such uniformly classified cards it is easy to compile scientific data for any particular group of diseases. These cards read as follows:

Metal poisoning diseases: Diagnosis Case No. Hist. No.
Name: Age: M. F. S. M. W.
Occupation:
Occupation in detail:
Drinker (hard, moderate, abstainer). Syphilis (years)
Years employed Hours of work No. of co-workers Are they also affected?
Prophylactic instructions?
Washing facilities (good, poor). Lunch eaten where?
Ventilation of room? Masks, respirators (for fumes)
Room cleaned, how often?
Details of metal: dust, filings, fumes, alloys (composition) Solder?
Port of entry: mouth, nose, finger-nails.
Protective agents: gum or tobacco chewing? Milk? Wife's miscarriages?
Physical examination: gums teeth beard?
arteriosclerosis blood pressure heart, size
murmurs lungs
digestion constipation
nervous system: neuritis cramps palsy
hands: eczema fissures ulcers
Blood examination: Hb.% red cells white cells
basophiles
Urine examination: alb. casts sp. gr. lead?
Eyes: trauma injury by heat, light
Acute symptoms at beginning of work vertigo
Gastro-intestinal nervousness
Synopsis of present symptoms: chief complaint

In recording the history of a case upon this card inquiry is made as to the existence of chronic alcoholism and syphilis, because these conditions act strongly as synergists in predisposing to metal poisoning of all kinds. The chewing gum or tobacco affords a ready means of introducing the poison into the mouth with soiled fingers. Inquiry is made regarding the workman's wife's miscarriages, because such accidents have occurred as a result of chronic plumbism in the male.

Respiratory diseases: dust, fumes: Diagnosis
Case No. Hist. No.
Name Age M. F. S. M. W.
Occupation:
Occupation in detail:
Drinker (hard, moderate, abstainer). Syphilis (years)
Years employed Hours of work No. of co-workers
Are they also affected?
Prophylactic instructions?
Ventilation: Fans, hoods, windows (open, shut). Masks?
Respirators?
Room cleaned, how often?
Exposure to cold, heat or wet?
Physical examination of pharynx
lungs heart
General condition: Weight anemia, Hb.% r. b. c. w. b. c.
digestion
cough sputum exam.

Acute symptoms at beginning of work; coryza, headache:
Note especially: recurrent bronchitis, asthma, dyspnea, rhinitis, laryngitis, vertigo, pneumonoconiosis, tuberculosis.
Onset of tuberculosis in relation to duration of employment.
Present symptoms: chief complaint

Many of the occupational diseases have become so familiar to workmen that they have given special names to them, such as, "painters' colic," "painters' palsy" or "drop-wrist," "brass chills," "potters' rot" (phthisis), "miners' asthma," miner's "beat hand" and "keens," "phossy jaw" (of match-makers), "hatters' shakes" (mercurial poisoning), the caissonmen's "bends" and "chokes," "knife-grinders' phthisis," "shoddy fever" (among garment workers), "benzene drunk." Other diseases, very insidious but very numerous, pass unrecognized by the workman, at least in so far as he correctly attributes them to their origin.

A striking illustration of the lack of attention usually given to the increasingly large and important group of occupational diseases is the fact that the only occupational poisons (apart from anthrax and glanders) which are mentioned in the International List of the Causes of Death, republished by the United States Bureau of the

Census in 1910, are three, namely: chronic lead, phosphorus and mercury poisoning.

Such important causes of death as chronic poisoning by antimony, arsenic, and numerous gases, vapors and fumes, acids and dusts are placeable only under the single heading of "other chronic occupational poisonings." The only division under which deaths from many acute poisons such as ferrosilicon, methyl alcohol, arseniuretted hydrogen, hydrofluoric acid, and a host of others may be placed is the single general heading, "other acute poisons." Work, however, is in present progress upon a thorough international classification of all the occupational diseases.

In the Milan Clinic the industries are grouped for purposes of study as follows (L. Carozzi, "Il Lavoro," 1911, vol. iv, nos. 19-21):

(1) Chemical
(2) Mineral and metallurgical
(3) Electrical
(4) Woodwork
(5) Stonework, cement, etc.
(6) Construction and transportation
(7) Agricultural
(8) Textile
(9) Garment making
(10) Foodstuffs
(11) Animal and vegetable materials (dyestuffs, fertilizers, gelatin, etc.)
(12) Cartographic
(13) Rubber and tobacco
(14) Miscellaneous (compressed air, divers, firemen, etc.)

THE MOST HAZARDOUS OCCUPATIONS

The question arises with occupational diseases as it often has with occupational injuries or accidents, as to which are the most

hazardous occupations? It may be answered partially, at least, as follows, and as applying to the industries of this country:

(1) *Occupations producing the greatest number of victims of chronic poisoning* are those of the lead industries. Of these, painters —especially those applying enamel paints and sandpapering the successive layers—form the numerical majority of victims, but those working in storage-battery making and white and red lead production present the most serious lesions. Next ranks the pottery industry, from the numerical point of view.

Sir Thomas Oliver has said that, "next to white and red lead industries, the trade which gives the largest number of victims of plumbism is that of china and earthenware."

(2) *Occupations producing the most serious chronic lesions,* either deforming or incapacitating, are first of all the poisonous phosphorus match industry (now, however, practically abolished by law), next the felt hat industry, or such part of it as exposes the worker to mercuric nitrate; the lead production industries (smelting, paint making, etc.), storage-battery making, sandblasting and emery-wheel grinding.

(3) *Occupations most likely to produce acutely fatal results* are those of compressed air workers, varnishers using wood alcohol, workers in toxic gases, especially carbon monoxid, sulphuretted and arseniuretted hydrogen, carbon bisulphid, nitrous acid and nitrous compounds, anilins. Beyond these very general statements it is impossible to classify the relative frequency of the different occupational diseases in much detail because of great variations in local conditions and the many complex factors which enter into the problem.

A similar list, issued by the Italian Ministry of the Interior in 1895, divides the most hazardous industries into two classes, according to their virulence. The first group comprises fifty-six industries and the second sixty-two. (This list is published in Dr. Giovanni Allevi's admirable work, "Le malattie dei lavoratori e l'igiene industriale," Milan, 1908.)

Accurate governmental estimates of frequency of illness among workmen classified by occupations have been made earlier and more

thoroughly in Austria than anywhere else. For the five-year period, 1891-1895, 32 occupations of males between 15 and 60 years of age were studied (H. Schneider, "Gefahren der Arbeit in der chemischen Industrie," s. 13). For every 100 such workmen there were 42 cases of illness of all sorts during this period on an average of all 32 industries, but in the chemical industries (making and use of acids, pigments, chemical supplies, etc.) there were 170 cases, or a preponderance of 70 per cent. more cases.

Weyl has shown by statistics covering fifteen years, from 1888 to 1904, that in the chemical industries only twelve employees per 100 remain free from illness throughout the year, whereas in all industries combined sixty can be reckoned as remaining healthy.

Leymann has shown by statistics covering twenty-three years that occupational diseases are thirty-five per cent. more common among chemical industries than among other industrial groups.

In Germany, in 1907, 172,441 persons were employed in the various chemical industries which may present disease hazards, such as the production and use of acids, alkalies, pigments, chemical supplies, explosives, fertilizers, etc., representing an increase in twenty-five years of 140 per cent. (H. Schneider, "Gefahren der Arbeit in der chemischen Industrie," s. 1).

II. GENERAL PATHOLOGY AND ETIOLOGY

GENERAL PATHOLOGY

The industrial poisons may enter the body or irritate the external surface. The ports of entry are through the nose and respiratory system, through the mouth and alimentary canal, and by absorption through the skin. Some poisons enter by one channel alone, but others may enter by all three, according to the nature of the occupation or of the toxic substance. On entering the body the poison may produce localized irritation or inflammation of the mucous membranes or lung tissue, or general systemic symptoms on being absorbed into the blood or lymph channels. The pathological changes produced are various, but chiefly fall under the headings of

inflammation, fatty degeneration, necrosis, and cirrhosis. These lesions may be either acute, subacute or chronic in character. Elimination of the toxic materials takes place, according to their nature, through the lungs, kidneys, and perspiration. An excess of poisonous substances swallowed may be eliminated with the feces. Some poisons, such as certain metals and the inorganic insoluble dusts, may be stored in the tissues or organs of the body for a very long time, or permanently. The most seriously toxic substances, on being absorbed, may produce chemical reactions with the body tissues, and many of them are hemolytic, causing rapid disorganization of the blood, particularly of the red cells.

The local reactions produced by the industrial poisons chiefly affect the conjunctival, buccal, and nasal mucosa and the skin, causing a variety of changes, such as inflammation, necrosis and ulceration with vascular and nerve disorders.

Chronic cutaneous irritation in rare instances may give rise to new growths such as epithelioma.

ACUTE AND CHRONIC POISONING COMPARED

In reviewing the effects of the various industrial poisons they may be divided into acute, subacute and chronic phenomena; but, as far as the individual poison is concerned, its effects very often come under each category, and in chronic cases a prolonged exposure to the poison seems to be of as much or more importance than the size of the daily toxic dose. Some poisons, chiefly those among the toxic gases, vapors and fumes, act exclusively in very acute manner, and practically never chronically. Such, for example, are methyl alcohol vapor, sulphur vapor, etc. Others, either from the nature of the industry or that of the substance itself, act only insidiously or chronically, like silver nitrate. Others may act either acutely or chronically, according to the size of the dose, like carbon monoxid, or according to the physical form of the substance, like metallic lead as a fume which causes acute symptoms, and lead as a salt or other compound which may be very chronic in its effects. As Straub says, "Acute poisoning is a physiological experiment;

chronic poisoning is a disease," or, broadly speaking, one might say that acute poisoning causes disturbance of functions; chronic poisoning causes histological changes or lesions in organs and tissues. For example, acute mercurial poisoning disturbs the gastro-intestinal and renal functions, but chronic mercurial poisoning acts mainly through lesions of the central nervous system. Acute arsenical poisoning is not unlike cholera in its symptoms, but chronic arsenical poisoning acts as insidiously as tuberculosis.

As it is more easy to recognize immediate physiological disturbances than the onset of subtle organic changes, it often happens that the effects of chronic industrial poisoning proceed to a serious extent before they are discovered, and as the victims of chronic poisonings far outnumber those of acute forms, the matter becomes of great importance, and every effort should be made to secure means of early diagnosis. Moreover, by virtue of their long duration, the influences of chronic poisons have more opportunity to be associated with, as well as confounded with, many other disease agencies, such as alcohol, syphilis, inadequate food, foul air, etc., factors which often seriously complicate or obscure diagnosis.

The specific selection of many industrial poisons for definite structures of the body is an exceedingly interesting and highly obscure phenomenon, analogous to that of many drugs. Thus methyl alcohol elects the optic nerve; the carbon monoxid of illuminating gas poisoning, the lenticular and caudate nuclei; phosphorus, the bones of the jaw; chromates, the cartilages of the nose; lead, the tunica media of the arteries, etc. In some of these instances (as shown under their respective headings) these phenomena have been explained, but in many others the selective action is a problem which awaits further research for solution.

ARTERIOSCLEROSIS

Arteriosclerosis and the resulting cardiac hypertrophy is one of the commonest of all the lesions of the diseases arising from occupation, particularly among workers with the poisonous metals and those whose occupation involves much strain of the circulation,

as in the muscular effort of lifting heavy weights. For these reasons, as well as from the fact that it is greatly enhanced by alcoholism and syphilis, it is far more common among men than women. In my service in Bellevue Hospital, composed chiefly of members of the laboring class, artisans, etc., it is no exaggeration to say that almost every hard-working man forty years of age presents decided evidence of arterial thickening, and if, in addition, he is alcoholic or syphilitic, the sclerosis may be well marked at thirty-five or even thirty years of age. It is often only one manifestation of a general sclerotic process in middle-aged men, evidenced by emphysema and cirrhosis of the liver, kidneys and heart. With the arterial thickening, and no doubt associated with it in a causative relationship, is high arterial tension, which in the absence of organic heart disease is usually 160 mm., or in many cases 200 mm. or more. Among elderly men, i. e., those in the eighth decade of life or more, who belong to the group of workers under discussion, extensive atheroma of the arteries is exceedingly common, and the service always presents well-marked examples of the broken "pipe stem" type of calcareous deposit in the radial and other superficial arteries.

Arteriosclerosis, incurable when once well established, may only be arrested to some extent from progressing by methods of treatment which, unfortunately for the workingman, rarely come within the possibilities of his purse. He cannot take the rest which he needs, and often cannot alter his occupation. It is, however, most important that the metal worker who shows beginning arterial hardening and persistent high blood pressure should change his work if possible, or, if not, that he should take exceptional precautions to avoid saturation of his body with the poison. This is particularly true of all workers in lead production, painters, etc. Equally true is it of those whose work involves the constant strain of lifting heavy weights or other forms of strenuous muscular exertion.

It is further desirable to restrict proteid intake as much as possible, and the more nearly the victim of arteriosclerosis can come to vegetarianism without becoming anemic or losing strength, the better. A good rule for the workingman is to allow him red meat only two or three times a week and only once a day each time. At

other meals he may eat fish, bacon or eggs in lieu of beef or mutton. Water drinking, also, should be directed, so that too much fluid is not taken into an empty stomach and absorbed so promptly as to raise the blood pressure. Frequent sweating is desirable, and, if it is not produced incidentally to the work itself, it may be induced once or twice a week by a hot bath before retiring, or, if the patient can afford it, by a Turkish or electric light bath. The patient should be cautioned against unnecessary hurry, much stair climbing, and all serious muscular strain.

The bowels should be kept active. The patient should diet with coarse cereals (hominy, oatmeal, Graham or bran bread) or laxative fruits (prunes, oranges, apples), and a five-grain blue pill or other cathartic should be prescribed once in a week or ten days. Medicines in general, in my experience, avail little in this condition. It is a very old custom to give potassium iodid. This may be of benefit in cases complicating syphilis, but otherwise it does not appear to do more than disorder digestion. Thyroid extract I have tried extensively, but it produces no lasting effect in reducing arterial tension where the high tension threatens complications, gives rise to dyspnea, etc. Five-grain doses of chloral four times a day with purgation produce more relief than nitroglycerin or other remedies. When the arteries are greatly thickened it is difficult to reduce the tension by medication so long as the patient is obliged to keep at work and cannot take the rest which is so important for reducing the work of the heart.

FIBROID PHTHISIS

Fibroid phthisis is produced by the mechanical irritation of constantly inhaled hard, sharp particles of such substances as sand, glass, emery, flint, brick dust, cement, granite, sandstone and other stones, iron and steel dust and filings, brass filings, diamond dust, etc.

The morbid process is a chronic interstitial inflammation of the lungs, usually most intense at the apices, but to a considerable extent found elsewhere. The lung is pervaded with minute nodules, so that the freshly cut surface feels rough and grates upon the knife.

Within the nodules are permanently imbedded the irritating sharp particles. The bronchial and mediastinal glands are similarly filled with the disseminated particles which have been conveyed to them by leukocytes. These lesions are not of themselves alone liable to prove fatal, but they so weaken the resisting power of the lungs as very strongly to predispose to chronic bronchitis, asthma, emphysema and particularly to tuberculosis. There are, however, cases in which, after the original irritation and inflammation have subsided, if the occupation be changed, no further injury results.

Nothing can be done by way of treatment to remove the imbedded particles, but much may be done to lessen further irritation and consecutive disease.

Recently considerable controversy has arisen over the theory advocated by Vilaret, Calmette and others that pneumonoconiosis is of intestinal origin, dust being swallowed and absorbed by the intestinal lymphatics, whence it is conveyed to the mediastinal and bronchial lymphatic glands. Experiments with guinea pigs fed upon coal dust in which the carbon has been traced to the lungs are cited in support of this view. This theory has not been generally accepted, although it is well known that in coal miners particles of carbon may be widely distributed to different organs through the lymphatic system and active agency of the phagocytes.

ACTION OF METALS AND THEIR COMPOUNDS

The mode of poisonous action of the metals and their compounds is very varied, and the effects are both general and specific, acute and chronic. Broadly considered, the specific effects are more important than the general, and the chronic than the acute, both numerically as to the number of workmen affected and as to the permanence of the lesions produced. The metals may enter in pure form and be dissolved in the body, or, as various salts or other compounds, they may gain access to it in solution. They also may enter as dusts or in volatilized form. Lead affords one of the best illustrations of all four methods of poisoning. Iron and steel, on the other hand, act solely as mechanical irritants to the respiratory

system and eyes when in the form of dust or fine grindings. With the exception of iron, heavy metals are foreign to the tissues of the body and have no part in its functions. Other normal ingredients of the body, such as sulphur, phosphorus, sodium, potassium, calcium and magnesium act mainly in the industries as fumes or in irritant solutions, and their effects are described under those headings. The present section, therefore, deals only with the poisonous heavy metals and their compounds.

Some of the heavy metals, like gold, appear to lack any definite toxic action upon the body, at least as far as their industrial use is concerned, and in general the poisonous effects of any metal, in distinction from purely mechanical irritation as a dust, depend upon its degree of solubility in the body and the power of the blood and tissues to absorb it. In other words, it is not so much a question of how much of a metal enters the body, but how much of it is ultimately absorbed. The same metal may be much more actively absorbed in one of its physical states than another. Lead as a volatilized fume, for example, is far more toxic than it is in its various solid compounds, and the latter also differ greatly in rate of absorption. Moreover, there is often personal idiosyncrasy regarding toxicity from metals. One painter, for example, may handle lead paint for a score of years without special precautions and yet escape being incapacitated by plumbism, whereas another may succumb to the poison within six months. It is this fact which often makes it difficult to convince workmen of the value of precautionary measures. In many cases, too, the effects of metal poisoning are so insidious that much organic change may be wrought in the tissues or organs of the body before the victim is aware that any harm has been produced. In such cases the metal poisoning may merely open the way for other diseases, such as tuberculosis, to act, and the underlying poisoning is overlooked in the presence of more definite disease symptoms.

Although the various metal poisons produce quite characteristic lesions, many of them affect a number of different organs in the body, and one or another organ may be affected in very different degree. For example, in chronic lead poisoning the predominating

symptoms may be manifest either in the kidneys, arteries, blood or nervous system, just as is the case with chronic alcoholism, or in another person all the symptoms may be present simultaneously.

The *mode of action* of the metal poisons is through transmission by the blood, to which they gain access either by entering the lungs in the form of volatile fumes or as dusts, or by entering the alimentary canal by being swallowed. In the latter, which is the more frequent mode for many heavy metals and their compounds, they gain access to the mouth by means of dust inspired or conveyed to the mouth by unclean fingers, contaminated food or by fingering chewing tobacco.

The researches of Prof. K. B. Lehmann and two Japanese pupils in Würzburg conducted upon animals have demonstrated that as much as three-fourths of an inhaled dust may enter the stomach rather than the lungs, being either directly swallowed or retained in the nasal, buccal and pharyngeal cavities for a time and swallowed later.

Once within the system, the metal compounds may either retain their original composition or be altered by various chemical reactions such as that of the hydrochloric acid of the gastric juice. In some cases the metals themselves may be deposited in various organs of the body, such as the liver, lymphatic glands, etc. This is notably true of lead and arsenic.

The metals possess, above all other industrial poisons, the property of producing serious organic changes, particularly of the type of sclerosis, while acting in exceedingly minute doses through long periods of time. The result is that, although the victim may recover from the more acute symptoms, the organic changes of permanent nature place the body in a weakened condition and render it much more vulnerable to other diseases, especially those of germ origin.

The heavy metals, in so far as they are not deposited permanently in the body, leave it principally by means of the kidneys, as is the case with lead and arsenic, for example. Lead, also, may be eliminated through the sweat glands in very minute quantity, as shown by the black sulphid produced by sulphur vapor baths.

General Symptoms of Poisoning by the Heavy Metals

Acute Poisoning.—Acute poisoning by the heavy metals when it occurs in the industries is usually the result of the inhalation of fumes, such, for instance, as arise in lead or zinc smelting. Nervous symptoms and digestive disorders predominate, naturally, also, with much bronchial irritation, and the victim may die in a comparatively short time from cardiac syncope. Such cases, fortunately, are rare. Recent experiments upon animals have shown that the injection into the blood of fine metallic particles may give rise to chills.

Chronic Poisoning.—Chronic poisoning possesses certain symptoms in common for many of the heavy metals and their compounds. Prominent among them is pronounced anemia. There is also much disturbance of the alimentary system, such as anorexia, nausea, vomiting and constipation. In the nervous system common symptoms are headache, vertigo, visual disorders, and marked tendency to neuritis, palsies, muscular weakness and atrophy. The kidneys often give evidence of irritation. Specific symptoms are numerous and constitute a very interesting study, being often difficult of explanation, although very constant and definite. They are fully described under the account of the action of the individual poisons, but prominent among them are those due to the particular distribution of the nerves or muscles affected, the production of bone and joint lesions, the deposit of certain metals in the gums, peculiar ulceration of the mucosa, etc.

ACTION OF TOXIC GASES, VAPORS AND FUMES

Effects in General of Volatile Irritants Upon the Organism

These effects are largely specific for each substance, for most of the volatile irritants produce diagnostic symptoms. The effects are more often acute and the symptoms more urgent than is the case either with dusts or metal poisons in non-volatile form. This is owing to the ready solubility of many gases and vapors in the blood

and the consequent distribution of the poisons throughout the body. In some instances, however, the effects are chronic and insidious, everything depending upon the degree of dilution of the poison in the atmospheric air. But there are some effects produced in common, and these will first be considered.

General Effects.—These are due in part to replacement of oxygen in the air inspired by the toxic substance, and by depriving such air of its subtle inherent qualities of "freshness" and purity. In part, they are due to irritation of the epithelium and nerves of the respiratory mucosa, and in part to the added factor of extreme heat with which many vapors and fumes are inhaled, as in smelting and chemical processes of various kinds.

Specific Effects.—The specific effects vary all the way from the intensely corrosive action of acid fumes to the insidious action of such colorless, odorless and therefore imperceptible gases as carbon monoxid and dioxid. Fortunately, many of the most poisonous volatile substances possess easily recognizable characteristics. Some, in fact, like ammonia vapor and sulphur fumes, are so intensely irritant as to produce immediate respiratory spasm and thus automatically, so to speak, prevent deeper inhalation which would prove fatal. The specific effects may be either acute or chronic.

Acute Effects.—The acute effects may act more promptly than any other form of industrial poison, as when the vapor of hydrocyanic acid causes instant death. The effects vary very much, but collectively they are manifested principally upon (1) the eyes, (2) the respiratory system, (3) the blood and circulation, (4) the digestive system, (5) the nervous system, and in a few instances (6) the bones.

(1) The *eyes* are irritated intensely by strongly acid or alkaline fumes, fumes of coal tar products, and many of the metallic fumes. Lacrimation, smarting and burning pain are followed by congestion and intense conjunctivitis. The fumes of wood alcohol produce amblyopia and may cause permanent blindness. Some of the sulphurous fumes and fumes arising in brass foundries may cause temporary double vision and other ocular disturbances. On the other hand, many very toxic gases, like carbon monoxid, have no

effect upon the eyes or vision other than might accompany serious weakness from any cause.

(2) The *respiratory system* is greatly irritated by strongly acid and alkaline fumes, vapors of turpentine and similar organic compounds, and fumes of metals. Coryza may be produced and dryness and burning, with a disagreeable taste, may affect the mouth. The pharynx and larynx may be inflamed, with painful choking sensations, and spasm of the epiglottis and vocal cords. Acute bronchitis frequently results from the volatile irritation and sometimes bronchopneumonia, in extreme cases. There may be pulmonary hemorrhage and often edema of the lungs.

A former assistant in my laboratory, Dr. W. G. Hudson, has made a special experimental study upon animals of the effects of acid fume poisoning. Exposure to a variety of toxic acid fumes was found almost invariably to produce pulmonary edema when inhaled in massive doses. He states: "The usual secondary symptoms which have been so fatal are the result of a pulmonary edema which the acid fumes excite. This pulmonary edema shows no pathological difference from the pulmonary edema met with in general medical practice, although it occupies a rather unique position in being a simple, uncomplicated pulmonary edema, while that met with in medical practice is always secondary to some other disease.

"But the experiments show in addition that when the exposure has not been sufficient to cause pulmonary edema it may easily be sufficient to be the exciting cause of a lobar pneumonia."

On the other hand, some of the toxic gases, like carbon monoxid and dioxid, are completely inert as regards local manifestations of irritation, and, like the anesthetic vapors, act only upon the system as a whole after inhalation.

(3) The *blood and circulation* are more or less affected by all the volatile poisons which are capable of absorption. Such absorption may take place in any part of the respiratory system, and is usually extremely rapid. Many of the most seriously poisonous gases and vapors are actively hemolytic, producing rapid disintegration of the blood. Some, like illuminating gas, produce a fixed com-

bination with the hemoglobin (methemoglobin) which permanently prevents the red corpuscles from carrying oxygen to the tissues. Some of the sulphurous compounds like sulphuretted hydrogen gas act in this manner and may be hemolytic as well. The heart may be paralyzed by direct poisoning or by deprivation of proper blood supply. Some vapors, like those of the nitrogen compounds, are also vasodilators.

(4) The *digestive system* is indirectly affected by many volatile poisons which often cause vomiting, and sometimes diarrhea.

(5) The *nervous system,* including the brain, may be affected directly or indirectly through the hemolytic blood. Common symptoms are vertigo, headache, general muscular prostration, paralysis, and coma or convulsions. In illuminating gas poisoning cerebral softening may result from a curious localization of thrombosis in branches of the middle cerebral artery.

(6) The *bones* illustrate other curious localized action, as in the necrosis of the jaws in poisoning by white (or yellow) phosphorus vapor, and necrosis of the cavities of the teeth and of the lower jaw in mercury vapor poisoning. These vapors, also, have profound toxic effect upon the central nervous system. The fumes from chromic acid, which are not violently toxic to the system at large, give rise to a localized necrosis of the cartilaginous portion of the median septum of the nose, with ulceration of the soft parts adjacent.

Chronic Effects.—Chronic effects of many of the toxic gases, vapors and fumes arise from the long-continued inhalation of minute quantities. They are manifested chiefly by marked anemia and digestive disturbances, and sometimes, as in the case of mercury and phosphorus poisoning, by nervous and mental disturbances, such as chills (as in the brass-founders' ague) or "shakes," tremors, palsies, loss of memory, and mental confusion and depression.

Elimination

After absorption the toxic gases, vapors and fumes may be eliminated by the lungs, or form various compounds in the body,

or pass off in more or less altered form by the urine, as in the case of turpentine vapor, which, after inhalation, imparts a strong odor of violets to the urine. Sulphuretted hydrogen gas imparts its odor to the urine and other secretions and may be smelled in the breath long after it has been inhaled. Hydrocyanic acid gas, when not immediately fatal, imparts an odor of bitter almonds to the urine and breath of the victim.

ACTION OF ACIDS AND TOXIC FLUIDS

General Effects of Acids, Alkalies, Dyestuffs, Petroleum and Similar Products

The effects of irritant fluids are, in the main, local and exerted upon the cutaneous surface, although some of them give off fumes (which are elsewhere described). These irritants may be spattered into the eyes or mouth, causing local hyperemia, congestion and inflammatory reaction.

Their chief toxic action, however, is through local irritation of the skin, and exceptionally, through sufficient absorption, to give rise to mild constitutional symptoms. Naturally the bare hands and arms afford the surfaces in immediate contact with this form of irritants; but, through leaning over various receptacles of the fluids, the skin of the face may be affected by spattering or they may be conveyed to it by the moist hands, which in the male often, also, convey the irritants to the skin of the penis and scrotum in the act of micturition. The clothing, too, often becomes saturated with the fluid irritants, causing cutaneous irritation over large surfaces of the body. The numerous varieties of skin lesions thus produced are described in detail in the section on Diseases of the Skin. The effects of the irritants are often heightened by excessive heat of the fluids, by pressure and friction of the skin incident to the particular form of work, by the rubbing into the folds of the skin of various kinds of dirt, oil from machinery, etc., and by prolonged maceration in moisture.

Although some of the fluid irritants cause more or less hardening of the skin, the softer lesions produced are characterized by

marked tendency to recurrence, for in general the resistance of the skin becomes permanently lowered.

ACTION OF DUSTS

General Effects of Dust Inhalation

Dusts act upon the organism in five principal ways:

(1) By mechanically obstructing the air passages;
(2) By lacerating the delicate mucous epithelium;
(3) By conveying soluble toxic materials into the system;
(4) By conveying germs;
(5) By acting as irritants upon the skin, choking the sweat and sebaceous gland ducts and irritating the epithelium.

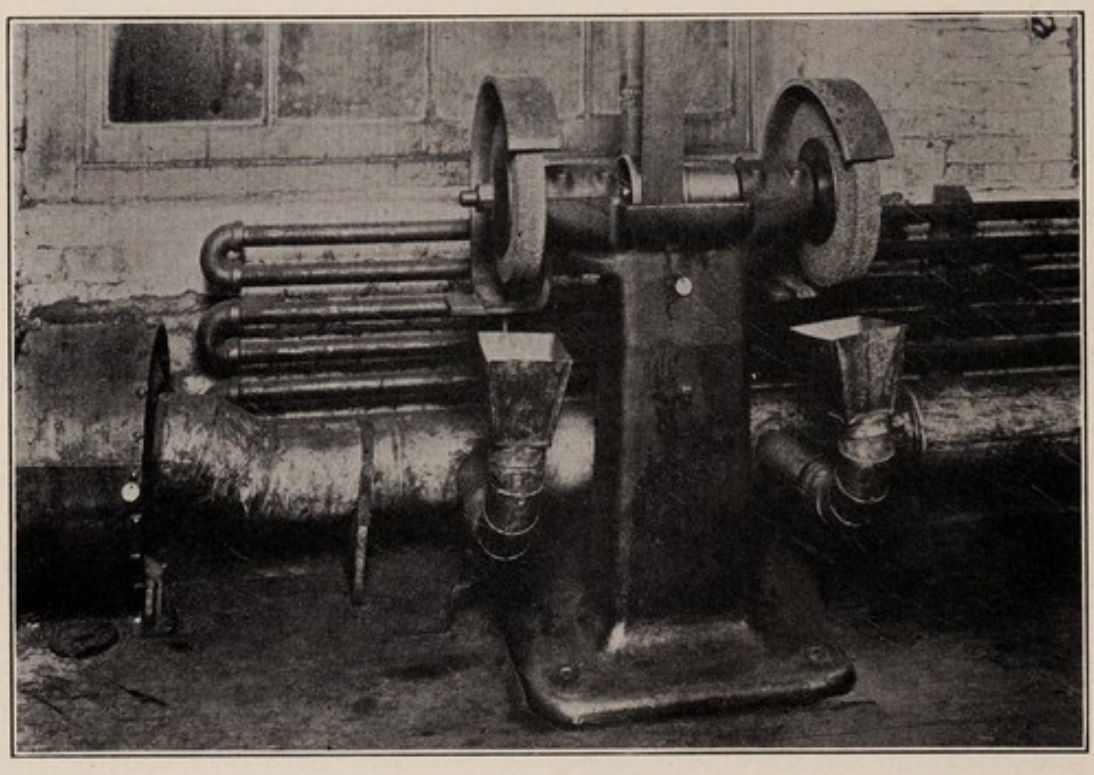


Fig. 4.—Protected Emery Grinding Wheels. These have dust aspirators below connecting with large dust exhaust tubes into which the steel, iron, or emery dust is drawn downward as the wheel revolves.

The dust content of the air is a fair measure of its purity, and J. Rambousek goes so far as to state that "where no dust is there are no bacteria in the air."

Although the noxious dusts differ somewhat in detailed effects upon the organism, they have certain general effects in common. These may be either acute, causing prompt irritation reflexes, such as cough, increased secretion of tears, etc., or subacute or chronic, causing congestion and inflammation of the mucous membranes of the respiratory passages. It is a common experience for workmen when first entering a dusty trade to suffer severely from acute coryza, with sneezing and lacrimation, and sometimes slight febrile reaction. These symptoms pass off after a few days of exposure to the irritant, but may recur on resuming work after a brief holiday or the enforced idleness of a strike.

Dusts are irritating to (1) the skin, (2) the eyes and (3) respiratory passages, and may enter (4) the alimentary canal.

1. **The Skin.**—Upon the hands and arms dusts may give rise to pruritus, erythema and eczema. Mixed with sweat and working into the deeper folds in the skin, they may give rise to ulceration, and, exceptionally, to epithelioma.

2. **The Eyes.**—The sharp insoluble dusts irritate the cornea, in time giving rise to ulceration. Conjunctivitis, lacrimation, conjunctival swelling and ulceration may be produced, and some of the soluble dusts may cause pustular inflammation. The vessels of the elbow); inflammation of the synovial lining of the wrist joint and painful, so that in many cases work is seriously interfered with.

3. **The Respiratory Mucosa.**—The Schneiderian membrane is much irritated. It may become congested and swollen, the hypersecretion of mucus is common in the earlier stages of irritation. In some cases there is ulceration with formation of dry crusts over the surface of the ulcers which cause bleeding on removal.

Some of the soluble dusts are absorbed in the mouth, producing local or constitutional effects of poisoning. The larynx may be irritated. Cough is common and there may be hoarseness. Thirst is also a common symptom. Acute and chronic bronchitis are the usual result of persistent inhalation of irritant dusts.

Many dusts do not penetrate very deeply into the lungs, not beyond the first or second bifurcation of the bronchi, but the heavier metallic dusts, such as steel filings, and especially sharp insoluble

dusts like spiculæ of silica, emery, etc., in time give rise to pneumonoconiosis. The bronchitis is, to a certain degree, protective, for the tenacious mucus expectorated brings out much dust which otherwise in time would tend to occlude the air cells. The wandering phagocytes often pick up insoluble particles and convey them to deeper parts of the body. In coal miners, for example, particles of carbon are uniformly deposited in the bronchial and mediastinal glands, and may be carried as far as the liver and deposited there. The constant bronchial irritation, as well as pneumonoconiosis, strongly predispose to acquisition of tuberculosis. Asthma and emphysema are other common results of continued inhalation of injurious dusts. The soft organic dusts, such as minute fibers of hair, feathers, etc., may convey germs into the lungs, and give rise to pulmonary abscess. The more serious forms of dust inhalation greatly impair the general health, owing to pulmonary irritation, purulent bronchial secretion and defective oxidation, so that the victim becomes anemic and emaciated.

4. The Alimentary Canal.—The soft organic dusts and hard, insoluble inorganic dusts, when caught in the secretions of the mouth, may be swallowed in considerable quantity, but do not produce any symptoms of consequence. The soluble mineral dusts, however, composed of pulverized metals and their salts, when conveyed into the alimentary canal, are absorbed and produce typical organic symptoms. Most of the cases of lead and arsenic poisoning, for instance, are produced in this manner.

ENVIRONMENT AND HABITS OF LIFE

This problem, both in its general and specific aspects, greatly complicates the study of the occupational diseases, particularly when the question arises as to legislative control. In some instances, no doubt, especially in the case of garment-workers, the conditions of work may be hygienic, but the home in a crowded, filthy tenement may be so insalubrious that enforcement of tenement house regulations, or the economic problems of shorter hours of work, better wages and better food may be much more important than any special

hazard arising from the nature of the employment itself. The strained, overworked, underfed employee who sleeps in an inside bedroom at home, or with closed windows and possibly a gas stove to further pollute the air, will acquire symptoms difficult to distinguish from those of a dusty trade, for example, or one in which he is exposed to noxious gases and vapors.

The problems of environment, therefore, resolve themselves into the following subdivisions, in addition to the nature of any specific poison to which the workman may be exposed:

1. General conditions
2. Specific conditions
   a. Air
   b. Humidity
   c. Temperature
   d. Light
   e. Odors
3. Home conditions

1. General Conditions.—In many instances poor ventilation in low-ceiling rooms with windows kept always closed; the accumulation of dust and dirt on floors, rafters and machinery, or damp floors, are responsible for the ill health of employees, who, with the same occupation conducted in dry, well-aired, clean rooms, remain well and develop much greater efficiency. The provision of adequate washing facilities, water closets and opportunities for removing overalls so that they do not have to be worn home when impregnated, for example, with lead dust or dyes, are other factors of much importance in influencing general health.

2. Specific Conditions.—The specific conditions concern the air, as to its purity, humidity, temperature and other qualities, light and the odors resulting from the manufacture of certain products.

a. Air Purity.—The air surrounding the workman may be impregnated with dust or toxic gases, although the general conditions of ventilation of the workroom are good, and the use of blow fans and exhausts, dust shields and similar apparatus becomes essential to protect the lungs from injury. The air pressure may be

excessive, as with work in caissons or diving, although the air itself be pure.

b. Humidity.—The humidity of the air which the workman may be forced to breathe becomes a special hazard wherever much steam is set free, or in evaporation processes, or where the floor of the workroom is liable to be constantly wet. In the pottery trade, bleaching, tanning and dyeing processes, and many similar trades, excessive moisture is a necessary accompaniment of the material handled, and humidity of the air often becomes extreme. In some trades, such as laundering and the washing of many articles of manufacture, the hands and forearms, and sometimes much of the body, are almost constantly soaked in water, which is not without effect upon the general health, as well as the cutaneous surface. The most desirable humidity for the workroom is 55 to 65 per cent., and where artificial ventilation is used the air should be renewed three times per hour.

c. Extremes of Temperature.—Here the environmental hazard may consist in passing constantly from one extreme of temperature to another, in remaining in the extreme cold and damp, for instance, of the interior of a large cold storage plant, as butchers do in large beef-dressing establishments, or in exposure to intense heat, either with or without steam. Stokers, firemen, bakers, kiln men, smelters, puddlers, glass blowers, pottery makers and workers in many other trades are thus exposed, with resulting effect upon the skin, eyes, respiratory passages, circulation and kidneys. The excessive perspiration induced leads to concentration of the urine; and, if the workmen pass suddenly into the outer air in winter, the surface of the body becomes chilled and congestion of the lungs or kidneys sometimes ensues.

d. Light.—Excessive light acts mainly upon the eyes and skin, causing superficial burns of the skin, congestion and inflammation of the eyes, etc.

e. Odors.—Many industries result in the production of odors which are extremely unpleasant, if not nauseating, to those unaccustomed to them. The worst of these are connected with handling animal products, such as hides in tanneries, bone fertilizers, fat

reducing, lard refining and soda manufactories, etc. Other nuisances are the odors emanating from gas works, petroleum refineries and a variety of chemical works.

Distinction should be made between the odors of volatile substances and the really toxic material which such substances may contain; for repugnant odors are not harmful *per se,* else the workmen employed in tanneries, for example, which give off notoriously unpleasant effluvia, would suffer from them instead of being the uncommonly healthy set of workmen they often are. W. C. Garrison, in a report on the leather industry in the State of New Jersey, writes on this topic: "Although thorough examinations have been made to determine the effect of offensive odors in the factories or about the neighborhoods in which they are operated, the only conclusion reached regarding any one occupation has been of an entirely negative character. No special unhealthfulness could be traced to foul smells, although there is authority for believing that such offensive vapors may cause something in the nature of a deterioration of the general health of those who inhale them, and thus bring about conditions that may be favorable to the development of contagious diseases."

I have known the evil emanations from a petroleum refinery to awaken persons from sound sleep when the wind bore them in a certain direction, and foul odors undoubtedly irritate and destroy the rest and appetite of those unaccustomed to them; but, beyond this, they are incapable of harm even when derived from sewage or offal, unless accompanying decomposition gives rise also to toxic gases, which are often themselves inodorous.

3. Home Conditions.—The workman who goes home to a scanty meal, wearing clothing steeped in perspiration and the fumes, dust or solutions of toxic materials in which he has been working, and who sleeps in a close, dirty apartment in which he hangs his reeking clothes, carries much of his occupational hazard with him, if it be of toxic nature. If, furthermore, he is tired out from long hours of work or the strain of "speeding up," or depressed by anxieties over low wages and other conditions, he is in poor condition to resume work on the morrow. He thus in time becomes anemic and weak,

suffers from anorexia and digestive disorders, and arrives at a state in which he becomes more and more susceptible to whatever hazard there may be in his special work, a hazard which may be insignificant for one in better physique.

These are not all conditions which can ever be controlled by legislation, but are largely to be remedied through education of the workman in personal and home hygiene, and by such moral and social influences as may be brought to bear upon the situation. No small part of this responsibility lies with the medical profession, whose instructions are often heeded by the workmen who disregard general advice from laymen. This has been noticeably true in the prevention of tuberculosis, and there is no reason why it should not be so in many matters connected with industrial hygiene.

RELATION OF OCCUPATIONAL DISEASES TO INDUSTRIAL INJURIES

The United States has been much slower than many of the foreign countries, notably England, Germany and France, to recognize in any official manner the deleterious effects of hazardous trades or industries. Of the two great divisions of the industrial hazards, (a) industrial disease and (b) industrial injuries or accidents, the latter has been the first to claim attention, and the studies made in this subject, as well as the regulation by preventive and other legislation, have antedated, by a number of years, similar interest in the disease hazards. This is due, no doubt, to the much greater definiteness and clearer limitations of accidents as compared with disease; especially as viewed by laymen. A man's hand lies upon the workbench, cut off by a revolving saw—nothing could be more definite as to the relationship of cause and effect. He recovers from the injury, and it is easy to determine the degree of his incapacity for further work. The condition is self-limited and non-progressive. With industrial disease, on the other hand, many complex factors arise. It is claimed that a workman is the victim of chronic lead poisoning; but are his arteriosclerosis and nephritis due exclusively to lead poisoning or are alcohol, syphilis or gout the underlying

causes? Is his neuritis due to arsenic or alcohol? To what extent has there been contributory negligence? Was he tuberculous before he undertook work in a pottery, or did his work contribute to the disease? Is the mercurial poisoning of which he is the victim likely to continue its destructive effects until the victim dies, or is he likely to recover completely upon cessation of his hazardous work? Are his chronic bronchitis, anemia and malnutrition due to chronic gas poisoning acquired as a garment presser, or are they due to defective hygiene at home, poor food, lack of exercise, and the strain and anxieties of poverty?

Such are the types of questions which constantly arise in connection with the occupational diseases, and it requires far more experience and judgment to solve them justly and accurately than it does to determine the nature and extent of the great majority of industrial accidents. Some industrial diseases and the effects of some industrial poisons, it is true, are as definite in their results as are accidents, but their number is limited in comparison with the vast number of cases of disease, often obscure, very slow in onset and chronic in course, which affect many large classes of workmen. The caisson disease, for example, is due to a single definite cause; its symptoms are immediate, uniform and easily recognizable for the most part, even by laymen. Similarly, when a man enters a brewery vat to shellac the interior with a preparation dissolved in wood alcohol, and dies from the fumes before he can be got out, the cause and effect are simple enough to establish.

The misery and poverty entailed by the partial disability produced by more insidious poisons or injurious surroundings are much more difficult to estimate with accuracy, even when one is well convinced of it; that is, although the moral evidence is complete, the legal evidence is often very difficult to establish before a jury in a suit for damages, before an industrial insurance company or before a legislature when remedial laws are sought. This was well illustrated in the prolonged effort required successfully to induce Congress to establish prohibitory taxation upon poisonous phosphorus matches, although evidence of poisoning in this instance was fully as definite as evidence usually is in machinery accidents.

In some cases, moreover, injuries may themselves give rise to disease, as when the trauma of impact of foreign particles against the eye gives rise to corneal ulceration, chronic conjunctivitis and other ocular diseases.

Despite these minor difficulties of classification, however, the subject of occupational diseases, in distinction from industrial accidents, is at length being recognized in this country as of at least equal, if not greater, importance to the community, not alone from the humanitarian but from the economic point of view as well; and its study merits serious effort and exhaustive research.

RELATION OF OCCUPATIONAL TO OTHER DISEASES

This is a very important matter, for it not rarely happens that an occupational disease which is not necessarily fatal so strongly predisposes to some other disease by undermining the resisting power of the organism that the combination does prove fatal. This is particularly true of the diseases which, like those resulting from the metal poisons, may give rise to arteriosclerosis of advanced degree, and of the hard inorganic dusts which, by irritation of the respiratory processes, beget sclerosis of the lung and chronic bronchitis, so that the victim becomes an easy prey to tuberculosis.

The independent diseases most often associated with occupational diseases are tuberculosis and pneumonia, and the former is so important that it will be discussed in a separate section.

Anemias, too, are a frequently associated group of diseases, for they are not only produced by numerous toxic agents, especially of hemolytic type, but result from many conditions of environment apart from the actual work of the laborer, such as are discussed in the section on Harmful Environment.

Rheumatism, chronic and subacute, is associated with many occupational diseases involving exposure to frequent changes of temperature and excessive moisture.

Gout is another disease sometimes associated with occupational diseases, particularly with lead poisoning. English writers lay much stress upon this association, and gout is as liable to occur

among the underfed and overworked as among the affluent. The combination of poor food and a poor quality of malt liquors is very liable to produce it.

Diabetes, although not a disease of the nervous system, is made distinctly worse and is often apparently induced by occupations involving unusual nervous strain and mental worry. Asthma is associated with, as well as derived from, many of the dusty trades. Patients having any form of heart disease should avoid trades in which the circulation is liable to be overtaxed by exposure to extremes of temperature, irregular hours, nervous strain or great physical fatigue. Those having a special tendency to catarrhal troubles, bronchitis or asthma should avoid all dusty trades, as should those having incipient tuberculosis or poor respiratory capacity. They should seek outdoor rather than indoor occupations and avoid extremes of temperature, work which induces too much perspiration or exposure to wetting, which lower the resisting power against all such diseases.

Those having chronic pulmonary or bronchial disease of any sort should keep out of all trades in which toxic gases, vapors or fumes are evolved. Those having chronic nephritis should avoid trades in which great humidity and extremes of temperature predominate. No one who has weak lungs, a weak heart, nephritis or arteriosclerosis, or who is very stout should ever undertake caisson work.

Arteriosclerosis is one of the inevitable processes of advancing age, but ordinarily should not give rise to symptoms much before the seventh or eighth decade of life. It may, however, occur at any time after twenty-five or thirty years of age. Hence the apt saying that "a man is as old as his arteries." Arteriosclerosis and chronic nephritis appear to be upon the increase, for both may be caused by alcoholism, both are rapidly advanced by worry and mental as well as physical strain. The ordinary day laborer, entering Bellevue Hospital, who has handled the pick or coal shovel, or lifted heavy weights as a longshoreman, who has solaced his leisure moments with poor whiskey, is, if he has passed his thirty-fifth year, morally certain to have thick-walled arteries. If he is a little older,

he may have an aneurysm, or dilated artery; and, if older still, he may have a broken bloodvessel in the brain.

There are two diseases often associated, namely, Bright's disease of the kidneys and arteriosclerosis. Their frequent occurrence as a result of metal poisoning has been mentioned, but, in addition, they are produced by many forms of occupations aside from those of metal workers. Exposure to cold and wet among fishermen, the strain of heavy lifting among longshoremen, exposure to great heat among stokers and foundrymen are well recognized among the causes of these diseases. These types of laborers are very prone to the constant use of strong liquors, and chronic alcoholism is thus usually added to the exciting causes of such diseases. These diseases may not prove fatal for many years, but they impair general health and strength, and lessen the capacity for work. Moreover, any intercurrent serious infection like pneumonia is very liable to prove fatal; or, a few years later, the diseased arteries may give rise to apoplexy and the diseased kidneys to convulsions or fatal coma.

The two diseases which are most important, from a numerical point of view, in association with the occupational diseases, are syphilis and chronic alcoholism. They both tend to render their victims far more liable to the influence of chronic metallic poisoning and the diseases of dusty trades. They both tend to produce sclerosis throughout the tissues of the body, but particularly in the arteries and kidneys. Hence a metal like lead, which has similar tendency, is greatly augmented in its effect by either of these independent diseases, and when all three conditions—syphilis, chronic alcoholism and plumbism—coexist the deterioration of the structures of the body may become extremely rapid and widespread. A large proportion of my cases of plumbism in hospital practice have been patients presenting this combination, and the arteriosclerosis reached a very advanced grade at a very early age.

Neurotic persons should avoid confining sedentary occupations and all occupations involving the breathing of vitiated air. I meet every year with a large number of patients engaged as "machine operators," i. e., workers in the clothing industry who sit for long hours in dusty, ill-ventilated rooms, who become highly neurasthenic

and hypochondriacal. If their racial tendencies, as in the case of Hebrews, predispose to neuroses, this industry becomes particularly undesirable for them.

A. Tuberculosis

The definite relationship of tuberculosis to occupational diseases is of the greatest importance, but the questions involved are often complex, and statistics, to be of scientific value, should be collected with great care and on a very large scale; for it is often not the occupation which is at fault, but the manner in which it is conducted. In general, however, there are three groups of cases:

(1) Those in which the nature of the work is such as obviously to be the direct cause of pulmonary fibrosis, chronic bronchitis or other diseases well known to favor the acquisition of tuberculosis, such as advanced anemia. In this group are those cases in which the exposure has been to mineral or metallic dusts, toxic gases, vapors and fumes, and any strong respiratory irritant. Also, where the exposure has been to sudden temperature changes, as in the case of bakers and stokers, or to constant cold and wet.

(2) Those in which the occupation itself is quite innocuous, but in which the home conditions or those of poor food, poor housing and poor clothing, overcrowding, alcoholism, etc., reduce the general vitality so far as to render the workman an easy prey to tuberculosis.

(3) Those in which there may be a combination of the factors of the two other groups, making it quite impossible always to determine which is chiefly responsible. For example, of two steel-grinders with tuberculosis, one may have had obvious pulmonary fibrosis and chronic bronchitis and live in good home surroundings. It is fair to assume that his occupation predisposed to his disease. The other, working at his side, may have had no previous pulmonary or bronchial disease, but live at home in an inside dark bedroom, with possibly a tuberculous wife, or may be a victim of alcoholism. In this case it is manifestly unfair to attribute the tuberculosis to occupation alone, or, in fact, to attribute it to occupation at all. One frequently meets with statements that the mortality among bakers,

potters, flax-spinners, *et al.*, from tuberculosis is very high; but without statistics covering the questions of home environment, alcoholism, adequate food supply, etc., they may prove quite misleading, especially when introduced as a basis for legislation. In other words, the poor and ignorant are very subject to tuberculosis, no matter what their occupation, and in present days it is quite possible for the factory to be healthier than the home.

The tuberculosis mortality as affecting workers in dusty trades has been studied upon an extensive scale, and is found to be about double the mortality from this cause among those having outdoor occupations such as farmers.

According to statistics of the United States Bureau of Labor, published in 1908-9, among males from 25 to 34 years of age in all occupations, the mortality from tuberculosis constituted 31 per cent. of the total mortality, but, estimated by selected trades, the rates were as follows:

Grinders	71	per cent.
Tool makers	59	" "
Printers	56	" "
Stone cutters	53	" "
Weavers	53	" "
Spinners	50	" "
Woollen mill workers	44	" "

According to the *Report* of the New York State Bureau of Labor for 1906, "pulmonary tuberculosis was the leading disease in 78 per cent. of the trades enumerated. The highest death rate (5.40 per 1,000) from this cause was credited to marble and stone cutters, who inhale large quantities of mineral dust. This was more than double the average rate in this class (2.62). Cigar makers and tobacco workers died at the rate of 4.76 in every 1,000 from the same disease. They inhale considerable vegetable dust, which contains nicotin and some ammonia. The death rate among compositors, printers and pressmen from this disease was 4.35, while the rates of mortality of tinners and tinware makers (3.65), cabi-

net makers and upholsterers (3.59), painters, glaziers and varnishers (3.19), leather makers (3.11), coopers (2.99), plumbers and gas and steam fitters (2.94), brick and stone masons (2.93), and butchers (2.87) were far in advance of the average for this group of occupations. The trades that showed the least effect from the ravages of consumption were boot and shoe makers, machinists and millers, the death rates being, respectively, 1.35, 1.95 and 1.98 in those callings."

Five cases of pulmonary tuberculosis were reported by physicians in 1912 to the New York State Bureau of Labor as occupational in origin. "Three of these were grinders in a hammer factory, one a clay mixer in a porcelain factory, and one a foreman in a cement plant."

Dr. Frederick L. Hoffman, statistician of the Prudential Life Insurance Company, at the Sixth International Congress on Tuberculosis, presented the following statistical summary:

"In the group of occupations exposing chiefly to inhalations of metallic dust the proportionate mortality from consumption was 37.4 per cent. Animal and mixed fiber dusts, 32.3 per cent., and exposures to mineral dust, 28.6 per cent.

"At the ages of 25 to 34 years the mortality was:

Metallic dust..... 56.7% of deaths from all causes
Vegetable fiber dust..... 53.3% of deaths from all causes
Organic dust..... 50.1% of deaths from all causes
Animal and mixed dust..... 49.7% of deaths from all causes

"At the ages 35 to 44 years the mortality was:

Metallic dust ..... 43 % of deaths from all causes
Animal and mixed fiber..... 40.4% of deaths from all causes
Organic dust ..... 36 % of deaths from all causes
Vegetable dust ..... 89.8% of deaths from all causes"

He also gives the following detailed percentage of deaths from tuberculosis in dusty trades as compared with the deaths from all

other causes in such trades (Sixth International Congress on Tuberculosis, vol. iii, sec. v, p. 141):

	PER CENT.
Grinders	49.2
Plasterers	38.7
Brass workers	38.9
Instrument makers, engravers	34.9
Printers	38.6
Compositors	35.1
Stone workers	35.2
Marble cutters	28.0
Glass cutters	34.5
Furriers and taxidermists	32.4
Silk mill workers	35.9
Bakers	20.4
Button makers	37.8
Leather workers	32.0

These figures include workmen between the fifteenth and sixty-fifth year. Selecting the decade between the twenty-fifth and thirty-fourth year inclusive, the rate of mortality is still higher, as follows:

	PER CENT.
Grinders	70
Engravers	61
Compositors	66
Stone workers	52
Millers	87
Bakers	42

The United States Census states that about 472,000 males are exposed to fifteen of the most hurtful organic dusty trades, including the leather, button, tobacco and grain-milling industries. Among them the tuberculosis rate is 2.29 per 1,000 as compared with the rate of only 1.55 for all occupied males. An insurance rating of

the same group of industries states that they furnish twenty-three per cent. of all deaths from tuberculosis.

Sommerfeld's table of the relationship of dusty occupations to pulmonary tuberculosis, which is often quoted, is as follows:

NUMBER OF DEATHS FROM THIS DISEASE AMONG INHABITANTS OF BERLIN

Occupations	*Deaths due to Pulmonary Tuberculosis per 1,000 Inhabitants*	*Deaths due to Phthisis per 1,000 Deaths*
(1) Non-dusty.....	2.39	381.0
(2) Dusty	5.42	480.0
(a) Metallic dusts.....	5.84	
Copper.....	5.31	
Iron	5.55	
Lead	7.79	
(b) Mineral dust.....	4.42	
Pottery	14.00	
Masons	4.26	
(c) Organic dusts.....	5.64	
Leather, furs, feathers.	4.45	
Wool and cotton.....	5.35	
Wood and paper.....	5.96	
Tobacco	8.47	

Although the mortality from tuberculosis among coal miners is, as generally stated, surprisingly low, it should be remembered that many of them die from or are incapacitated by accident at an age when they would be naturally most liable to that disease. Moreover, many of the statistics are furnished by employers, not by qualified medical examiners; and, as Hoffman states, "It must also be considered that the mortality from respiratory diseases of all kinds is invariably high among coal miners."

Dr. Arthur R. Perry has shown by an investigation of the cotton weavers of the New England States that the death rate from tuberculosis among the female operatives is more than twice as great as the average female death rate from this disease (LXI Congress, 1913, *Senate Document, No. 645*).

In New York City a hotbed of tuberculosis is found in the so-called "sweat shops," where so much ready-made clothing is manufactured. If a man comes to my Cornell Out-Patient Clinic and gives his occupation as a "tailor's presser," I always ask him at once how long he has had a cough. He is almost certain to have worked in a densely crowded unventilated room, dusty from the lint of clothing, and with his tailor's iron heated over a gas stove, which adds to the vitiation of the atmosphere. He has had long hours of work and poor food. Thus, anemic, ill-nourished and fatigued, his body is in an ideal condition for the development of the germs of tuberculosis, which one of his comrades is tolerably certain to pass on to him in the sweatshop.

Another potent predisposing influence for tuberculosis is working in cramped positions over machines, etc., over a bench, or like a shoemaker over his last, which prevent adequate lung expansion. As regards factory ventilation, it may be said, generally speaking, that the mortality rate from tuberculosis moves up and down with the window sash.

Dr. E. R. Hayhurst, in the *Bulletin* of the Ohio State Board of Health, July, 1913, states:

"Nearly every one of the 36,923 persons in occupations who died of consumption in the year 1909 [in the registration area of the U. S. census] ought to be living to-day.

"*Dust, dampness, darkness, devitalized air, food, fatigue, inactivity, unsafe temperatures, avoidable poisons and infections*—one or more of these factors paved the way for 'died of consumption.'

"Not alone occupations but housing, habits and, greatest of all, ignorance of the correct conditions of living and working, summarize the causes."

B. Epithelioma and Carcinoma

The influence of long-continued local irritation has long been recognized as a factor in determining the development of certain cases of carcinoma, and particularly epithelioma, and many cases have been recorded in which occupational irritants have favored the

growth of malignant granuloma, or epithelioma in the lips, mouth, hands, scrotum, etc. For example, workers in tar, pitch, rosin and paraffin may exhibit such growths in the hands; and epithelioma of the hands and scrotum was formerly described among chimney sweeps.

Carpenters, in nailing shingles or the old-fashioned wooden laths, in order to work more rapidly, frequently hold the nails in the mouth. Formerly occasional cases of epithelioma of the tongue were reported among them which were attributed to this source of irritation. Diseases of this type, however, are rarely met with at the present time, owing to better understanding of their nature and improvement in methods of work.

Carcinoma of the bladder develops sometimes as a result of irritating poisons which are eliminated through the kidneys, causing usually also hematuria. Cases have been reported from chronic anilin and benzin poisoning.

RACE AND OCCUPATIONAL DISEASES

The influence of race upon occupational disease is afforded a wider field for study in this country than in any other, owing to the enormous and varied foreign population derived from so many widely different sources. The subject cannot be entered into fully within the limits of this work, but a few general considerations may be noted. The selection of certain occupations by members of particular races or nationalities is in great part an economic rather than a medical problem, and is in part, though by no means exclusively, due to existing conditions of occupation and education in the country from which the immigrant has come. To a certain extent, also, a sort of natural selection enters into the problem, the weaker races naturally avoiding the more arduous industries, and *vice versa*. Thus, miners, steel foundrymen, and smelters are largely recruited from Scandinavians and Poles. Caisson workers are principally Swedes and Irishmen, with a few stalwart negroes. The clothing industry is mainly followed by the Hebrews. Many Poles are workers in mills for fabrics and textiles. Some nationalities are

represented chiefly in outdoor occupations, for instance the Italians; whereas the Hebrews in general seek sedentary or indoor trades requiring less arduous muscular effort.

In the wards of Bellevue Hospital, where almost every nationality and many races are represented, and where occupational diseases abound, I find a most interesting field for study of these relationships, and very noticeable is the influence of the alcoholic habit and of syphilis in connection with racial characteristics and as bearing upon the diseases of occupation. Thus, if lead poisoning causes an Irishman or an American to seek hospital treatment, he is apt, also, to be a hard drinker and have advanced arteriosclerosis. If he be an Italian painter, he is much less likely to present the added factor of chronic alcoholism. The Germans take kindly to many dust producing trades, such as metal working, and also to dyeing and tanning trades. There are, however, many exceptions to all this, and any conclusions must be very general.

SEX AND OCCUPATIONAL DISEASES

Apart from the natural physiological differences between the sexes in muscular strength, nervous organization, temperament, etc., there has been observed marked difference in the effect of various poisons. Women, for example, are much more susceptible than men to lead poisoning. They are more liable to acute symptoms of plumbism, and most of the cases of lead encephalopathy occur among them. Similar differences exist in regard to phosphorus and mercury poisoning, arsenic and some other chemical substances. Women, too, are somewhat more susceptible than men to pulmonary occupational diseases, and especially to the subsequent development of tuberculosis, although the sexual differences with such exposure are less decided. Not a few of the occupational toxic hazards have been found so much greater for women that they are forbidden by law to be employed in them. In occupations involving nerve strain and long hours of work women are more apt to become neurasthenic.

In the matter of clothing they are somewhat handicapped, especially where they are exposed to irritant dusts or to constant wet, as in the case of laundresses. Their long hair is more difficult to keep

clean and they suffer more than do men from cutaneous irritation of the scalp and hands. These, however, are comparatively minor matters, capable of regulation, to a great extent. Under adverse conditions of breathing foul or toxic air women are especially prone to anemia, digestive disorders, constipation, headache and neuralgias or neuritis.

In general in the United States, as compared with foreign countries, women are much less employed than men in lead works, pottery glazing and other especially hazardous trades, so that serious cases of lead and other metallic poisons are far less often met with among them.

Among the many industries in which women and young girls are employed in great numbers, sometimes almost equally with men, are the shoemaking industry in factories, tanning works, cotton, jute, wool and other fabric mills, jewelry manufacture, dyeing, scouring and naphtha cleaning of clothing, match manufacture, paper making, felt hat making, pottery, glazing and scouring and the tobacco industry. In steam laundries females compose about three-fourths of the force; in telephone offices, nearly 99 per cent., at least among day workers. Statistics compiled in Leipzig of deaths among females employed in industrial occupations showed an estimated death rate per 100,000 females in all such occupations of 530 (for all ages), but in the selected chemical industries the rate was 850.

A very important matter in connection with sex and occupation, and its relation to the welfare of the race, is the question of overwork of women during the period of parturition. It is estimated by the United States Bureau of the Census that fully 2,000,000 married women and as many more unmarried are occupied in the various trades and productive industries. Pinard is quoted by Coughlin (*N. Y. Med. Jour.*, June 10, 1911) as giving "the effect of employment upon the weight of a child by weighing 500 infants in each of the following classes: (a) 500 infants of women working right up to the time of labor, 3,000 grams; (b) 500 infants of women who spent the last few months in a lying-in hospital, 3,290 grams, and (c) 500 infants of women who spent the whole of pregnancy in a hospital, 3,368 grams."

The special influence of plumbism in producing miscarriages and affecting the health of the young offspring of lead workers is considered under Chronic Lead Poisoning.

AGE AND OCCUPATIONAL DISEASES

Both extremes of life are quite unfitted for certain occupations. Growing and developing children need the best possible conditions of fresh air, regulation of rest and exercise, etc., as everyone knows, yet they are often placed in very dusty trades, such as pearl button making, carding, loom tending, etc., where the air is constantly filled with fibers. In tobacco factories they are quite susceptible to tobacco poisoning through dust inhalation. Children are often employed in merely sorting and packing articles of manufacture in connection with which much dust is evolved, and such trades are particularly bad for them.

Statistics of illness occurring in thirty-two industries, classified by age, gathered by the Austrian Government in the five-year period, 1891-1895, showed marked preponderance in early life in the chemical industries. The average cases of illness of all sorts in all thirty-two occupations for males from the fifteenth to the twentieth year of age numbered 42.3 for each 100 employees, but in the chemical industries (making and use of acids, pigments, chemicals, etc.) the cases of illness during five years numbered 1,002, or 137 per cent.

In lead and brass manufactories or anywhere that lead is a disease hazard children should never be permitted to work, or in occupations employing phosphorus or mercury, for they are far more susceptible to all the metallic poisons than adults. In the manufacture of artificial flowers, since the substitution of anilin and other pigments for arsenical colors, one seldom meets with arsenic poisoning among the young.

Children are naturally less careful and less intelligent than adults about self-protection from occupational poisons.

Children who work under bad conditions of lighting, or whose work necessitates constant observation of rapidly moving objects such as shuttles, often suffer from muscular and other forms of eye strain.

It is estimated that 2,500,000 children from six years of age upward are employed in the United States in factories, mills and mines, a number which fully justifies the present universal activity in child labor legislation, but the study of the subject is usually made more in the line of general hygiene, questions of long working hours, absence from school, etc., than from the scientific investigation of occupational in distinction from ordinary disease.

As age advances much beyond the half-century mark the chief hazard is in regard to arteriosclerosis, which makes trades involving metal work and the strain of lifting heavy objects very undesirable. Coincident myocardial degeneration adds greatly to such disease hazard. Aged persons who are prone to asthma, emphysema and chronic bronchitis should, whenever possible, avoid all dusty trades.

EXERCISE AND OCCUPATIONAL DISEASES

Many occupations are healthful by virtue of the reasonable exercise which they demand, others are the reverse because of the excessive muscular fatigue engendered, and others again are unhealthful largely because of their sedentary character and entire lack of muscular exercise. In general, excepting the existence of serious specific poisoning, trades requiring fairly vigorous exercise are more healthful than those which demand a minimum of physical exertion. This striking fact is stated by W. C. Garrison: "The ratio of tuberculosis as compared with other diseases among wage-workers is greatest where the amount of exertion is least, and lowest where it is greatest, the intermediate degrees showing an intermediate ratio. Work requiring unusual physical strength, such as is performed by stone cutters, masons and steel construction men, is not prejudicial to health and longevity by reason of any circumstance peculiarly relating to them. Indeed, being performed in the open air, these and other outdoor occupations are practically free from the incidental circumstances which lead to pulmonary troubles, and their mortality ratio is much smaller than that of the comparatively unlaborious trades carried on indoors." This, however, is something of an over-

statement, and much depends upon the quantity and quality of the mineral dust.

IRREGULARITY OF EMPLOYMENT. "SPEEDING UP"

Many trades, owing to different seasons of the year at which they are followed, or fluctuations in the market, economic or otherwise, demand employment for special periods under strain of great activity, followed by periods of idleness. Thus, the workman for a portion of the year may have intense labor, with good wages and abundant food, followed by poverty and insufficient food from lack of employment. Such trades, for example, which may be shut down in winter are brick-making, fruit and vegetable canning, outdoor mason work and painting, etc. More or less serious effect upon the general health of the workman is the natural outcome of such industries. In periods of idleness, too, there is often greater resort to alcoholic stimulation.

"Speeding up," as the process of hurry to fulfill requirements of contracts, especially in the textile and clothing industries, is called, subjects the operatives, who are often women, to most unhealthful nervous tension and general physical fatigue, resulting, as it often does, in neurasthenia. The modern machine sets the pace for labor, and the workman must keep up with it or abandon his occupation. As the factory has largely supplanted the small shop, and machines have supplanted individual tools in many industries, too often workmen are crowded together under conditions of noise, dust, foul air and general confusion. They no longer can individualize their work and lack the mental pleasure of completing a varied piece of manual work. Under these conditions, when a faster rate of work is demanded, they feel the strain sooner and sometimes resort to stimulants to brace them for the emergency.

EFFICIENCY AND OCCUPATIONAL DISEASES

Mr. Taylor's researches in efficiency showed that a man employed constantly in lifting heavy weights, such as pig-iron, should

only be under load 43 per cent. of the working day and must be entirely free from load for 57 per cent. to attain the maximum efficiency.

In the study of the relationship of efficiency, i. e., of mechanical output of energy in any industry, in relation to factors of health, it should be borne in mind that some industries are hazardous by virtue of some one seriously poisonous substance, whereas others are so from the combined result of a number of mildly deleterious conditions. In so far as muscular work is a mechanical problem, its extent is directly dependent upon the good health of the operative, which implies not alone good muscular contractility, but normal coordination and activity of brain and nerves in directing and controlling muscular activity. The workman employed in bad ventilation, with resulting poor oxidation of his tissues, in bad light, with its depressing mental effect and the increased effort expended to counteract it, or who is surrounded by conditions of dirt, excessive humidity and exhausting temperature, loses in efficiency of output to a degree which is often one-third or perhaps one-half of the normal standard.

Dr. Elliott Washburn cites an instance where twenty-eight emery grinders in Massachusetts, working in a badly lighted, ill-ventilated basement, increased their efficiency nearly thirty-three per cent. on being transferred to a hygienically lighted and ventilated workroom.

In Illinois were two white lead establishments. One, which made no attempt to save the health and lives of its eighty workmen, was compelled to replace almost its entire working force every two and a half months. The other, employing double the number of workmen and supervising their safety, changed less than 100 workmen a year. The time lost in instructing new laborers constantly is no inconsiderable factor in efficiency (Dr. Alice Hamilton). Writing further of this topic, Dr. Hamilton states (*Amer. Assoc. for Labor Legislation Publications, No. 10,* 1910): "I do not know whether it is an advantage or not to have a large body of men moving in and out of the smelting works, lead pipe works and white lead factories, staying for a month to a year and dropping out as soon as they are leaded. It is true that the individual worker does

not suffer as serious damage as in the old countries, where work is not so abundant and a man must stick to his job, even if it makes him ill, but, on the other hand, there is a much larger number of men exposed to lead poisoning. One smelting works, with a pay-roll of 600, reports that at each pay day, that is every two weeks, they lose from five per cent. to fifty per cent. of their men, and must send beforehand to the big cities for gangs of new men. Another smelting plant loses twenty-five to thirty per cent. of the men each month."

Dr. Hamilton found another lead manufactory in Illinois in which 300 men had to be engaged yearly to maintain a working force of 50, and in another, with 450 to 600 employees, twenty to forty per cent. dropped out every pay day because of plumbism. The policy of regarding such economic losses as inevitable is inconceivably stupid. On the other hand, Dr. Krautz states (*Sozial Technik IV,* No. 2, 1912) that whereas in a German zinc smelting works employing 1,200 there were in five years, from 1879 to 1885, no less than 819 cases of serious lead poisoning, in 1910, under modern hygienic regulations, in the whole of the Upper Schlesingen district, employing 6,400 workmen in zinc production, there were only 78 cases of plumbism.

In a storage battery plant in New York City, investigated by Dr. John B. Andrews, the men working under the worst conditions of hygiene usually developed lead symptoms within a month. He estimated the loss in wages and expense of medical treatment at about $65 per man for each attack. After the building was replaced by a modern hygienic one the trouble virtually disappeared.

In one of the Californian gold mines, where uncinariasis affects fully half the workmen so that they cannot do the work of healthy men, Dr. Herbert Gunn estimates the net loss to the owners at over $20,000 a year. A few doses of thymol for the men and proper hygiene in the mine might save this entire waste!

In discussing the matter of efficiency as effected by the workman's health, there are two peculiarities which differentiate very strikingly the labor of this country from most foreign countries, and which are not without considerable influence upon industrial dis-

eases. First, owing to the large immigration of able-bodied workmen, in many localities it is easy to replace those who are invalided, whereas in many foreign countries the working population, being much less migratory than in this country, remains to toil and grow old often in one locality. This applies chiefly to unskilled labor, but it is precisely with this type of workman that many of the greatest risks are run in smelting works, the handling of crude chemical products in bulk, etc. Moreover, being unskilled, he is also ignorant both of the risks he runs and of fundamental laws of hygiene. He is often unable to read warning notices, or at least to read them in an unfamiliar language. He is left to himself as far as any instructions are concerned, and when, for example, he promptly acquires lead, arsenic, mercury, nitroglycerin or carbon monoxid poisoning he is dropped from the pay-roll and turned off to seek another job, which he usually first finds consists in lying for some weeks or months on a hospital cot. It is difficult to see that this state of things makes for economic efficiency, and it certainly, from a humanitarian point of view, is a disgrace.

The second difference above referred to is that the average American workingman is of younger years than the foreigner, again because of immigration conditions.

In any statistical study of workingmen and efficiency it should always be borne in mind that some types of work naturally attract the robust and vigorous, whereas other types attract the weak. A tanner, for example, or a steel rolling mill worker, is naturally a robust man or he could not enter the industry; but a clicker, pegger or cutter in a shoe factory may be a mere stripling or physically weak from any cause. Hence comparative industrial statistics should always be taken *cum grano salis* when applied to arguments as to disease and mortality.

NIGHT WORK

Much has been written regarding the alleged relative harmfulness of night as compared with day work. Much night work is absolutely essential, especially in foundries, where the fires must be kept

up. Among engineers, stokers and many types of transportation workmen night work is necessary. It is claimed that the workshops, poorly lighted with artificial light, are depressing to the nervous system and mind, and that it is more difficult to obtain adequate sleep in the daytime. I confess I have not been impressed by these claims. Practically, the work of coal and other miners is the same, day or night, as is that of a stoker in the hold of a steamship; and in many industrial establishments artificial light is depended upon both by day and night. It is, of course, a disadvantage from the standpoint of home life to have to sleep while others are active, and *vice versa;* but there is little in night work *per se* that is injurious, and my experience is that night workers are quite as healthy as day workers in the same occupation. It is further claimed that for women and young girls night work is morally deleterious, but this is a matter which also has been much exaggerated. It is not work that leads the young astray, but idleness and opportunity, which may be quite as available, or more so, in the home than in the factory or mill. As a matter of fact, with very many night workers the condition is regarded as temporary and the work is frequently changed.

COMPULSORY REPORTING OF OCCUPATIONAL DISEASES

Following the practice in vogue in England for more than a decade, the system of requiring physicians to make official reports of cases of certain of the occupational diseases has been instituted quite recently in the United States. In 1911 six States passed laws covering this matter which are substantially the same. These six States were California, Connecticut, Illinois, Michigan, New York and Wisconsin. Five more States, including New Jersey and Maryland, have been added to this list. The reportable diseases concern four metals—lead, arsenic, mercury and phosphorus, or their compounds—one germ disease, anthrax, and one environmental disease, compressed air illness. All the States require the same list, with the exception of Wisconsin, which omits anthrax and adds brass and zinc smelting, and New York, which added, in 1913, wood alco-

hol poisoning and brassfounder's ague to the original six diseases. In Connecticut and New York the reports are to be sent to the Commissioner of Labor, and in several other States to the State Board of Health. The object of the reporting is to enable the State authorities to collect data and locate the foci of occupational diseases, so that State inspectors may visit them and make detailed reports upon the conditions prevailing among the workmen. From such study it is hoped that sufficiently accurate data may be gathered upon which remedial legislation may be based, when found desirable. Moreover, it is expected that the reporting itself may prove educational by directing the attention of physicians and others to the extent to which occupational diseases have developed in this country. The list is a meager one, but it is intended to add to it from time to time as further study of the subject may warrant. It was copied from the British law, and in some respects is ill-adapted for this country. For example, anthrax is so rare a disease in the United States that legislation regarding it appears superfluous, and in States like Connecticut there is little or no caisson work or underwater tunneling from which compressed air illness might be derived. On the other hand, there are many other incapacitating diseases of far greater frequency and importance. It is well, however, that a beginning has been made toward statistical accuracy, and in time defects in the law may be amended. In each State, excepting Connecticut, there is a penalty, varying from ten dollars to one hundred dollars, for failure to report, and in Connecticut and California small fees are given to physicians who make reports. As proof of the value of the reporting system may be cited the experience with lead poisoning in England. In 1900 more than 1,000 cases of plumbism were reported, but, owing to remedial legislation which ensued, in 1910 the reported cases were only 553, or nearly one-half the original number.

Reporting of occupational diseases should not be regarded merely as preliminary to legislation, for in many instances educational influences may be brought to bear by the State authorities which may be more beneficial in the end. The various health boards now require the reporting of many contagious or infectious

diseases against which no legislative action is found necessary. Nevertheless, such data are of great scientific value, and in this light primarily the reporting of the occupational diseases should be regarded.

In New York State the registration blank for occupational diseases has been made to conform in size and general character with the national death certificate blank recommended by the Bureau of the Census.

Following is this certificate blank for notification issued in 1912 by the New York State Department of Labor. It was devised by Mr. L. W. Hatch, Chief Statistician of the Bureau of Labor Statistics, in conference with the Committee on Occupational Diseases above referred to (page 7). This certificate is reproduced in full, as a sample, for it is more complete than are some others of the

New York State Department of Labor — Bureau of Labor Statistics

CERTIFICATE OF INDUSTRIAL DISEASE

NAME OF PATIENT.....

ADDRESS: Street and No. ..... City or Village .....

PERSONAL AND STATISTICAL PARTICULARS

Sex	Age	Color	Country of birth

Single, married, widowed or divorced (write the word)

Occupation

(a) Present trade, profession or work.....

Particular kind of work in such trade, etc.....

Date of entering present occupation .....

Employer's name.....

Address .....

Business (kind of goods made or work done).....

(b) Previous occupations:

Name of occupation	Entered (year)	Left (year)

Previous illnesses, if any, due to occupation:

Disease or illness	Year

MEDICAL CERTIFICATE OF DISEASE

Diagnosis of present illness.....

Chief symptoms and conditions.....

Date first symptoms appeared.....

Complicating diseases (such as alcoholism, syphilis, tuberculosis, etc.)

Additional facts .....

Date of diagnosis....., 191.....

(Signed)....., M.D.

....., 191..... (Address).....

State certificates and might well be adopted for the sake of uniformity as a general model. It has been copied, practically *verbatim,* by the Ohio State Board of Health.

I submitted the following summary to be printed on the back of the above certificate for the information of physicians not familiar with the full scope of the occupational diseases; but it was decided to issue it not on the certificate, but, with additional data, as a pocket booklet to be distributed with the blank certificates, which is described in the Appendix.

SPECIAL OCCUPATION HAZARDS AND HARMFUL SUBSTANCES

Such are derived from—**I. Metals. II. Dusts. III. Gases, Vapors and Fumes. IV. Injuries to Nerves and Muscles. V. Injuries to the Eyes. VI. Injuries to the Skin. VII. Compressed Air.**

I. **METAL POISONING** is derived from filings, dusts and fumes of metals or their salts, which enter the system through inhalation or swallowing, being conveyed to the mouth often by unclean hands or food eaten in dusty workshops.

Poisonous or irritating metals include: antimony: arsenic: brass: copper: iron or steel: lead: manganese: mercury: phosphorus: silver: tin: zinc: bronze powders: lead or solder: or compounds of any of these substances. Special attention should be given to reporting diseases of the bones due to mercury, chromic acid, etc.

II. **DUSTS** cause irritation of all the respiratory passages and of the eyes and skin. In some instances the metal dusts enter the mouth as well as the lungs and are swallowed and absorbed. Irritating dusts are of three classes:

(a) **Insoluble Inorganic Dusts** (irritating the respiratory passages): flint: silica: sand (e. g., sand blasts, sand paper): carbon (e. g., coal, soot): brick dust: marble: granite: terra cotta: cement: asphalt: enamel: glass: quartz: lime (e. g., gypsum, plaster): meerschaum: phosphates (e. g., fertilizers): guano: emery: diamond dust: metal filings (e. g., lead, brass, iron and steel, etc.): pumice: ashes.

(b) **Soluble Inorganic Dusts** (liable to be swallowed and absorbed): soluble arsenic, mercury, lead and silver compounds: metal filings of lead, brass and zinc.

(c) **Organic Dusts** and fibers arising from handling or manufacture of wood, bone and shell: from fur, skins, hides, and leather: feathers: brooms and straw: flour and grain: jute: flax (linen): hemp: cotton: wool (worsted, etc.): tobacco: felt: carpets: rags and paper: horsehair: street sweepings.

III. **GASES, VAPORS and FUMES** irritate the respiratory passages

and eyes and may cause poison by absorption. The most important are: illuminating gas (oil gas): gases from coke and coal: coal gas: carbon dioxid (brewers' vats, bakers' ovens, aërated waters), chromic acid: **mineral acids,** sulphuric, hydrochloric, nitric, etc. (acid factory workers, engravers, etchers and lithographers): mercury cyanid: **heated lead:** ammonia: ammonium carbonate, ammonium chlorid: **tar and creosote** (distillers): **asphalt** and petroleum products, (naphtha, benzene, gasolene—used in dry cleaning and otherwise), **wood alcohol: smoke** (firemen, varnish makers, varnishers): arseniuretted hydrogen (copper refiners): ferrosilicon: **amyl alcohol:** dinitrobenzol: **nitroglycerin:** cordite: **carbon disulphid: chlorin:** chlorid of lime: carbonyl chlorid: phosgene (dyeing industry): **formaldehyd:** hydrofluoric acid: hydrocyanic acid: ammonium, sodium and potassium cyanids: pyridin: sulphur and **sulphuretted hydrogen: anilin:** dinitrobenzene and dinitrotoluene vapors.

IV. **INJURIES TO NERVES AND MUSCLES** are derived from occupational strain, fatigue, repeated blows and vibrations, excessive pressure, repeated muscular contractions, faulty positions, as in standing, sitting, leaning over benches, etc. The so-called "Occupation Neuroses" are comprised under this class of injury and disease. The principal effects of nerve or muscle strain are observed as: palsy, cramps (writer's, telegrapher's, typewriter's), sciatica, neuritis, neuralgia, tremors, vasomotor disorders, gastric and intestinal disorders, general "nervousness" and insomnia: deformities of chest from cramped positions (as in tailors): curvature of spine, flat foot, etc.

V. **INJURIES TO THE EYES:** Excessive light causes eye strain to electric light men, X-ray workers, steel foundrymen, etc., and excessive heat subjects puddlers, glass workers and others to optic neuritis, conjunctivitis, etc. Dusts of various kinds irritate the eyelids or injure the eyeball.

VI. **INJURIES TO THE SKIN** are caused by acids, corrosive alkalies, lime, irritating dusts, tar, creosote and petroleum products, especially paraffin, dyes, etc. They give rise to eczema, fissures, ulcers, boils, epithelioma, etc.

VII. **COMPRESSED AIR** affects caisson men and divers. The former are subject to cramps, paralysis, serious lesions of the spinal cord, etc., sometimes proving fatal.

Statement of Occupation. *Precise* statement of occupation is very important so that the relative healthfulness of various pursuits may be known. It is necessary to know (a) the trade, profession or particular kind of work, as *printer,* or *brass worker,* and also (b) employment in detail in such trade, etc., as *type-setter, linotype operator,* or *polisher, buffer.* It is important to distinguish, where possible, between present and previous occupation as the cause of present illness. Disease contracted in an occupation is itself among the causes leading to frequent change of occupation among industrial workers.

Owing to the meager literature of the occupational diseases as observed in the United States, and the fact that in most medical colleges the subject is either entirely omitted or dealt with in a

most cursory manner, physicians who have not given special thought to the matter, or whose experience with this important group of diseases is very limited, are not likely to be conversant with the number and extent of the industrial disease hazards. This is clearly shown by the lack of provision for their classification in ordinary hospital and dispensary reports. To aid in correcting this deficiency I suggested to the State Bureau of Labor that a booklet be issued and sent to physicians, together with the above described notification blanks. The suggestion was adopted, and the text which I supplied comprises a working basis of classification of all the common disease hazards of occupation as met with in this country. Among other items it contains a "Tabulated List of Certain Harmful Substances and Their Effects," in which are arranged in parallel columns (a) The Harmful Substance; (b) The Industry Where Prepared or Used; (c) Mode of Entrance into the Body; (d) Diseases or Symptoms. Copies of this booklet may be obtained upon application to the Chief Statistician of the New York State Labor Bureau at Albany. A somewhat more elaborate classification is comprised in the Appendix to this volume.

Following are some of the data required in the notification blank of another State:

GENERAL FACTS (at time of attack)

1. Were instructions given you concerning the dangers of the work and how to safeguard yourself?
2. Were such instructions posted in the factory?
3. What sort of breakfast were you in habit of eating?
4. How much tobacco do you use and in what form?
5. How much alcoholic drink and in what form?
6. Did you eat in the workroom?
7. Did you wash before eating? Hot or cold water?
8. Do you change your clothing before leaving factory? At home?
9. Did you wear a mustache? Beard?
10. Can poisoning be attributed to any other than industrial causes? Canned goods, water pipes, etc.?
11. What precautionary devices have been installed in the lead factories where you have worked? Ventilation, hoods, exhausts, wash-

rooms, soap, towels, hot and cold water, overalls, lunchrooms, lockers, doctor, respirators?

12. What protective devices might have been put in?

SYMPTOMS

1. Nature of attack
2. Diagnosis by
3. Permanent effects

The following statement from the *Board of Trade Labour Gazette* of London (Jan., 1912) illustrates the value of the English compulsory reporting law:

DISEASES OF OCCUPATIONS

in Factories and Workshops

The total number of cases of poisoning and of anthrax reported to the Home Office under the Factory and Workshop Act during December, 1911, was 77, consisting of 63 cases of lead poisoning, 2 of arsenic poisoning, and 12 of anthrax; 4 deaths due to lead poisoning and 2 to anthrax were also reported. In addition, 21 cases of lead poisoning (7 of which were fatal) were reported among house painters and plumbers.

During the twelve months ended December, 1911, the total number of cases of poisoning and of anthrax was 755, as compared with 574 in 1910. The number of deaths was 49 in 1911, as compared with 48 in 1910. In addition, there were 263 cases of lead poisoning (including 48 deaths) among house painters and plumbers during 1911, as compared with 232 cases (including 35 deaths) during 1910.

Reporting by Factory Inspectors

The Illinois State Department of Factory Inspection provides blank forms for inspection reports which call for the following data, among others, and may serve as an excellent model.

Besides the usual name, age, sex, detailed occupation and social status data, a description of the local sanitary conditions is called for, such as the use of dressing rooms, overalls, respirators, washing facilities, hot and cold water, individual clean towels, waterclosets, separate lockers for street and factory clothing, disinfectants, soap or other cleansing materials, nail brushes and shower baths; details

of ventilation, such as blowers, fans, hoods, heat and moisture, cleaning of flues, dust removal by floor washing, sweeping, forbiddance of sweeping during working hours, cleaning of benches and work tables, dampening of dust and of materials used; separate lunch rooms; time allotted for meals and for cleaning hands before meals; prohibition of taking food and drink into workroom; proper drinking water supply and sanitary faucets; fumes, ore, slag, dross, etc., kept in separate rooms dampened when possible; separate rooms for mixing, sorting, weighing, packing, etc., of dusty materials, and for grinding, buffing, polishing or finishing; cleaning of fixtures, machinery and tools; hoods and covers over hoppers, boiling kettles and vats, etc., connected with exhaust ducts; accumulation of refuse; posting of notices for employees as to hazards; other preventive instruction, verbal or written, the latter in various languages where foreigners are employed.

PART II

GENERAL REMEDIAL MEASURES

I. PROPHYLAXIS

OUTLINE OF GENERAL REMEDIAL MEASURES

In a paper read before the Albany County Medical Society and Hygiene Exhibit, Albany, October 18, 1912, I have summarized the work of prophylaxis of the occupational diseases as follows:

(1) What the State may do. The work of the State should be (a) educational, through the collection and dissemination of data; and (b) preventive, through prohibitive and protective legislation.

(2) What special organizations may do.

(3) What the employer may do to protect the workman.

(4) What the workman may do to protect himself.

(5) What the physician may do in scientific investigation and the collection of accurate data.

(6) What the general public may do through coöperation of the many interests involved and endowment of museums and clinics for the study of the occupational diseases.

(7) What the public press may do in popularizing accurate information as to industrial disease hazards.

(These several topics are considered in detail in the following pages.)

Among the general remedial measures for the lessening of the occupational diseases are:

(1) Congressional investigation by commission, to be followed by such legislation as the anti-poisonous match law of 1911, etc.;

(2) Investigations of special industries by the National Department of Commerce and Labor;

(3) State investigation by commission, factory inspection, labor bureau and health board departments, with appropriate legislation and especially published documentary evidence, information and instruction;

(4) Employer's liability and compensation acts for diseases as well as accidents due directly to industrial hazards;

(5) Independent investigations and a campaign of education among physicians, employers and employees, conducted by the national and state associations for labor legislation, economic associations, the National Association of Manufacturing Chemists, and similar organizations;

(6) Collection of accurate systematized records based upon a uniform nomenclature by the National Bureau of the Census, and by general hospitals and dispensaries;

(7) Collective investigations by medical societies;

(8) Establishment of industrial museums, occupational disease clinics and hospital services;

(9) Additions to the literature by publication of reports of cases and descriptions of occupational disease hazards;

(10) Periodic examination by trained physicians of employees in dangerous industries.

EDUCATIONAL MEASURES

The Employer.—In seeking statistics from employers of men in hazardous trades there are usually three groups of answers: (a) from those willing and sometimes eager to coöperate in the betterment of their working conditions, either from economic or humanitarian reasons or both, and who only lack the requisite knowledge of such means of betterment; (b) from those who have already adopted all practical means of avoiding disease hazards for their workmen; (c) from those who assert, through indifference or ignorance, that such alleged evils as industrial diseases do not exist, at least in so far as their own establishments are concerned, or that, if they do, they are solely due to the workman's own negligence. As W. C. Garrison says in writing of this topic, "The workman's trials are,

for the most part, viewed through the office window, and often the purpose of such closer scrutiny as he may receive is to note, not how his health is being affected by work, but rather how nearly the product of his labor is in proportion to the wages paid. Of his illness or death there is often 'no record' save that which is incidental to a deduction of wages for lost time in one case and in the other the substitution of a new name for his own on the pay-roll."

In many industries where unskilled labor is employed it is far simpler for the manufacturer to discharge the workman who is incapacitated temporarily by illness resulting from the industry, and replace him, than to take the trouble and incur the expense of installing proper sanitary equipment and regulations.

Such evil conditions can be met to a limited extent by legislation, but legislation regarding protective hygiene necessitates constant inspection to insure its enforcement, which involves great expense to the state. The same or better results may frequently be brought about by instruction. To make this effective, reliable data should be collected and printed by the various state labor bureaus or factory commissioners, concisely summarized for each separate hazard. The employer, when presented with such data, may be convinced of the extent and seriousness of the disease hazards as they concern his own industry; and, if practical and reasonable suggestions for betterment are simultaneously issued, he is almost certain to be convinced, at least, of the economic value of the suggestions, and may put them into effect for greater efficiency if not for humanitarian reasons. The gathering and interpretation of such data is expert work which the employer has not always the means or knowledge to undertake, and the results should be summarized and printed for him in convenient and striking form.

Some of the large manufacturing corporations of this country have already gone so far in hygienic progress as to employ trained nurses to visit the homes of their women employees, who take charge of cases of temporary illness and look after the hygiene of the employee's children, particularly as to the care of their teeth and tonsils, etc., so that the mothers will be less frequently disturbed by illness in their homes.

The Workman.—One difficulty in educating workmen in the avoidance of industrial diseases is found in the shifting character of unskilled labor. Many of the occupational diseases, like chronic lead poisoning, for example, arise most insidiously, and when the workman begins to ail he merely quits his "job" instead of seeking to remedy insalubrious conditions. This fact materially adds to the difficulty of obtaining accurate statistical information regarding the disease hazards of many occupations.

Workmen in general are more ready to enter upon trades in which the hazard is of the nature of accident or injury in distinction from disease. To the workman's mind, an injury is a definite thing which he feels he can understand and avoid, but a trade having a bad name for begetting disease is vague and mysterious, and, if he enters upon it, it is more apt to be under stress of circumstance, with the intention of quitting as soon as he can find better employment.

When attempts are made to secure data from him, moreover, as to his own or fellow workmen's ailments, he frequently denies that such exist, for fear of making it appear to his employer that he is not able to meet standards of efficiency in his work or for fear of dismissal.

Some years ago workmen from a large brass foundry adjacent to one of my clinics came in frequently for treatment for "brass founder's ague." As soon as one of my assistants, however, began to show special interest in the details of their work and environment, and the condition of their fellow workers, they ceased to visit the dispensary and none have come since. Similar experiences are very common.

In order to interest workmen in care of the general health as a means of self-protection against occupational hazards, I have adopted the plan of distributing to them printed circulars of information and precautions. A sample circular follows, devised by my chief of clinic, Dr. W. H. Sheldon, and we have found them much appreciated by the workmen, who take them home and often discuss them with their friends, whereas they are very liable to forget or fail to comprehend mere verbal directions given them at the time of ex-

amination. Many minds, too, are much more impressed by anything which is seen in print.

MEDICAL CLINIC
CORNELL UNIVERSITY MEDICAL COLLEGE
OUT-PATIENT DEPARTMENT

RULES FOR GENERAL CARE OF HEALTH

1. Remember that rooms that have no sunshine are not healthy.

2. Sleep with your windows open and spend as much time as possible in the open air.

3. Take a tepid sponge bath every day, and at least two warm baths a week. Brush the teeth every morning and evening.

4. Unless you have out-door work, walk at least two miles every day. Practice breathing exercises and take fifteen minutes exercise daily with light dumb-bells, or a cane.

5. Habits:

   Sleep eight hours every night.

   Be sure to have one good movement of bowels every morning.

   Do not drink more than one cup of tea or coffee a day.

   Use tobacco in moderate quantities only.

   Drink no liquor of any kind. It destroys digestion, ruins the kidneys and leads to dropsy and other serious diseases.

6. Meals:

   Eat moderate quantities. Chew your food well. Rest for half an hour after each meal.

7. Diet:

   Dairy products.—Milk, cream, butter and cheese.

   Cereals.—Oatmeal, hominy, rice, Indian meal, etc.

   Eggs.—In any form except fried.

   Fish.—Any fresh fish, boiled, baked, or broiled.

   Meat.—All the red and white meats, boiled, broiled or roasted.

   Vegetables.—Potatoes, beans, peas, carrots, beets, turnips, squash, lettuce, tomatoes, spinach, onions.

   Fruits.—All fresh fruits except bananas.

Avoid.—All fried foods, fresh breads, canned or salted meats. Do not eat pickles, pastries or candies.

Remember.—That all alcoholic liquors, including beer, are poisonous.

Do not take alcoholic drinks.

Another sample is given under the heading, Prophylaxis of Lead Poisoning.

Similar circulars might be distributed on a large scale through the agency of trades unions, the circulars being supplied by the state labor bureau or any philanthropic agency.

Another means of educating the workman in special dangers of occupation is by placards posted conspicuously in the workrooms where the danger exists. Such placards of warning have proved valuable in the prevention of accidents, as so well demonstrated by the Illinois Steel Company. The objection to their use is that they are either overlooked or read more superficially than the circular which the workman takes home with him and regards as a personal message.

Some employers are willing to grant time to their workmen to attend brief talks on special hazards given in the mill or workshop by a physician or qualified sanitarian. In New York City lectures on industrial diseases are shortly to be given to workmen in the public schools in the evening. The best method, however, of enlightening the workingman is through increasing the number of physicians appointed to examine workingmen periodically to detect early symptoms of industrial diseases and give direct personal instruction as to avoiding danger. Wherever this has been practiced, as it has been notably in the lead industry in England, it has resulted in enormous reduction of morbidity.

In summary, the workman should be educated through the means of printed circulars, posted warnings, free illustrated lectures, and personally by visiting physicians wherever feasible.

The Physician.—Dr. J. T. Arlidge, of London, has said, "It is as essential to the medical man to acquaint himself with the occupation of a patient as an important health factor as with the hygiene of his home and neighborhood or with his family history. And it is

important for him to arrive at a correct estimate of the part played by employment in producing the symptoms he detects or in causing the mortality he deplores."

It is time that instruction in the occupational diseases should form part of every medical college curriculum, so that interest in this most important branch of medical science may be stimulated at an early period. Further, educational work may well be conducted by the state, which has the means for collection of statistics and for summarizing them in impressive form. Compulsory notification of the occupational diseases (described in the section on this topic on page 68) is the chief means for this purpose, and the notification blanks should be accompanied by circulars or booklets of information on the disease hazards in general, to be sent to those working in municipal hospitals and dispensaries where cases of industrial disease are met with most often. Such institutions, moreover, should see to it that their records of occupational cases are properly classified and tabulated—a matter which is surprisingly neglected in many institutions of high standing.

The rapidly increasing number of monographs published and of medical society discussions upon the occupational diseases evidences the rapid development of a new interest in this matter, and medical societies can accomplish much good by promoting intensive study of all the more important industrial diseases and publishing their scientific reports.

The Public.—The direct interest of the public in the problems of occupational diseases is humanitarian, economic, sociological and legislative, and much is being done for enlightenment through such agencies as social service workers, associations for the study of economics, and labor legislation, through factory inspection commissions and many other forms of special investigation. The problem is as great as that of tuberculosis, and, judging from what has been accomplished in this field in the past decade, there is every reason to hope that equally striking results may soon follow for the mitigation of the occupational diseases. The "traveling exhibits," described on page 6, of the industrial hazards and the establishment of the so-called museums of safety, where many of these

hazards may be illustrated, will do much to promote further public interest in the problems involved.

The Public Press.—Generally speaking, the attitude of the press toward the problems under discussion is improving. Much important information was published in connection with the recent International Hygienic Congress and its admirable exhibition, and the manner in which the campaign against phosphorus poisoning was supported by the press was of great service in suppressing that evil.

One of the most influential of the New York daily papers has begun a collection of printed reports upon occupational diseases to be kept on file for reference when special occupational poisons may demand public attention in its editorial columns, so that correct points of view may be presented.

WORKINGMEN'S INSURANCE AGAINST OCCUPATIONAL DISEASE

It is beyond the scope of this work to enter upon a discussion of economic problems, but no discussion of prophylaxis of the occupational diseases can be complete without, at least, a brief reference to the progress which is being made, through legislation, in helping the workman to secure prompt and scientific treatment for many of the diseases which may be acquired as the direct result of occupation. In German legislation, instituted in 1883 and fully developed since that date, is found the best exposition of this system. The German laws compel the industrial workman whose annual wage is less than 2,000 marks ($480) to insure himself in an insurance fund for which he pays not more than six per cent. of his earnings. This premium, whatever it may be, is doubled by further payment by the employer. The insured acquires free medicine, attendance and treatment, and, if unable to work by reason of illness, he is partially supported for a reasonable time, determined by special conditions.

Dr. George M. Kober, in his report for the Committee on Social Betterment for the President's Homes' Commission, 1908, states that the result of the workingmen's insurance system in Germany has been as follows: "The hygienic conditions of the workingmen

have been improved, both on account of the safeguards which the accident insurance organizations require employers to use and because of the special efforts made by the 'sick funds' to reduce the sick rate among the members to a minimum. The general knowledge in regard to the preservation and promotion of health, which the 'sick fund organizations' have disseminated by means of circulars, monographs, popular lectures, etc., has exerted a tremendous educational influence in the promotion of health and morals. One of the most beneficent features of the entire system has been that parts of the funds of these organizations are invested in model houses, hospitals and sanatoria for the use of members."

And Professor Henderson states: "Property is owned to the amount of $408,000,000, of which $120,000,000 have been invested in workmen's dwellings, hospitals and convalescent homes, sanatoria, baths and similar institutions of welfare."

Not least among the benefits of this industrial insurance system is the important fact that it largely tends to eliminate the elements of anxiety and worry over conditions of illness which so often retard convalescence. Another benefit consists in securing for the workman prompt and skillful care which he otherwise would probably be unable to obtain.

HYGIENE OF THE WORKROOM AND FACTORY

As Dr. Alice Hamilton has said, "The hygiene of a factory depends much more upon the management than upon the construction."

Space.—It is difficult to formulate rules for proper space in factories; for space which may be ample for certain employments is far too restricted in others where dusts and fumes or other deleterious substances pollute the air, where too close proximity to machinery favors accidents, or where an accumulation of manufactured material constantly encroaches. In general, factory laws, in the States where they exist, demand from 250 cubic feet of air per occupant (as in New York State) to 300 cubic feet. In many of the factory laws the floor space per occupant is defined as well as

the cubic air space. But in a large factory room a mere space law is inadequate for controlling health conditions; for parts of the room may be sanitary from proximity to open windows or blow-fans, but other parts may be most unhealthful, where dusts accumulate, or undesirable conditions of moisture and heat prevail. In

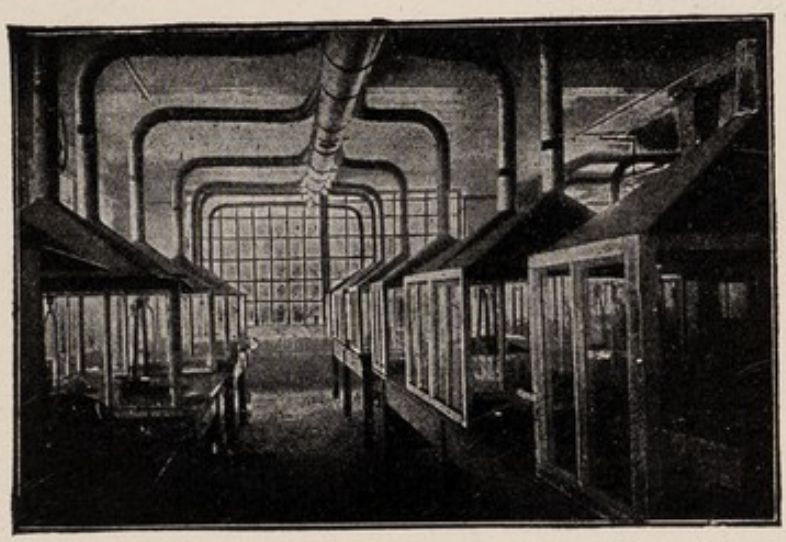


FIG. 5.—INTERIOR VIEW OF A CLEAN, WELL-LIGHTED AND WELL-VENTILATED WORKROOM. Note the broad windows, open hoods over forges, and enclosed hoods over machinery, with elaborate system of exhaust ducts. (From *Rauch und Staub.*)

some industries, as in chrome works, lead works, etc., the packing of injurious materials may be conducted in a very unsanitary room which communicates too directly with an otherwise healthful one. In such cases double sets of self-closing doors should be provided when possible.

Flooring.—The flooring of workrooms is a matter of great importance. Many toxic metallic and other dusts work into wooden floors and accumulate so that where such dusts are generated it is desirable to have the floor made of cement, asphalt, concrete, tiles or some similarly impervious material, which presents a hard, smooth surface and may be thoroughly washed daily. Similar flooring should be used wherever animal products are dealt with, as in tanneries, slaughter houses, bone fertilizing plants, etc., so that it can be cleaned with antiseptics. Such floors, however, are often cold and hard to stand upon all day, as in tending a loom or card-

ing machine, and in factories of this order wood flooring may be preferable, or, if harder floors are used, the workmen may be given strips of linoleum to stand upon. Silicate solutions are sometimes applied to both floors and walls to render them impervious to moist-



FIG. 6.—A MODEL LAVATORY AND LOCKER ROOM. A. 40 wash bowls, or one bowl for 2½ men. B. 156 lockers; this provides one locker for each of the 156 day and night turn mill men. C. 4 shower bath compartments. One shower for 25 men. D. One slop sink. E. One heater. (Pipe Mills of the National Tube Company.)

ure and dust. Whenever workmen are employed in work where the floors are liable to be constantly wet, or where acid or dye solutions may be spilled, as in tanneries, paper mills, pottery glazing rooms, dye houses, etc., their feet should be protected by standing upon wooden or other slabs, raised a few inches above the floors.

Ceilings and walls should be limewashed two or three times a year or freshly painted once a year, and beams, shelves, corners, sills and all recesses should be kept dust free as far as possible.

Lighting.—Proper lighting of workrooms is most important. Good daylight, and especially sunlight, is necessary for purifying the air, besides improving the cheerfulness of surroundings and consequently the morale of the worker. The evil effects upon the eyes

of wrongly placed artificial lights are described under Eye Strain, and illustrated in Figures 7a and 7b. In addition to the effect upon the health of poor light is the extra hazard from accidents from machinery or otherwise which it engenders.

The construction of many modern factories with walls largely composed of glass in iron frames has done much to promote health and efficiency. The area of factory windows should be at least one-third of the wall area, and one-sixth of the floor space. In Germany, for illumination of modern factory buildings, a light area of $8\frac{1}{2}$ to $10\frac{3}{4}$ square feet for every workman employed is required. For the best results in general artificial lighting, factories should have light-colored smooth walls for reflection and lights backed by reflectors should be suspended near the ceiling.

In artificial lighting of workrooms in general this overhead system is best, with lights placed well above the natural level of the eye. In some cases, however, side illumination is essential, and beams, walls, girders or partitions, when painted white, may often be utilized to reflect and diffuse light, and, also, in some cases, to conceal it and prevent the glare which causes so much fatigue of the workman. Workmen who constantly look down on their work suffer less from fatigue than when the eye must glance along horizontal and brightly reflecting surfaces, as in polishing bright metals. In the latter case, when possible, the light should fall upon the object from behind the workman, or at an angle at which it will be reflected away from, rather than toward, the eye. C. E. Clewell, investigating for the Westinghouse Company, writes that in one factory "the almost humorous statement was made upon the installation of a good overhead system that the men did not wear out their shoes as fast as formerly—meaning that the matter of getting around had been complicated by their stumbling against the loose iron and other material which had been allowed to accumulate."

When the nature of the work requires the use of strong light very close to the operator it should always be so placed and screened as to prevent injury to the eyes. Brightly shining surfaces, especially if in motion, are injurious to the eyes if closely watched.

Workrooms and storerooms containing inflammable materials, like



FIG. 7A.—POOR ILLUMINATION OF A FACTORY.



FIG. 7B.—GOOD ILLUMINATION OF A FACTORY. This is a room in the same factory shown in Figure 7A. Note the well-diffused overhead and lateral illumination.

turpentine, benzene, ether, or explosive dusts, like sugar, fine sawdust, flour dust, etc., should be lighted only by electricity, preferably from without, through a window, or enclosed lighting plant, and entered only with safety lamps. Otherwise, serious explosions and burns or other injuries may occur.

Drinking Water.—An adequate supply of good drinking water is most essential, particularly in such occupations as expose the work-



FIG. 8.—SANITARY FOUNTAIN WITH COOLED WATER. (Carnegie Steel Company.) The box behind the fountain contains ice surrounding a coil of pipe through which the water supply runs. (*Monthly Bull.*, Amer. Iron and Steel Institute, June, 1913.)

men to constant loss of water from the system by perspiration, as in the case of foundrymen, glass blowers, bakers, potters, stokers and others exposed to great heat. The concentration of waste matter in the system induced by excessive perspiration predisposes to the acquisition of constipation, catarrh, rheumatic affections, etc.; and in many cases two or three quarts or more of water daily are needed

in the system to counterbalance loss through perspiration. On the other hand, the drinking of large quantities of ice-cold water at a time tends to produce gastric catarrh, dilatation, and diarrhea. Hence, the water supply should be easily accessible, so that lesser quantities may be drunk at frequent intervals. In certain cases oatmeal water or barley water may be supplied with advantage to quench thirst and prevent excessive drinking.

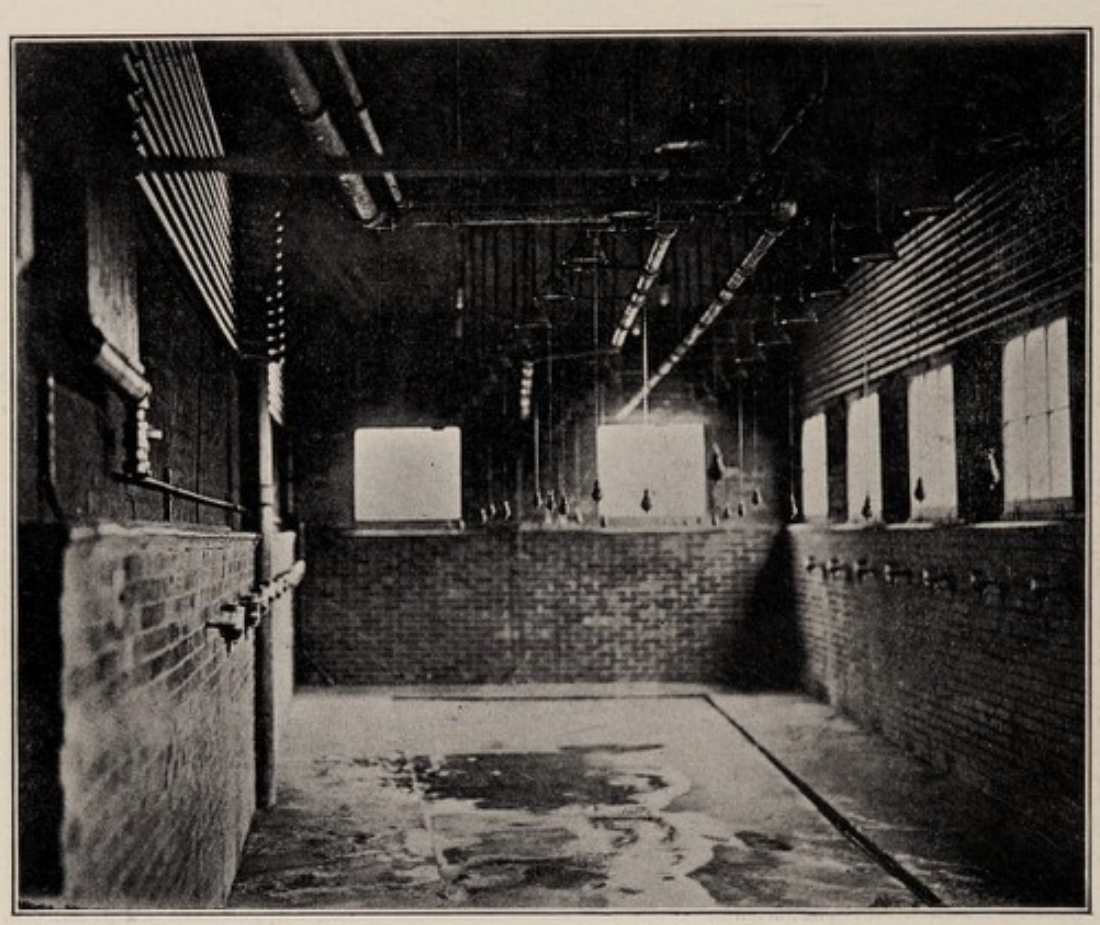


FIG. 9.—MULTIPLE SHOWER BATHS FOR CHEMICAL WORKERS. (From the Illinois State Department of Factory Inspection.)

Individual drinking cups are now required by law in many states. They may be made cheaply by folding a square piece of paraffined paper into a cone or cornucopia; but a vertical tap of running water, controlled by a foot pedal which needs no cup, is the most hygienic, as well as the most economical arrangement. It not only prevents the introduction into the mouth of poisonous metals on the rims of dirty drinking cups or glasses, but, also, the possible oral transmission of syphilis. (Fig. 8.)

Washing.—Water should also be supplied abundantly for washing the face and hands, and in the dusty metallic industries for use in cleansing the teeth, as well. Whenever possible the water supplied for these purposes should be both hot and cold, and this is obligatory in lead works under the English factory laws. The best bathing facilities which are required in white lead works, chrome works and similar extra-hazardous industries are supplied by over-



FIG. 10.—A CHANGE HOUSE OF THE OLIVER IRON MINING CO. Racks for drying clothes are shown, as well as lockers (on the left), shower baths (on the right), wash stands, and benches to sit upon while dressing. (From the collections of the American Museum of Safety.)

head showers or douches. (Fig. 9.) If the workman places a handful of soft soap on his head and stands under a douche of warm water, he can soon cleanse the body thoroughly with a minimum loss of time. Washrooms should be supplied with individual towels, and never with roller towels, which are most unsanitary and very liable to spread disease. Paper towels, which are very cheap and require no washing, are now much in use in the better class of factories.

Lockers.—Individual clothing lockers should be provided, and wherever the trade is so hazardous, as in lead works, that a complete change from the street clothing to working clothes is essential, two lockers should be provided for each workman, so that the locker contaminated by soiled overalls may not soil the street clothing. The lockers should be of metal, with open wire fronts and tops to promote free ventilation, and with a separate compartment for shoes at the bottom, if they require to be changed. The lockers should be fitted, also, with a shelf at the top on which the workman may keep his individual towel, soap and nailbrush; and, in some industries in which care of the mouth is most important (as in lead works), a toothbrush should also be kept on hand. The lockers should be close to the washroom, and, if the occupation is such as to wet the clothing or overalls, a drying room with suitable clothes racks should be close at hand. (Fig. 10.)

Cuspidors.—Although the spitting habit should be discouraged among all workmen, there are many who will not control it, or who use chewing tobacco and expectorate the juice. Dried sputum not only spreads tuberculosis, but also catarrh and influenza germs. The most sanitary cuspidors are flat boxes of wood or metal, at least a foot square, filled with dry sand or sawdust, which should be renewed frequently. Heavy penalties should be imposed for expectorating anywhere else than in a cuspidor. In every factory employing large numbers of work people a few are liable to have incipient tuberculosis of which they may be unaware. Hence the only safe rule is rigidly to control expectoration in every case.

Toilets.—Dirty waterclosets and urinals spread disease, prevent proper attention to the normal excrementory functions, and are generally demoralizing. The closets should always be separate for the sexes, and should be washed daily with a disinfectant. In several States the factory laws require a minimum of at least one closet for each twenty-five persons of each sex. The floor should be of impervious material, preferably cement, and the closet should have access to daylight and outdoor air. Printed rules for keeping the closets in sanitary condition should be posted plainly in sight in each one. A cold, damp, foul-smelling, dirty closet tends to short-

ening of the process of defecation and is a potent factor in inducing constipation.

Cleaning of Dusty Workrooms.—Workrooms should be cleaned only when the operatives are absent. Metal dust should first be wetted down with a water spray or wet sawdust, and workbenches, seats, window sills, tables, etc., should be cleaned with damp cloths to prevent agitation of the dust. Whenever dry sweeping is done much dust rises in the air, only to settle again on workbenches and seats after the imperfect cleaning has been done. When possible, dusty machinery or inaccessible corners holding dust should be cleaned out by a bellows or stream of compressed air. Floors should be flushed when possible, and mopped at least twice a week. After the workmen have left a dust-filled room sufficient time should elapse for the dust to settle before it is cleaned.

Furnaces, evaporating and drying chambers, pottery baking ovens, brick and lime kilns, etc., should not be entered to be emptied or cleaned until so thoroughly cooled that all dust and fumes have had time to settle. It is often possible to moisten such oxidizing chambers before they are entered without damage to the product, and this should be done when

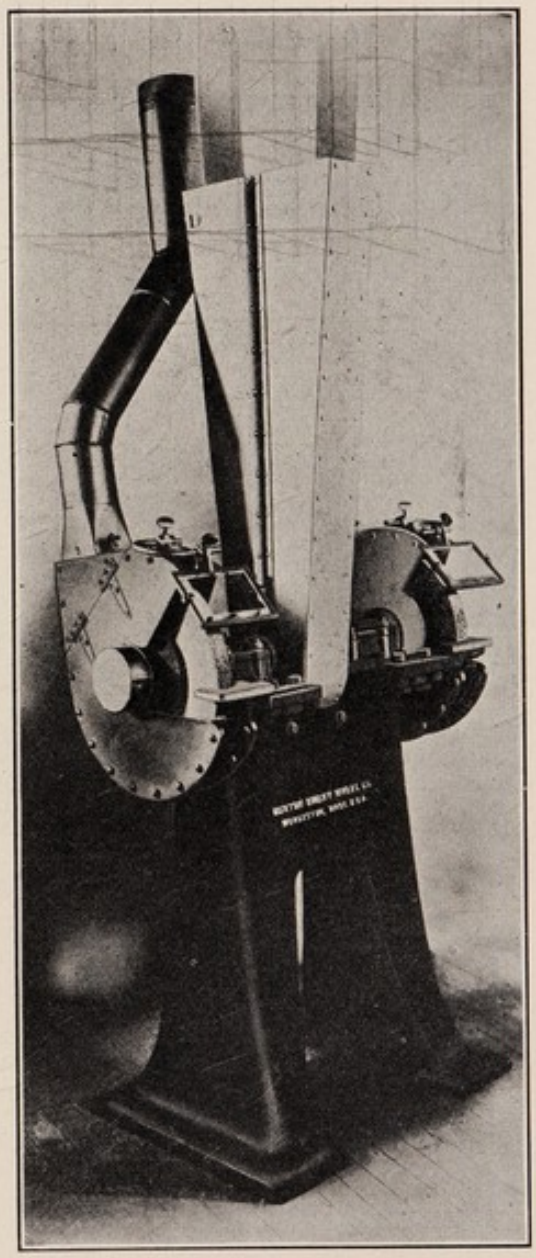


FIG. 11.—WELL-PROTECTED GRINDING WHEELS. Note the small surface of wheels exposed, the glass shields to keep sparks and dust from the workman's eyes and the excellent dust exhaust pipe system. Hazards: emery and metal dust. (From the plant of the Addressograph Company.)

practicable. In some cases dust may be allayed by sprinkling a surface to be scraped or sandpapered with a non-drying chemical oil. In certain industries, like cement making, dust has been successfully precipitated by means of electricity. (*See* Cement.)

All packing of dusty material, "heading up of barrels," etc., should be done in separate rooms provided with special ventilation exhausts, and the employees should wear respirators.

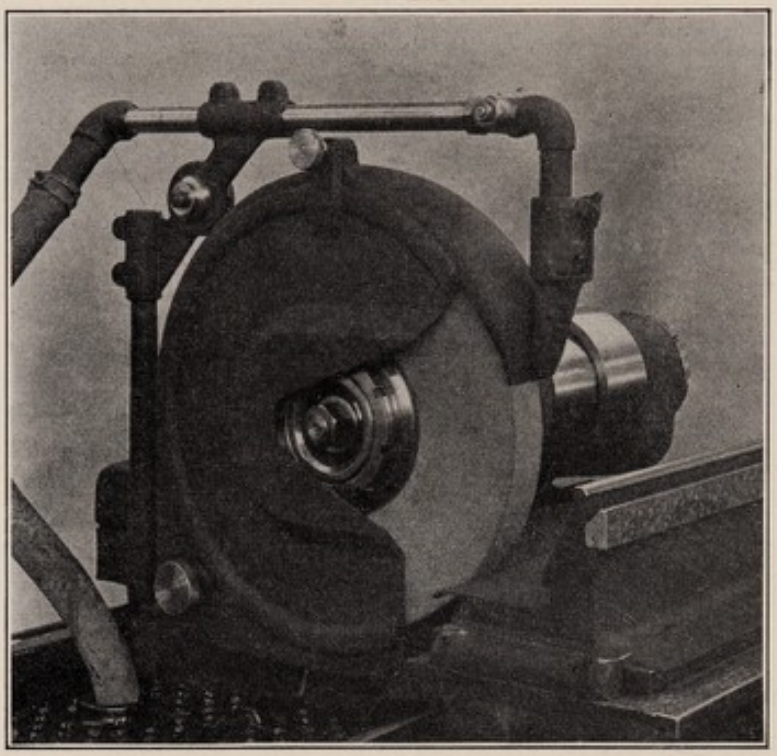


FIG. 12.—EMERY WHEEL FOR WET GRINDING, WELL-PROTECTED BY A SHEATH. It does not require an exhaust hood. Water flows over the wheel from the pipe above. The material to be ground is held on a lathe, hence there is no dust hazard for the workman.

Grinding of ores, slag, lead carbonate, chromates, pottery scouring, and all similar extra-hazardous dusty work should be done by machinery protected by drums, removable tight-fitting hoods, or other safeguards against dust dissemination. (Figs. 11, 12.)

Joints of containers, machines, conduits, flues, etc., which are liable to permit the outward leakage of dusty material should be wrapped with thick felt, wool or asbestos to prevent such leakage into workrooms.

The practice of carrying molten metal in uncovered pots through the workroom should be prohibited.

Protection of Receptacles.—Kettles, tanks, etc., containing boiling oil, acids, dyes, etc., which substances are liable to do injury to the eyes or skin by spattering, should not be filled to the top, and

should be protected by properly fitting covers, or connected with hoods, when necessary, through which toxic fumes may be drawn off by exhaust fans. They also should be provided with an overflow channel and receptacle. Openings in the covers to admit the stirring and inspection of contents should have sliding valves or traps. Pots, kettles, evaporating pans or other receptacles of dangerous liquids which cannot be covered without interfering with the process in hand should be elevated above the floor to a sufficient height to lessen the danger of spattering fluids or of inhaling fumes when leaning over the receptacles.

Grinding and Mixing.—The grinding and mixing of raw materials of toxic nature, such as chrome, lead salts, lime, phosphorus paste, etc., should always be conducted in separate apartments, especially ventilated, to prevent access of dust to other departments. The same rule applies to barreling or packing all such products. Respirators, special overalls, or gowns, and head covering should be worn while conducting such processes.

Antidotes and Protectives.—In certain industries antidotes for poisons or other means for prompt emergency relief should be kept close at hand. Where caustic soda or potash is dealt with, syringes or wash-bottles filled with pure water should be ready for use in case the material be spattered into the eyes, mouth or face. Wherever strong acids are in use, buckets of water should be at hand, or vessels of alkaline solutions, for use in case receptacles of the acids be broken or the contents otherwise spattered upon the skin or into the eyes. In foundries, acid and dye works and the like, where burns of the face, hands or eyes are liable to occur at any time from spattering, an emergency kit should be kept always ready containing lime water and olive oil (to make the carron oil emulsion), vaselin, rubber protective, absorbent cotton, bandages, boric and carbolic acid solutions as disinfectants, and brandy. Further emergency protection of the eyes with oil, etc., is described under Diseases of the Eyes.

In powder works, gas plants and all chemical works where the workmen might accidentally be asphyxiated by sudden escape of poisonous gases or fumes, resuscitation appliances and hypodermic

stimulants should be kept ready for prompt emergency use. (*See* Pulmotor.)

In chemical works, where sulphuretted hydrogen or other dangerous gases are liable to be inhaled, respirators should be worn charged with moist oxid of iron.

Where the dressing of hides, making of bone fertilizers, or other occupations liable to cause infection through skin abrasions are conducted, antiseptic solutions with collodion and protective plasters should be kept at hand to apply at once to any cut or abrasion of the hands.

In chlorate mills tallow should be used to protect the exposed skin. In many industries in which fumes are liable to injure the skin of the face it may be protected by smearing with oil, tallow or other lubricant.

Hours of Work.—In many excessively hazardous trades it is necessary to restrict the hours of work very definitely and prescribe intervals of rest. This applies particularly to work in compressed air, vulcanizing rubber by means of carbon bisulphid, dinitrobenzol, cleaning out the "blue beds" of lead carbonate, phosphorus, and in some departments of the felt hat industry.

VENTILATION OF THE WORKROOM

The problems of factory ventilation which concern the health of the workman are exceedingly difficult to formulate, owing to the lack of generally accepted standards and the varied requirements of different trades and subdivisions of the same industry. There were, in 1911, only ten States having legislation for protection of the laborer from toxic gases, vapors and fumes; and in only six is this legislation fairly definite as to the use of exhaust and intake fans. In general, where many workmen are crowded together in the same room, a minimum air space of 250 to 700 cubic feet per person is prescribed (as it was in eight States in 1911) for each person to work in; but, obviously, much more depends upon frequent change of the air, dust removal, and that the air space shall go with a reasonable floor area, and not include portions of air so

far above the workman's head that it is of little use to him. Factory room air becomes vitiated from the following sources:

(1) Products due to materials consumed in the industry, as by combustion;

(2) Products liberated from materials used, as by evaporation, dust production, escape of gases, vapors and fumes, etc.;

(3) Products of incomplete combustion of gas, petroleum, or other materials used for heating and lighting, as by gas stoves and burners;

(4) Products of exhalation from the lungs, skin emanations, and expectoration, coughing, etc., of the workmen;

(5) Dust and dirt brought in from outside or from adjoining dusty workrooms by the shoes and clothing of the workmen;

(6) Excessive steam and moisture;

(7) Impure air supplied by blow-fans which derive the intaken air from vitiated sources, as smoke and dust liberated from other parts of the building.

In Manchester, England, it was estimated that in three days there fall upon one square mile, as products of incomplete combustion of coal used in factories, 1,455 lbs. of soot, 110 lbs. of sulphuric acid and 55 lbs. of hydrochloric acid. This illustrates the extreme degree to which pollution of the air by factories may attain.

The question of adequate ventilation of factories is twofold, dealing first with the ventilation of the building as an ordinary problem of air renewal in large rooms with many occupants, and, second, with the removal of special products of vitiated air generated through processes of manufacture. The first does not differ in principle from ordinary ventilation of large buildings and should, as far as possible, be independent of elaborate mechanical appliances.

The second problem demands forced ventilation by a more or less complicated system. I have had much experience with elaborate ventilation mechanical systems in hospitals, lecture rooms, etc., and am convinced that any air supply which has been superheated, humidified or otherwise artificially tampered with is rendered undesirable thereby. Nevertheless, in many factories, mills, chemical works, etc., harmful dusts, gases or fumes are evolved incident to

the particular variety of manufacture, which must of necessity be removed by stronger air currents than can be depended upon from natural sources, and forced intake and outflow of air must be maintained by artificial means.

Many chemical analyses of factory air and dust have been made of recent years, and they are frequently of value in determining legislation for control of deleterious conditions. The study of the effects of polluted air in factories upon the human organism, which is of much greater importance from a scientific point of view, has heretofore been much neglected.

The study of the fitness of the air supplied by any artificial system may be tabulated crudely as follows:

METHODS OF STUDYING THE FITNESS OF THE AIR FOR RESPIRATION

I. *The physiological method*	II. *The physical method*
The use of the nose.	The thermostat and thermometer.
Blood pressure tests.	Cubic feet of air supplied per hour.
Metabolism tests; volume and composition of expired air.	Air analyses.
Symptom tests, as blood tests, headache, indigestion, dyspnea, etc.	Hygrometry.

It will be seen at a glance that these two methods are diametrically opposite, for the first deals with the man, the other with the environment. Yet the former method has been so much neglected that few reliable data are obtainable concerning it, while the latter method is supported by volumes of highly impressive theoretical calculations.

The use of the nose, of a reasonably educated nose, as a means of detecting foul air, is entitled to far more respect than it generally commands. Bad odors, of course, do not prove that a given atmosphere is irrespirable. Bad odors of a certain kind do prove indisputably that the air is not *clean* air, that it is not fresh, and that

it has been inside of someone's lungs already or is polluted by foreign substances. One of the most striking of the effects of inhalation of stale or foul air by those who are ill with such diseases as pneumonia, pleurisy and other pulmonary affections is the influence upon blood pressure.

In the Presbyterian Hospital, New York City, I have found a difference of 20 to 30 mm. in patients placed under the opposite conditions of stale and fresh air. In the same patient I have repeatedly measured a difference of 20 mm. on taking the patient to the open air, returning him to the ward, taking him out again, etc. In the fresh air, the cyanosis disappears, delirium subsides and many other symptoms promptly improve.

Dr. B. Raymond Hoobler, working in my clinic in the wards of Bellevue Hospital, New York City, has charted a series of blood pressure experiments of this kind, several of which are reproduced here from my article on "Ventilation Problems in Hospitals and Schools," published in the *Heating and Ventilating Magazine,* May and June, 1912.

Metabolism tests of the rate of chemical interchange, i. e., of the nutrition of the body, involving oxidation processes, as modified by air of different sorts, have hitherto been much neglected, but with the perfection of modern calorimeter apparatus, as adapted to human respiration, such tests are being made and constitute a very convincing argument for the admission of fresh outdoor air to factory workers, in whom it cannot fail to promote efficiency in labor.

In the case of a patient recently experimented upon for me by Drs. Hoobler and Burnham, in Bellevue Hospital, the following result was obtained. The patient was left overnight in a small room with window tightly closed. A pipe was then introduced through which the patient breathed fresh outdoor air while still remaining in the closed room. A brief supply of this air lasting only fifteen minutes made no appreciable difference, but after the window was left open for a couple of hours, all conditions surrounding the patient remaining otherwise the same, the rate of metabolism was increased to a very striking degree, as shown by the following charts, 13, 14 and 15:

Under some conditions, with poor ventilation or stagnant air, a variety of symptoms obtains, such as anemia, headache, anorexia, etc., or, if they already exist from other causes, it is found to be impossible to procure betterment under the influence of poor air. The behavior of these symptoms constitutes far more convincing proof of the real conditions of the air than any theoretical computation of the number of cubic feet of air supplied per hour, hygrometric tests, etc.

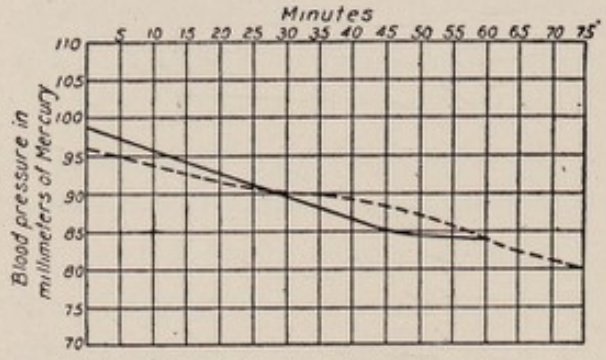


FIG. 13.—TWO BLOOD PRESSURE TESTS ON PATIENTS WITH PNEUMONIA, FROM THE TIME OF GOING INDOORS FROM OPEN AIR. One case is shown by the dotted line, the other by the continuous line. (Hoobler.)

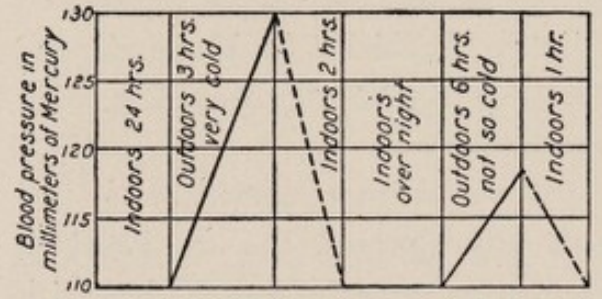


FIG. 14.—BLOOD PRESSURE TESTS ON A PATIENT WITH PLEURISY AND EFFUSION, MODERATE FEVER. Continuous line, outdoors; broken line, indoors. (Hoobler.)

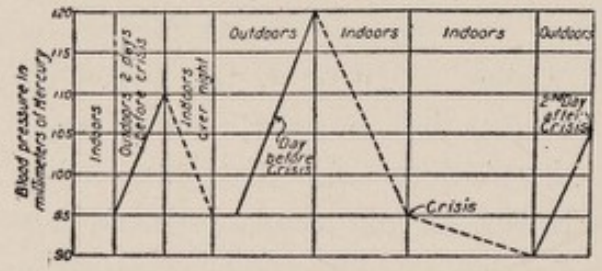


FIG. 15.—BLOOD PRESSURE TESTS ON A PATIENT WITH LOBAR PNEUMONIA. Continuous line, outdoors; broken line, indoors. (Hoobler.)

The value of the carbon dioxid test to determine the fitness of air for breathing has been much questioned, especially where attempts are made to establish legislative standards for factory ventilation. Originally regarded as of prime importance, the test has been discarded by many upon the ground that the gas when present in reasonable quantity is not especially injurious. In fact, the present tendency is to substitute humidity tests for it exclusively. This is based upon a misconception of what the test reveals. In all metabolism experiments which include analyses of the expired air, the CO_2 estimation is a most valuable index. (Fig. 16.) More-

over, the only source of CO_2 in an ill-ventilated room occupied by human beings (apart from that developed in certain trades) is the lungs. Hence, CO_2 accumulation in a room means that the air has been breathed many times over by the occupants, and is, therefore, unclean air.

When rightly interpreted, therefore, CO_2 estimation has distinct value as a ventilation test of room air. I published in the *Medical Record* of February 9, 1907, the results of some very careful CO_2 tests made for me in the wards of the Presbyterian Hospital by Dr. C. G. L. Wolf. We found that when fresh air on the hospital roof was practically normal (i. e., 4.06 parts CO_2 per 10,000 volumes of air) that in the wards, with the most complete closed ventilation system in full operation, contained as much as 4.71 parts CO_2, and after twenty visitors and four nurses had spent one hour in the ward this content rose to 5.13 parts.

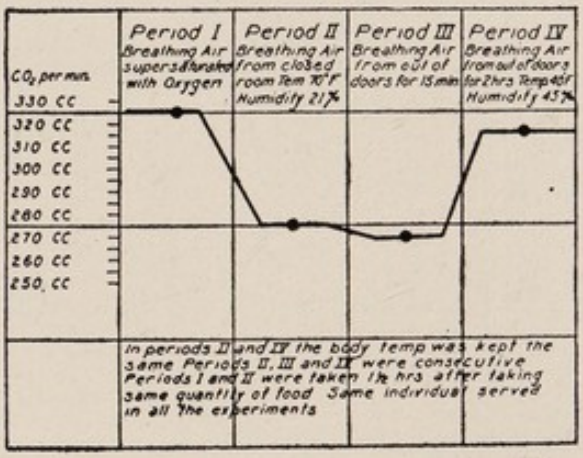


FIG. 16.—METABOLISM TESTS WITH PATIENT BREATHING DIFFERENT QUALITIES OF AIR. (Hoobler.)

Immediately thereafter the ward windows were opened for ten minutes only, and the CO_2 content at once fell to 4.34 parts, and, although on a cold December day, the ward temperature fell only 3° F. Thus an increase of more than 20 per cent. of CO_2 was produced in a short time by the visitors.

All this constitutes a strong argument for open-window factory ventilation wherever it is feasible. There are, however, objections to it which in some cases are insurmountable. Window ventilation is not strong enough, under ordinary conditions of external air, to drive out toxic gases, vapors or fumes developed in the nature of the industry; and to make exhaust fans effective the windows must be kept closed, at least where the ducts are very large. This, however, need not apply to the operation of small exhaust ducts placed, as

they should be, whenever possible, close to a localized source of air pollution, as over a small pot of molten lead in a linotype machine, or over an emery wheel, as shown in the illustration on page 93.

In general it may be concluded as follows:

(1) Whenever possible factories should be ventilated by open



FIG. 17.—SIDE AND OVERHEAD LIGHTING AND VENTILATION OF A COTTON MILL. Note the open transoms and skylights and the method of hinging the sash to swing as a whole—an excellent system. The unshaded electric lights are hung too low and cast a glare; the day illumination is better. Hazards: dust and oil.

windows, and, if the room be immediately under a roof, by the skylights as well. (Fig. 17.)

(2) Heat should be supplied by steam or hot water pipes placed below or near the windows.

(3) The windows should be either of the French casement type or hung upon central swivels to open either in the horizontal or vertical plane. This permits of the entire area of the window frame being opened at once (Fig. 17), instead of only half of it, as when the

type of window with sash, cord and pulley is used. Moreover, such windows, if made to open outward, may direct the inflowing air or control too strong a wind current.

(4) Transoms should be made to open above all windows and doors, and where the windows have several panes, at least one of them should be hinged so that it can be opened when the window is closed. One of the chief difficulties in window ventilation lies in the deep-rooted but fallacious objection on the part of the operatives to "draughts." Their work often requires good light, hence they work as near as possible to windows. They may become overheated, and, from the very fact that they breathe so much foul air, their sensitiveness to chilly sensations is greatly increased. By the means above suggested, however, the admission of pure outdoor air may be largely controlled so as not to annoy the workers.

In some industries, especially in the spinning and weaving of textile fabrics, outside dust entering through open windows might prove injurious to the products. Too often on passing a large fabric mill in New England, for example, one sees all the windows tightly closed even in midsummer. Outside dust may be kept out to a great extent by wire or thin cheesecloth window screens, which impair the lighting very little, but admit air by diffusion. Wherever space permits, as it often does in country mills, the outside dust nuisance may be abated by growing grass about the mill, and dusty roads may be tarred or sprinkled.

An important matter in factory ventilation is usually ignored. It is that overnight, on Sundays, etc., when the rooms are not occupied the windows should be widely opened to thoroughly freshen the air in which large numbers of persons may have to be confined for long hours next day. In many cases the windows should be opened at the noon hour, where separate lunch rooms are provided.

As accessories to window ventilation there are two appliances which are most effective and in no wise impair the principle contended for, namely, that air which has been superheated or otherwise altered by any artificial system necessarily loses its subtle quality of "freshness," on which invigoration of the working body so immediately depends, and which, while recognized by everyone,

is not capable of measurement or analysis by any physical or chemical means at present understood.

One of these is the use of electric fans so placed about the workroom as to keep the air in motion. This has the effect of developing gentle air currents, thus aiding diffusion and mixing the air. The zone of exhaled air with which everyone tends to surround himself when quiescent is broken up, and in warm weather evaporation from the perspiring surface of the body is promoted.

The other means consists in establishing vertical flues in the walls, opening to the outer air and opening into the workroom two or three feet above the floor, precisely like the method which is always so successful in ventilating cow barns. The room opening should have a sliding door by which its size may be regulated, and it may be desirable to set a gas burner within the flue to warm the upward current of air. This arrangement corresponds with setting a lamp in a bedroom chimney, which everyone should know is one of the best and simplest methods of ventilating a bedroom.

Too narrow an interpretation of the records of physical apparatus leads to many curious fallacies. One of the commonest of these is that with a given ventilation system an unvarying thermometric record is a test of its efficiency. Hence, also, the fictitious value of the thermostat.

Nature certainly intended man to have the stimulus to respiration and circulation of varying temperatures. The day and night temperatures vary naturally the world over, except, perhaps, in the "dog days" of midsummer, and all the vital phenomena of the body are gauged for the stimulus of change and rhythm.

A second fallacy, common among mechanical engineers, is the belief that computation of the number of cubic feet of air supplied by artificial force to a room is absolute proof of the quality of the ventilation. There might be some reason in this belief if a block, so to speak, of good air could be inserted in a workroom and simultaneously drive out another compact block of foul air, as one may fill or empty a syringe with air, or work an air pump. A most elementary knowledge of the laws of almost instantaneous diffusion

of gases, however, shows how impossible it is to thus "completely" change the air in a large room so many times an hour.

If good air is forced in, it mingles with the foul air, and, in the exhaust, a mixture of good air and foul air may be withdrawn. But there are always certain currents of such air, despite the diffusion, in a large factory, which are dependent upon differences in temperature at different levels, obstructions of various kinds, and the shape of the room, which give rise to stagnant areas where the air is very slowly changed. Experiments with smoke and various odors afford ample proof of these facts.

Fresh, clean outdoor air, admitted through a window, is, of course, subject to the same laws of diffusion, but it has the advantage of purity, has not been superheated, and the difference in temperature which exists, at least, in winter, favors interchange more rapidly with the indoor air.

A third fallacy is that hygrometry affords a complete test of the fitness of the air for breathing. It is rather a pity that this test is having at present so much attention focussed upon it, for it tends to divert investigation from other directions. I have listened to essays by enthusiasts according to which, so long as the air was kept at 65° F., with a relative humidity of 60 per cent., it was perfect for purposes of respiration, although it might previously have been breathed by a dozen persons and might contain sulphuretted hydrogen or carbon dioxid in large proportion, or it might have contained 50 per cent. of illuminating gas, for all that was stated to the contrary!

The question of relative humidity is not so easily disposed of. Alternating high and low humidities in time may irritate the respiratory mucous membranes, but atmospheric humidity should not be regarded as the sole or most important criterion in determining the fitness of the air to breathe. Superheated or "canned" air, remoistened to the desired humidity of 60 per cent., stagnating in a factory room, where it is rebreathed many times, may conform to all the physical standards of perfection, yet the workmen may continue to grow anemic, lose appetite and strength and suffer from headache and other nervous disorders until some humanitarian turns off the patent air washer or humidifier in the basement, opens the windows

to admit fresh, free-flowing outdoor air, and lets Nature take care of the humidity!

Humidity, moreover, acts more strongly upon the outer surface of the body than upon the ultimate respiratory interchange in the lungs; for upon the moisture and temperature of the air depend the other physiological processes of radiation and convection of body heat and stimulation of the cutaneous vasomotor nerves, processes quite apart from the mechanism of respiration, though often confounded with it in discussions on the fitness of the respired air.

A fourth common fallacy is the reference to the feeling of personal "comfort" to determine the fitness of respired air. Nothing could be more misleading, and it is precisely this feeling of "comfort" which makes it so difficult for many persons to tolerate open windows. Factory operatives, mill-hands and the like often say they are perfectly "comfortable" in an atmosphere which, to an outsider, is obviously extremely deleterious, if not seriously toxic. A man in my clinic in Bellevue Hospital was admitted in coma from accidental gas poisoning. When he recovered I asked him particularly about his initial sensations. He had not been in the least "uncomfortable" in an atmosphere surcharged with gas, in which he lay down and calmly went to sleep. I have seen many such patients, but recall none who was "uncomfortable," excepting as the odor of escaping gas is disagreeable to most persons.

This sensation, therefore, is a dangerous index of proper ventilation, being, in many cases, referable to cutaneous vasomotor and sensory conditions wholly apart from the mechanism of respiration.

The foregoing statements have largely been quoted from my article on "Ventilation Problems in Hospitals and Schools" in the *Heating and Ventilating Magazine,* May and June, 1912.

Haldane states that still indoor air is "uncomfortable" with the wet bulb thermometer at 70° F. and the room temperature high. I have personally, however, been perfectly "comfortable" with the wet bulb temperature at 74° and room temperature at 78° F., with air stirring from a window, and extremely "uncomfortable" outdoors with the wet bulb marking only 71° and the dry marking 76° F. At another time I have been very comfortable under identical con-

ditions, but with more air stirring. Haldane further states that, if the wet bulb temperature rises above 80°, elevation of body temperature may occur, and, if it be 88° to 90° F., the body temperature rises, even if one is naked and doing no work. In England, however, such midsummer conditions of humidity with high temperature rarely obtain as are so common in the Eastern and Middle United States; and in England the wet bulb temperature rarely reaches 70° F. in the open air even in the hottest summer.

Relative humidity is often quoted, but, as Haldane says, it is the wet bulb reading in connection with the atmospheric temperature which preferably should be cited.

It is a pleasure to note the reaction which is already taking place in regard to hygrometry. In the issue of the *Heating and Ventilating Magazine* for December, 1911, Rosenau and Amos conclude: "There has recently been a growing tendency to regard the ill-effects of vitiated air as due to the increased temperature and moisture, but it is now apparent that there are other factors which must be taken into account."

The point I wish to emphasize and which often is lost sight of is that it is not absolute standards of humidity alone which should be regarded in determining the healthfulness of the surrounding air in the workroom. I have dwelt at length on this matter because the English laws determine standards of humidity in many occupations, especially cotton and jute spinning. In this country the question has not thus far been arbitrarily formulated by legislation, no doubt because in summer in many parts of the country the natural atmospheric humidity exceeds the English legal standards and it is of course futile to legislate against natural phenomena.

Humidity, the moisture or dryness of the body surface and of the clothing, the motion of the air and its temperature, all enter into the relative comfort of the individual. Shortly after eating a heavy meal one may be uncomfortably cold in the same atmosphere in which he later becomes comfortable, owing to the deflection of blood from the surface of the body to the viscera during digestion. Ill health and feeble circulation, age and many other factors affect the sensation of comfort in different atmospheres.

The previous discussion deals with the problems of factory ventilation in general, where it may be possible to employ open windows and skylights, and supply necessary heat in winter by radiators. There remains the problem of ventilation where these conditions are made impossible from one or more of the following reasons:

(1) The nature of the products manufactured may require closed windows to keep out dust or retain a larger degree of moisture, artificially supplied, than is usually present in the outside air.

(2) The harmful substances produced incidentally to the manufacture may be present in such volume that forced air currents are necessary to drive them out of the room and keep the air respirable. Such are most of the toxic gases, vapors and fumes, and many of the dusts.

(3) The dusts produced may be so heavy, as in the case of emery dust, steel and brass filings, sand from sand blasting, etc., that they will not pass out of a window, but must be forcefully aspirated.

(4) The temperature and humidity developed may be so great as to require a forced air intake to neutralize the harmful effects.

(5) Outdoor weather conditions may exceptionally be so poor as to render closure of the windows necessary.

In all these circumstances air must be supplied through intake ducts of large size, so placed as to disturb both the dust and the workmen as little as possible. Such air currents are now almost universally supplied by rotary fans contained in large drums and propelled at great velocity by steam or electric power. The air thus supplied may be filtered by drawing it through cloths or wire mesh, and, if necessary, moistened by sprays of steam or water, or by passing over wet cloths or other wet surfaces from which the moisture is derived by evaporation. It is best, however, in all cases to supply heat and air by independent systems, i. e., by radiators independent of the air ducts, for in this manner the air need not be superheated, and the temperature of the workroom is more easily regulated. Moreover, on occasions the windows may be opened and fresh air admitted without using the ducts, but retaining the heat supply if necessary. In large factories it often happens that dif-

ferent temperatures are required in different rooms. The intake ducts for each room should be so arranged with valves or doors that the air from any duct may be turned off without dislocating the entire ventilation system of the building. This is a very important matter too often neglected. With independent supply ducts and

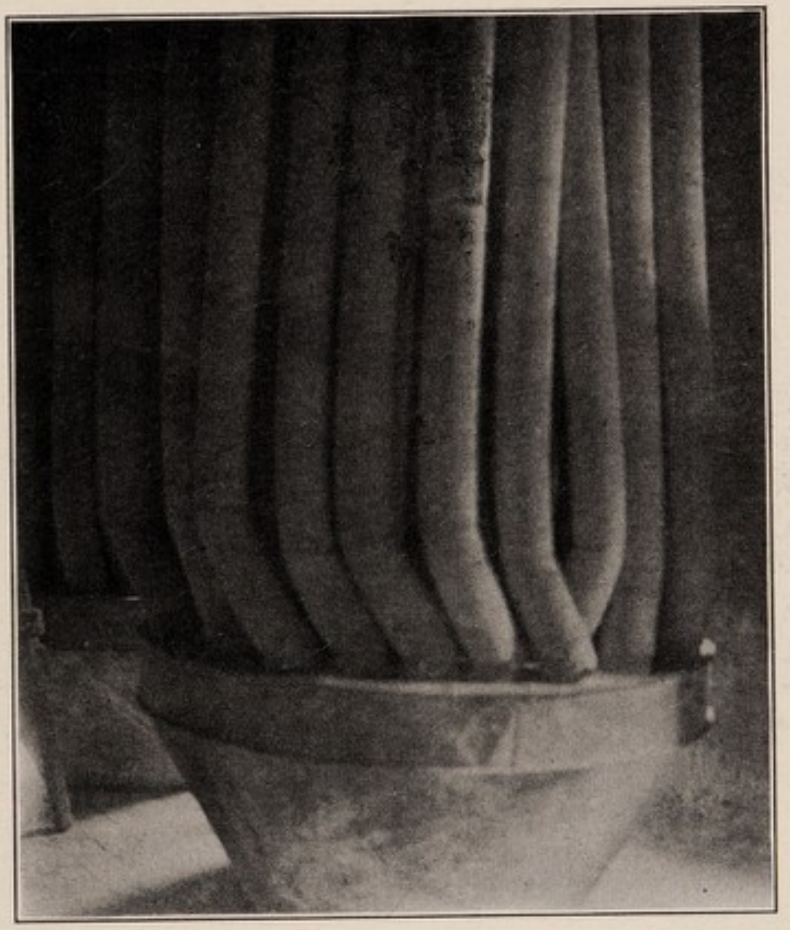


FIG. 18.—DUST COLLECTION THROUGH MANY TUBES BROUGHT TO A COMMON OUTLET. White lead works. (From the Illinois Department of Factory Inspection.)

independent heat source it becomes possible to secure all manner of variations of the atmospheric conditions in different rooms, and results further in considerable economy in heating.

The outlet or suction ducts should be placed as far away from the intake ducts as possible, so as not to short-circuit the air currents. I have seen them erroneously placed side by side, so that the entering air was deflected and immediately drawn out again without benefiting the general air of the room. In general the inlet ducts

should enter the room at a height of from four to six feet above the floor, and outlet ducts both near the floor and ceiling, for many toxic gases are heavy and should be drawn downward away from the workman's face; whereas air vitiated by human exhalations and products of illuminating gas combustion, when heated, tends to rise, although carbon dioxid is somewhat heavier than air. This applies

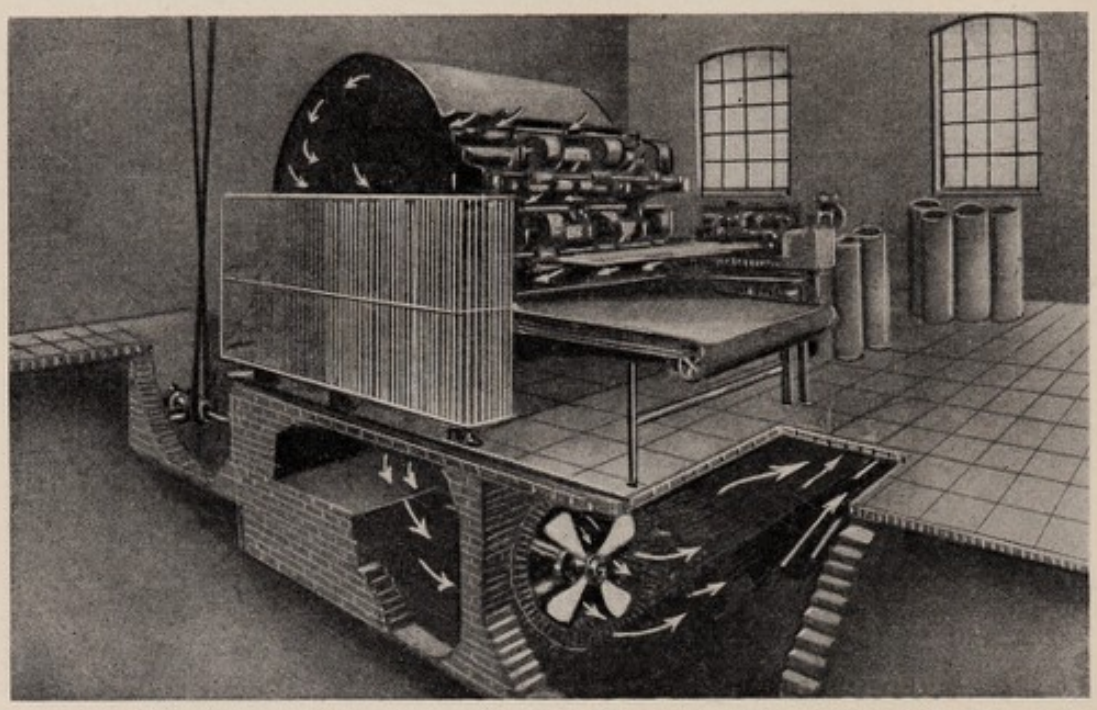


FIG. 19.—SECTIONAL VIEW OF A CARDING MACHINE DEVISED BY V. HUGO OF LILLE, FRANCE, SHOWING EXHAUST SYSTEM FOR REMOVING DUST PLACED BENEATH THE MACHINE AND THE FLOOR. Such machines making several hundred revolutions a minute tend to throw off dust in all directions by centrifugal force which is counteracted by the suction applied through the grating under the machine and in front of the workman who stands behind it. (L. Grillet, "L'hygiene du travail.")

to the majority of workrooms where the room as a whole must be emptied of widely diffused deleterious air.

But special problems arise in connection with ventilation wherever harmful gases, vapors or fumes are locally produced from pots, boiling kettles, evaporating pans, impregnated steam jets, etc. In such cases hoods or tight-fitting covers connected with the air ducts must supplement the general ventilation system of the room. In some cases where a number of separate dust foci exist, as about emery wheels, carding machines, etc., a large number of separate

exhaust ducts may be required (Fig. 18), so that one may be placed close to each machine, either above it or in the floor beneath it, and they may, if sufficiently numerous, replace the wall ducts. The latter, in fact, may be undesirable as causing cross circuits of air and tending thereby to distribute the dust before it is aspirated out of the room. Similarly the inlet ducts in the walls may sometimes be replaced by smaller ducts behind the workman or at one side, so that the deleterious air is forced away from him and driven directly into the aspirating ducts. The latter should, whenever possible, be operated by electric fans placed near the outlet to the outside air on account of the extreme ease with which their velocity and operation are controlled. When the outlet duct is placed beneath the workman's feet in the floor it is covered by a grating, or it may be in the machinery itself, as where a grating over a duct is used for sorting wool, hair or other particularly dirty dusts. (Fig. 19.)

In a straw hat factory in Baltimore, originally constructed without ventilation, the winter sick rate was 27.5 per cent. among the work people. After proper ventilation was secured the rate fell to only 7 per cent., and the company found that the apparatus installed was paid for in a year by the gain in efficiency.

Further discussion of this important topic will be found under the heading Dust Prevention.

HYGIENE OF THE WORKMAN

Although it is true that most of the workers in the poisonous metals are warned of their danger, my experience with them is that each man usually thinks he will prove an exception to the rule, and, like the coal miner, long accustomed to deal with fire damp, finally forgets the danger and courts disaster. Ignorant workmen, especially foreigners, will often neglect to follow rules of cleanliness or avail themselves of many of the means of protection offered. Nevertheless, much may be accomplished by instruction, inspection and sometimes a system of rewards for obeying the directions given; and these should be applicable in the home as well as in the factory, mill or workroom.

Exercise.—Those whose work is of sedentary character should endeavor to walk both to and from the place of work to the home, or, if the distance is too great, to walk part way. If it be impossible to walk both ways, the morning is preferable to the evening for walking, because after a day of fatigue walking may cause so much exhaustion as to impair digestion of the evening meal. Or, in such cases, it may be well to ride toward home the first part of the way, walking a few blocks at the end, in order to breathe deeply and inhale good fresh air. In walking the head should be held erect and the shoulders thrown well back to obtain maximum inhalations. When weather or other conditions do not permit of walking in the open air it is most desirable on rising and again on retiring to practice deep-breathing exercises in front of an open window, swinging the arms above the head and bending the body at the waist in different directions. These details are particularly important for women and young girls, whose occupations are often sedentary and who tend to become constipated and anemic, for they frequently have never learned to breathe properly. Correctly adapted exercises which strengthen the action of the diaphragm and abdominal muscles are of service in overcoming constipation.

Occupations which involve constant exercise are often conducted under such poor conditions of ventilation as to be merely fatiguing and injurious; and, under such circumstances, the respiratory muscles are rarely used to the best advantage, and supplementary calisthenics in good fresh air are very desirable. Such exercises taken for ten minutes at the noon hour should also be prescribed. In New York City, in the garment workers' districts, one may see thousands of workmen who every day at noon come out and stand at the street corners or walk slowly about. If they could be induced to walk briskly for ten minutes, swinging the arms and inhaling deeply, or if they would practice the "setting up drill," their health would be promoted and efficiency much increased.

Tolman and Guthrie, in "Hygiene for the Worker," refer to one factory employing 1,000 operatives in which at the noon hour the employees are permitted to dance, the music being furnished by volunteers. Although this is not outdoor exercise, if the room be

well ventilated, it gives opportunity to relieve the fatigue of certain muscles by exercising others, promotes breathing, and has the great advantage of introducing the element of mild diversion. On the other hand, in some department stores, telephone exchanges and other establishments where girls and young women are employed, rest rooms are furnished where complete rest may be secured at noon.

Conditions of work are so variable that it is impossible to formulate definite rules for all cases, but the essential principle is to secure a proper balance between physiological rest and exercise and to see to it that as often as possible during the day, whether at work or at home, deep inhalations of pure fresh air be secured. The sewing girl who sits at her work eight or nine hours a day is more in need of exercise than of rest at noon; but the loom tender who is on her feet for a similar period may derive more benefit from sitting or lying down. It is good economics for employers of large numbers of working girls to look thoroughly into this, as well as other principles of fundamental hygiene. In some few large manufacturing establishments gymnasiums have been installed where light calisthenics may be taught and practiced.

Bathing.—A full hot bath should be taken at least twice a week, soaking and soaping the body well. If the occupation has involved exposure to irritant dusts, vapors or fumes, the body should be sponged with warm water and well rubbed every night before retiring. More restful sleep will thus be secured and the skin will be kept free from eczema and other forms of irritation. A cold sponge bath should be taken every morning on rising, cold water at this time being more invigorating and refreshing than hot. Where no bathtub is accessible for full baths, a large wooden washtub will serve for immersing portions of the body in succession. The term "sponge bath" is not to be taken literally, for few workmen can afford to buy sponges, besides coarse wash rags are more hygienic, being more easily kept clean. Workers who are exposed to the fumes of molten metals should be afforded facilities for daily shower baths before going to their homes. (*See* Treatment of Lead Poisoning.)

Washrooms should be provided for all workmen, but they be-

come an absolute necessity in lead works, nitroglycerin works, and all establishments in which toxic materials are handled. The British laws require that they shall be fitted with basins in the proportion of at least one for every five workmen, or with porcelain-lined troughs of a length of at least two feet for every five workmen. They must be supplied with running hot and cold water, soap, nail brushes and individual towels. The workmen at meal time and before leaving the factory must be allowed at least ten minutes for ablutions. They should wash the face as well as the hands, and should scrub the nails thoroughly, for lead and similar metal dusts are readily conveyed from unclean finger nails to food. The soap supplied should be fluid and held in containers from which it may be poured without contamination.

Shower baths with hot and cold water are supplied in the better class of lead smelting and white lead works, chrome works, nitroglycerin plants, also in connection with many other industries in which very toxic materials are dealt with, or very dirty dusts, such as that of coal mines. Employees should be compelled to take a shower bath at least twice a week, or in some cases daily on quitting their day's work. (*See* Fig. 9, page 90.)

Care of the Mouth and Nose.—All workers in dusty atmospheres should frequently cleanse the mouth and nose. For the mouth and throat a wash and gargle of either common salt or boric acid solution should be used, in strength of about half a teaspoonful to the cup of water. For the nose a warm salt solution of the same strength may be used by inhaling a little of the fluid poured into the palm of the clean hand, or poured with a spoon into the nostrils and blown gently out again. In the nostrils the dust will thus be prevented from encrusting with the mucus and causing ulceration and chronic catarrh. Rinsing the mouth frequently aids in preserving the teeth, but in addition they should be well brushed on rising and retiring with a simple inexpensive powder or with castile soap.

Care of the Teeth.—Whereas proper preservation of the teeth is important for everyone, it is doubly so for workmen in certain hazardous trades on account of especially corrosive substances which may enter the mouth as fumes or otherwise. Decayed teeth almost al-

ways tend to impair digestion. With them are associated more or less gingivitis and alveolar abscess. The latter may lead to caries of the alveolar cavities, and the constant presence of pus in the mouth favors the production of anemia and sometimes of chronic sepsis. The worst form of decay of the teeth and maxillary caries results from phosphorus poisoning, and next in deleterious effect ranks mercury. The fumes of all the mineral acids produce erosion of the enamel and further decay of the teeth, and some of the chronic metal poisonings like those of lead and copper give rise to deposits in the gums and more or less gingivitis, which may assume an ulcerative type and be accompanied by salivation.

Antiseptic and cleansing mouth washes, such as boric acid or thymol solutions, should also be supplied freely and employees should be instructed in their use.

In lead and chrome works and similar establishments in which poisonous substances may enter the mouth, and particularly where phosphorus and mercury are used, the workmen should be supplied with tooth brushes and instructed to make thorough use of them before eating. In these industries the workmen's teeth should frequently be inspected and treated when necessary, for it is through cavities in carious teeth that such poisons are certain to gain access to the system.

Care of the Hands and Nails.—The hands should always be washed after going to the toilet and before meals. Whenever possible they should be washed in warm water with soft soap and cleansed with a stiff nail brush. Individual towels should be insisted upon for use after washing the face and hands, and the common roller towel should be discarded as liable to communicate disease. In some large factories paper towels are furnished which may be torn off from a roller and thrown in a hopper to be burned after use. The finger nails should be kept fairly short to prevent tearing and the accumulation of dirt. Workers in metals of all kinds, and especially lead, should pay particular attention to these directions. In English lead industries such directions are comprised in the details of factory laws, and their rigid enforcement is one of the chief agencies in reducing the frequency of lead poisoning.

Care of the Hair.—The hair, if not properly protected, affords a means of conveying dust and dirt into the home. Workmen in dusty occupations, or who are exposed to irritating fumes and gases, should keep the hair short, and it is best not to grow beards or mustaches. Lead dust, condensed lead fumes, chrome dust and many other irritants may condense upon the beard, be conveyed in the hair of the face or scalp, get into the food and be swallowed. Women in dusty occupations should protect the hair by wearing close-fitting paper or oilskin caps.

In general the hair should be shampooed at least once a week with tincture of green soap or castile soap, and the scalp well massaged. Men who work as lead smelters or in making white lead should wash the scalp daily before going home.

Stiff hats that fit too tightly impair the circulation in the arteries of the scalp and interfere with the nutrition of the hair. Lead and other poisonous metal dusts are easily carried home in the hair or beard, as well as clothing, and disseminated in the workman's dwelling.

Care of the Eyes.—Workmen who have to look at bright moving metal surfaces, as in polishing steel, should protect the eyes by colored glasses, or, if there is danger of breaking the glass by flying metal or stone particles, celluloid eye shields may be used. Close-fitting goggles, like automobile goggles, should be used wherever irritant dusts such as chrome dust, cement dust, etc., may injure the conjunctivæ, and at the close of the day's work the eyes should be bathed with a saturated solution in warm distilled water of boric acid, poured into the eyes with an eye cup or clean medicine dropper. If artificial lights are placed near the workman, especially electric lights, they should never be directly in front, but above or at the side, and he should avoid looking directly at any bright lights. The special dangers to which the eyes are exposed in glass blowing, metal casting, electro-metallurgy, X-ray work, etc., are described in the section on Diseases of the Eye.

Eye shields or goggles are made of various materials, such as plain, colored or wired glass, mica, transparent celluloid, and fine wire screening. The latter are especially for use where flying particles

of metal or stone or similar substances might splinter glass or render it opaque by frequent contact. Colored glasses are worn to protect the eye from bright surface reflection or the actinic or ultra-



FIG. 20.—SAND-BLASTING CASTINGS. "An improved helmet showing a small rubber tube going into the top, through which fresh air is supplied to the workman by a slight downward pressure. Note the accumulation of dust on the window framework." (Reproduced with permission of Dr. William C. Hanson, Massachusetts State Board of Health, Aug., 1910.)

violet rays of strong electric light, as in electro-welding, etc. (*See* Injuries from Excessive Light.)

Protective masks and helmets are made of a number of materials, such as leather, steel wire, canvas, cloth, mica, celluloid, cardboard, etc. They may cover the entire head and be fitted to the shoulders, to keep out dust, like the masks or hoods used in sand-blasting, or they may be made merely to fit over the face or the eyes. (Fig. 20.) Helmets are made of strong light material like a fireman's helmet, from the rim of which a heavy cloth, canvas or leather protector drops down and is secured to the overalls at the shoulders in such manner as to exclude dust as much as possible. Fresh air is

supplied to the workman through a rubber tube which may enter the helmet either at the top (as shown in the illustration above) or at the side of the helmet.

Respirators are described under that heading.

Care of the Feet.—It is distinctly worth while for workmen to keep the feet in good condition, for this does much to prevent fatigue in those who have to stand through long hours. Ill-fitting shoes, which tend to produce flat-foot, blisters, bunions, etc., greatly impair efficiency, and by pain or discomfort which they cause give rise to secondary troubles of various sorts. Female employees especially, who stand all day, as in tending looms or other machines, should keep an extra pair of easy shoes to work in, changing them for street shoes on going home.

In some occupations, as in chrome works, lead works, etc., irritant dusts are liable to work their way through ill-fitting or worn-out shoes to the feet and give rise to blisters, ulcers, callosities, etc. In dinitrobenzol and nitroglycerin works special care has to be taken that the workmen's shoes are thick-soled and in good repair, to prevent absorption of these highly toxic materials through the feet.

Workmen exposed to any of these risks should bathe the feet and change the stockings, if possible, before going home, and employees of every kind whose work compels standing will find that soaking the feet in warm water at night does much to lessen fatigue and prevent the excessive local sweating, which is another common source of irritation. This condition may be relieved by bathing the feet with a weak solution of alum or Labarraque's solution. (*See* Hyperidrosis.)

Stockings with holes or hard seams should not be worn. Where the nature of the work involves standing on wet floors, as in dyeing rooms, tanneries, paper mills, etc., wooden racks should be provided to keep the feet from the floor. Foreign workmen often wear wooden shoes while employed in such occupations, for rubber shoes, if worn constantly, induce perspiration of the feet and are fatiguing.

To aid in overcoming flat foot, as well as to relieve fatigue and foot deformities of every sort, massage is most useful, applied twice daily, by the workman himself. The thumb should be placed under

the arch of the foot and rotated with firm pressure while the toes are repeatedly flexed with the fingers. (*See* Flat-foot.) The ankles, too, should be massaged. Cacao butter or vaselin is a useful adjunct to the massage. The arch of the foot may be strengthened also by special exercises, such as walking a few steps on the outside of the bare feet, and raising the body well up on the inturned toes. Varicose veins in the legs are common among laundresses, motormen, car conductors, loom tenders, and others who stand in one position while at work. Massage, bandaging and the wearing of elastic stockings afford the best means of relief, and tight garters should never be worn.

Position While at Work.—Faulty positions of the body, especially those which impair breathing, are productive of many evils. (*See* Abnormal Positions of the Body.) They often may be overcome by correcting habit, and are otherwise best counteracted by taking a few minutes every hour or two for calisthenics. The time thus lost from work will be more than gained through greater efficiency while at work and the saving of days of invalidism.

Sleep.—Sleep, which is so essential to counteract the workman's fatigue, owing to the poverty of the home environment, is often a problem needing serious consideration, for many of the causes of impaired health of workmen originate in the home rather than the workshop. Without sleep many of the occupational neuroses are much more liable to be developed. Too often, from poverty, conditions such as uncomfortable bedding, overcrowding and living in noisy surroundings, sleep is greatly impaired, but a very common and most important factor is foul air. In summer the small or crowded bedroom becomes overheated, and in winter, from dread of cold, with tight-shut windows and often a gas stove, oxidation is lessened and sleeplessness, anemia and other conditions arise which are often erroneously attributed to the nature of the workman's occupation or his occupational surroundings. Abundant fresh air in the sleeping room is a need of the importance of which the workingman should duly be impressed. No sleep is restful or profitable without good air, and proximity to a window kept open both at top and bottom is a first requisite, worth oftentimes the sacrifice of other

features of the home. It should be impressed upon the workmen that the air is needed as much in winter as in summer, and, in fact, more so; for in winter the use of gas stoves, oil lamps, or other forms of combustion pollute and exhaust the air of the bedroom.

Heavy bed clothing is fatiguing. It should be warm but light, and cold air may be prevented from coming up through a thin mattress by a sheet or two of builder's paper or similar material. High pillows tend to cramp the head on the chest and bend the thorax to the side, thus restricting breathing. Thorough airing and sunning of the bed clothing every day is most desirable. Those who perform night work should seek sleep at once in the day, before doing other things. If the neighborhood be noisy, cotton should be put in the ears to shut out sound, and, if light cannot otherwise be shut out, the upper eyelids may be darkened by touching them with burnt cork.

To avoid insomnia from other causes the lungs should be well filled with fresh air before retiring, a glass of hot milk may be drunk, and in courting sleep the arms should be placed above the head. If the feet are cold they may be warmed by placing a couple of beer bottles in the bed, filled with hot water and encased in stockings to prevent them from burning, if too hot.

The circular issued by Dr. Sheldon to the working people who attend my medical clinic has been given on page 80. It comprises many of the directions above discussed in detail.

Clothing.—The workman's clothing should be adapted to the particular nature of his work, as well as to climate. Overalls or special working clothes are more generally worn in foreign countries, such as Germany and France, than in the United States, where many persons appear to think that a workman's uniform is a badge of servility which reflects unfavorably upon his independence; for when seen in public he does not like to be distinguished by such a costume, for instance, as the Frenchman's blouse and cap, but prefers a woolen suit and impractical stiff hat. But, on the score of economy, comfort and cleanliness, overalls, or rather special working suits, should be worn, for in hot rooms or hot weather practically all street clothing may be discarded for them. In some industries in this country,

such as that of mining, the manufacture of lead products, etc., and in many dusty trades, the use of a working suit is now insisted upon, but the importance of the matter should be more widely understood. The effect of the workman's taking dust and dirt and (as in the case of lead and mercury) often toxic materials to his home in perspiration-steeped and begrimed clothing is demoralizing for his family, disagreeable to those who come in contact with him in public conveyances and makes trouble for everyone.

This whole subject of the workman's proper clothing has been especially studied by Dr. George M. Kober, and is so well stated in his admirable *Report* for the Committee on Social Betterment for the President's Homes Commission, 1908, that I quote it in full as follows:

"As a general rule, warm woolen goods are best suited for winter wear, and cotton or linen for warm weather. It should be understood, however, that flannels absorb more dirt, odors, germs and water than linen or silk, whilst cotton occupies an intermediate position. The question of wet clothing, whether from perspiration or rain, is important, as the drying of clothing on the body involves an expenditure of animal heat, and it is not a matter of indifference whether this takes place rapidly or slowly. It is a fact that a wet cotton shirt or sweater feels more uncomfortable and colder than a wet woolen garment. The simple reason is that the cotton garment dries more rapidly, but it abstracts during the same time more animal heat than flannels. This fact is not without a practical bearing, as it teaches that persons who perspire easily will do well to wear flannels next to the skin, and this is all the more important when they are liable to draughts or abrupt changes in temperature.

"As a protection against *cold,* wool is superior to either cotton or linen, and should be worn for all underclothing. In case of *extreme cold,* besides wool, leather, fur or water-proof clothing, on account of their impermeability to air, are useful. As a protection against *cold winds,* for equal thickness, leather and india-rubber take the first rank, wool the second. As a protection against *rain,* india-rubber or oiled canvas clothing is the best, but it is an exceedingly hot dress, owing to its impermeability to air, which causes

condensation and retention of the perspiration. To overcome this objection, Dumas suggests a material, which is waterproof and yet permeable, prepared as follows: The garment is placed in a seven per cent. solution of gelatin, heated to a temperature of 100° F. After immersion for a few minutes it is dried in the air, and after drying is soaked in a three-quarter per cent. solution of alum and again dried.

"As a protection against *heat* in the shade, the thickness and conducting power of the material are the only factors to be considered. Texture has nothing to do with protection from the direct solar rays; it depends entirely on color, and white is the best. As a protection against *fire,* leather clothing is generally worn. The fabric can be rendered non-inflammable by the addition of twenty per cent. of tungstate of soda and three per cent. of phosphate of soda to ordinary starch sizing, while cotton or linen goods may be treated simply with starch and borax, in the proportion of a teaspoonful of borax to one-half pint of starch.

"*Clothing as a Cause of Disease.*—Clothing may impair the functions of the body and cause disease: 1, By improper fitting, which leads to compression of bloodvessels and nerves and interferes with the normal position of organs and the movements of the body; 2, By improper selection of material affording either insufficient protection or overheating a part or the whole of the body; improper material may also produce irritation or interfere with the ventilation of the skin; 3, By wet clothing, which, in drying, may abstract sufficient animal heat to cause peripheral irritation and reflex internal congestions; 4, By poisonous dyes, such as compounds of arsenic and antimony, chrome yellow, zinc chlorid and some of the anilin colors. The toxic symptoms may manifest themselves by general impairment of health or in local affections of the skin; 5, Clothing may harbor disease germs, and a number of instances are on record in which itch, smallpox, tuberculosis and scarlet fever have been spread by second-hand clothing and bedding. This points to the necessity of thorough disinfection."

The wearing of tight collars, garters, belts and corsets should be avoided. Such collars constrict the vessels of the neck under strain

of heavy work and may contribute to headache, vertigo or other vascular disturbance of the head. Tight garters very strongly favor the production of varicose veins in those especially who have to stand all day at their work. Tight belts and especially tight corsets tend to cause prolapse of the stomach and kidneys in women and such corsets also distinctly impair freedom of respiratory action.

I once saw a young factory girl who was operated upon in the New York Hospital under the mistaken diagnosis of an obscure abdominal tumor. She was very weak and had suffered much pain, so that she finally died, and autopsy revealed only an hour-glass constriction of the liver which had been forced downward and tipped over almost vertically by extremely tight lacing. The case was reported by the late Dr. George A. Peters in the *Medical Record* many years ago.

Overalls, Aprons and Caps.—In all occupations involving exposure to toxic metal dust and fumes, oils, irritant dusts, acids, and, in fact, toxic or irritant materials of any kind, overalls should be provided. They should be made of washable material, and in lead works, nitroglycerin works and all places where toxic substances may be retained in them they should be washed at least once a week. They should be kept in good repair and in well-aired individual wire lockers. Overalls or blouses should not be worn too loose where there are projecting parts of machinery on which they are liable to be torn.

Dressing rooms should be provided where the clothing may be exchanged for the overalls. In similar occupations caps of impervious material should be worn to protect the hair thoroughly. For women it is often best to provide hoods, and the hair must be so dressed as to admit of complete covering. Hoods have the further advantage of protecting the ears from such dusts as arise in jute or cotton mills, etc., which are liable to cake the natural ear wax and cause deafness. Caps and hoods, like the overalls, should be washed often.

In occupations involving constant exposure to steam, wet, or the spattering of acid solutions, dye-stuffs, boiling oils, etc., to which workers in paper-making, tanning, dyeing, electroplating, etc., are

exposed, additional protection should be afforded by large aprons of leather, rubber cloth, oilcloth or other impervious material.

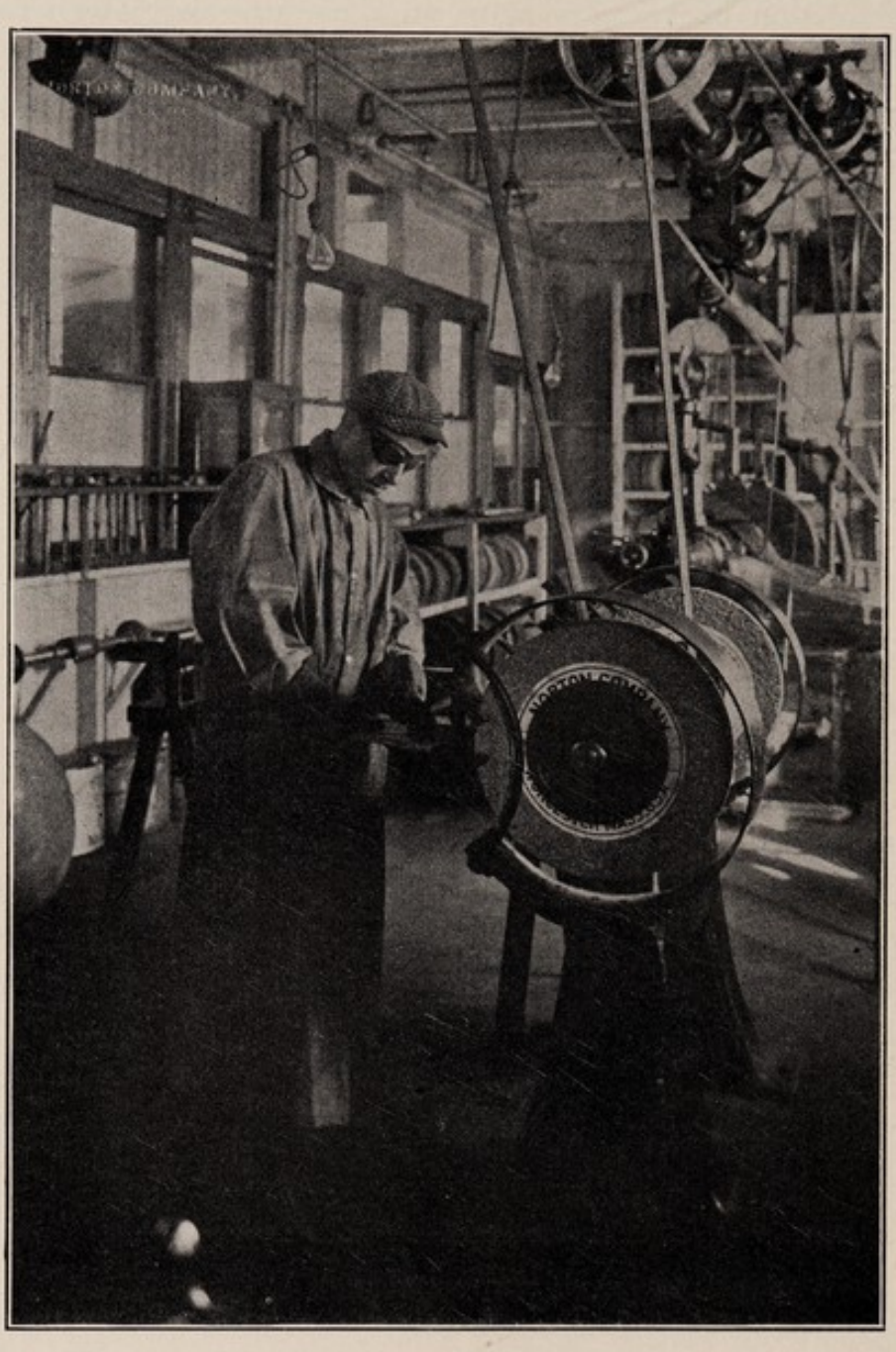


FIG. 21.—A WORKMAN WELL PROTECTED FROM BRASS AND EMERY DUST. Note the good type of dust gown, protection of hair by cap, eyes by goggles, hands by gloves, also leather spark brush and properly adjusted rest for the hands. The workman is well protected although there is no exhaust duct as shown in Fig. 4, p. 42. (From the Norton Company, Worcester, Mass.)

GLOVES.—Gloves of leather or rubber should be worn in industries requiring contact of the hands with toxic substances which are

liable to absorption, like nitroglycerin, or to irritate the skin, like strongly acid or alkaline solutions, paraffin or other coal tar products, etc. When, for any reason, gloves cannot be worn in handling irritant materials, the hands may be protected by first coating them with grease, oil or vaselin.

The accompanying illustration, Figure 21, represents a well-protected workman with head kept dust-free by a cap, eyes shielded from dust and sparks by goggles, hands well covered by gauntlets, and body enveloped in a long, loose, comfortable, one-piece washable gown. As much of the grinding wheel as possible is screened, and a firm, small platform supports the hands.

Cuts and Abrasions.—These should be cared for promptly to prevent infection. This is always important, but especially so in occupations involving the handling of animal materials, as in the work of those who deal with hides, slaughtering of animals, bone fertilizers, etc. The wound should be cleansed thoroughly with fresh water, and adjacent parts cleansed of dirt with soap. A 1-5,000 bichlorid of mercury solution should be applied to superficial wounds (when not too extensive) and a simple dressing of gauze dipped in the same solution bandaged on. Small cuts or abrasions, after thorough disinfection, should be protected by adhesive plaster or several layers of flexible collodion. In this manner serious septicemia often may be prevented.

Cold.—Measures should be taken for the prevention of the effects of cold, such as frost-bite, freezing, and chapped hands. Frozen feet, fingers or ears should be rubbed with snow or ice vigorously, then treated with cold water, and thoroughly dried and bandaged. Frozen parts should never be brought near an open fire or heater. The hypersensitiveness of the skin, which long remains, should be dealt with by rubbing with salt and cold water twice a day. Chapped hands should be dried thoroughly without friction after washing and rubbed with camphor ice, which is a compound of lard, vaselin and camphor.

Avoidance of Colds.—The workman should be made to realize that draughts alone do not cause cold. Most workmen are convinced that they do, and strongly object to draughts from open windows,

doors, blow-fans, etc. They should learn that fresh air and good condition of digestion and of the skin are the best preventives, and that all colds or catarrhs are of germ origin. Foul air, fatigue and lack of sleep are the real predisposing factors, not draughts of fresh air. The latter act only by chilling the body surface, when the body is in a condition of lowered vitality or resisting power due to the above mentioned causes. With many persons there is definite and oft repeated sequence of fatigue, indigestion, constipation, and exposure to foul air and dust, or inclement weather, after which a "cold" or catarrhal fever develops.

Heat.—The effects of great heat should be guarded against. During very hot, humid weather one should move slowly, drink no alcoholic beverage of any kind, eat very little meat, and take a lukewarm bath before retiring. Outdoor workers, while in the sunlight, should protect the head by a cloth wet in cool water, worn under a light-fitting hat. Sitting when overheated in a strong draught while perspiring, as in front of an air shaft or electric fan, cools portions of the body too suddenly or unequally by evaporation and tends to produce congestion of internal organs, especially the kidneys, or it may produce a localized myalgia, lumbago or neuralgia, or give rise to stiffness of the joints.

Acute enteritis is often induced in hot weather by sleeping uncovered while perspiring. A sudden lowering of temperature in the night chills the surface of the abdomen and a catarrhal enteritis, largely due to reflex irritation, results.

Enough cool water should be drunk in hot weather to replace the loss from perspiration, but it should never be poured down in large quantities at a time, for in this manner gastric catarrh and dilatation may result. In a large factory in which diarrhea among the workmen was very common in summer, it was entirely controlled by substituting moderately cool water for the ice water which the men had previously been in the habit of drinking.

The use of respirators is discussed fully under Prophylaxis of Dust.

Chewing Tobacco and Gum.—The practice of chewing tobacco or gum during working hours is especially harmful in industries in-

volving possibility of lead, arsenic, brass or other forms of metal poisoning, for the reason that when the workman takes a fresh piece out of his pocket with unclean fingers he is certain to convey poison to the mouth. The pockets of his overalls, too, are liable to become very dirty. Particular instruction should be given as to this hazard in the lead and brass industries, and rules regarding it should be enforced under penalty of dismissal, for it is difficult to break workmen of a long-standing chewing habit which they have never regarded as dangerous. The dyspepsia often induced by these habits may become a contributing factor in the ease with which plumbism is acquired.

FOOD AND DRINK

Food should under no circumstances be eaten in workrooms in which there are metallic dusts or fumes, or any substances liable to contaminate the food or the hands. Fluid food, such as milk, as well as drink, readily absorbs toxic fumes, and dust settles upon solid food or is conveyed with it to the mouth by unclean hands. Dr. M. A. Starr has suggested the simple expedient of eating foods such as sandwiches placed between two sheets of clean paper, so that contact with the fingers is avoided; but this method should not be allowed to supplant thorough washing of the hands. A separate lunchroom should be available, with arrangements for depositing the food which the workman brings with him, so that he need never take it into the workroom. It is true that in large establishments this involves much additional building space, but it has been abundantly proven that it promotes efficiency by conserving the health of the workmen.

In certain especially hazardous occupations, such as cleaning out flues in which metal vapors have left deposit, emptying the "blue-beds" of lead carbonate works, in caisson works, etc., it is desirable to supply the workmen with food on the premises, such as hot milk or hot soup, to prevent exhaustion or protect the stomach from absorption of toxic substances. On leaving a caisson after work under high pressure this is absolutely imperative.

Workmen in especially poisonous industries should be instructed

to eat hearty meals before beginning work, for an empty stomach and dyspepsia are conditions which are most favorable to the acquisition of many forms of poisoning. In very hazardous trades, particularly those involving exposure to metal or acid fumes, phosphorus or mercury, the use of intoxicating beverages more than doubles the hazard of poisoning. Particularly is this true of caisson men. A good supply of drinking water does much to prevent alcoholism by relieving thirst, particularly in industries such as smelting, pottery baking, stoking, and all similar work in which heat or heat and moisture in the atmosphere in excess induce constant perspiration.

At one manufacturing establishment in a western State the employees organized a club in a nearby building, where their employers furnished light, heat and room. Here the workmen at the noon hour obtain a wholesome hot lunch at a minimum price, and are diverted while eating by a phonograph and in other ways. In another room the girls employed may lunch, read and rest. The effect has been, according to Tolman and Guthrie, in "Hygiene for the Worker," that, whereas formerly fifty per cent. of the girls were constantly giving up their work, there is now a waiting list of employees to be taken on. In several other progressive establishments the employers have voluntarily furnished lunch and recreation rooms where at noon the employees may dance to music of volunteers from their own number, or use a library. One of the large cotton mills in the South has put up a bowling alley for the men and boys employed, and in one of the illuminating gas plants in New York City the employees have organized a vaudeville club for mutual entertainment during the noon luncheon hour.

In New York State the general labor laws specify that "in each factory at least sixty minutes shall be allowed for the noonday meal, unless the factory inspector shall permit a shorter time."

Diet.—Very many of the ills often attributed to occupation arise from faulty nutrition. In general the fundamental rules of dieting are poorly, if at all, understood by the workman, and of the relative nutritive value of different foods, particularly in relation to their cost, he knows absolutely nothing. It is futile to give him general directions—they must be specific and concise. In most dispensaries

frequented by industrial workers this all-important topic is greatly neglected.

In my clinic it is the custom to give to each new patient the printed circular containing rules for general care of health and brief suggestions for diet, reprinted on page 80.

We have found, however, as a result of considerable experience, that many patients are both willing and eager to have more detailed instruction. To meet this want Dr. W. H. Sheldon has prepared the following circular which is here reproduced in full in lieu of further discussion of this subject, as it is adapted for the understanding of the workman, or, more particularly, of his wife, who does the cooking.

In preparing the circular special attention has been given to the nature of the foods which come within the limits of the workman's purse and which are obtainable throughout the year. In any dietary often as much depends upon the preparation and proper cooking of food as upon the food itself, hence detailed directions for cooking were prepared for the circular by Miss Rose, one of the instructors in dietetics in Cornell University, and the wording is such as to be comprehended readily by the workman.

MEDICAL CLINIC
CORNELL UNIVERSITY MEDICAL COLLEGE
OUT-PATIENT DEPARTMENT

GENERAL RULES FOR EATING

1. Eat very slowly, chew your food well. If possible, rest one-half hour after each meal.

2. Drink water before your meals, instead of with them, or immediately after them.

3. Plan to have variety of foods, including always some fresh vegetable or fruit.

4. The food supplies force for the work of the body, just as coal supplies the work of the engine. The coal must be of good quality and right quantity, or the work is poor. Just so with food.

5. Many foods, especially canned vegetables, supply very little nourishment in proportion to their cost. Canned vegetables and fruits are mostly water and, therefore, are relatively costly.

6. The best diet for a healthy workingman is a mixed one, in which meat is about one-sixth part, bread and cereals about three-sixths, and potatoes or other vegetables about two-sixths. To this are added sugar, butter and fresh fruit.

7. Some foods produce more force in the body than others, that is, a man keeps stronger by eating some foods than by eating others. Thus, bread, potatoes, eggs, meat, butter, sugar, cheese, peas, beans, oatmeal and corn all are strengthening foods. Fresh green vegetables and fruits give variety and are wholesome, but do not furnish strength. Fats, such as butter, oil or bacon and sugar, are strengthening foods, and these foods as well as cheese, peas and beans furnish so much strength as to lessen the amount of meat required. Besides they are proportionally cheaper.

To get the same quantity of nourishment from each of the following foods one must take them in these different amounts:

Milk, one tumblerful
Condensed milk, sweetened, three heaping teaspoonfuls
Cocoa, four heaping teaspoonfuls
Clear stock soup, five teacupfuls
Eggs, three
Butter, three lumps (one inch cube)
Sugar, four heaping teaspoonfuls
Cheese, four cubes (one inch each)
Meat, minced, one and one-half tablespoonfuls
Beans, dry, two tablespoonfuls
Cereals, cooked (oatmeal, cornmeal, etc.), one teacupful
Peas, six tablespoonfuls
Potatoes, two, each three inches long
Bread, three slices, each four inches square and one-half inch thick
Oranges, three
Apples, four
Prunes, a saucerful

Both beans and cheese make very good substitutes for meat. For example, instead of eating three tablespoonfuls of chopped meat, or a couple of large slices of roast beef, or a helping of beefsteak, you can eat four tablespoonfuls of beans, or eight cubes of cheese one inch in size.

Instead of butter, oil or lard used in cooking supplies much nourishment.

Instead of sugar, molasses or syrup also supplies good nourishment.

Macaroni is about equal to bread in nourishment. Two teacupfuls of cooked oatmeal are equal to a helping of meat.

The following bills of fare are balanced so as to give variety and the right amount of nourishment in the quantities of foods ordinarily eaten:

BREAKFAST	DINNER OR SUPPER	LUNCH OR SUPPER
Oatmeal and Milk Bread and Butter Cup of Coffee with Milk and Sugar	Hot Soup with Bread or Crackers Macaroni and Canned Tomatoes Bacon and Eggs Bread and Cheese	Bacon and Eggs Brown Bread and Butter Stewed Prunes Tea
An Apple or Orange Hominy or Cornmeal Mush and Milk Cup of Tea with Milk and Sugar	Soup of Peas or Corn Corned Beef and Cabbage Boiled Potatoes Green Pickles Bread Pudding with Raisins	Ham and Baked Potatoes Bread and Milk Apple Sauce
Bowl of hot Soup or Broth thickened with Corn or Peas Bread and Butter	Pork and Beans Onions, Baked Potatoes Rice Pudding with Prunes	Barley Broth—Crackers Baked Custard Oranges Cup of Cocoa
Bacon and Eggs Cracked Wheat or Rice and Milk Cup of Cocoa or Coffee with Milk and Sugar	Barley Soup Codfish and Potatoes Tomatoes Cornstarch Pudding	Cornmeal Mush and Milk Crackers and Cheese Tea
Salt Codfish or Mackerel Brown Bread and Butter Stewed Potatoes Coffee with Sugar and Milk	Beef Stew with Carrots and Onions Boiled Potatoes Prune Pudding	Milk Toast Baked Beans Sliced Bananas
Cornmeal Mush and Syrup Stewed Prunes Bread and Butter Cocoa	Stock Soup—Crackers Boiled Rice and Beefsteak Apple Sauce and Gingerbread	Hominy and Syrup Corn Bread Oranges Cocoa
Hominy and Milk Eggs with baked Potatoes Tea or Coffee	Soup with Noodles Mutton Stew Spinach or Fresh Beans Cornmeal Pudding	Rice Pudding with Raisins Picked up Codfish or Custard Tea with Milk and Sugar

BREAKFAST	DINNER OR SUPPER	LUNCH OR SUPPER
Oatmeal and Milk Bread and Butter Cocoa or Coffee	Pot Roast of Beef cooked with Onions Carrots and Potatoes Bread and Gravy Prunes or Prune Pie	Cheese Pudding Rye or Whole Wheat Bread and Butter Sliced Oranges
Hash made with left-over Meat and Potatoes Bread and Butter Cocoa or Coffee	Steamed and Baked Heart (cooked with Roast of previous day) Bread and Gravy Mashed Potatoes Lima Beans Stewed Figs	Cornmeal Mush with Milk Apple Sauce and Gingerbread
Apples Fried Mush with Milk or Brown Sugar Syrup Cocoa or Coffee	Beef Loaf baked with Potatoes in pan Boiled Onions Bread and Gravy Chocolate Pudding (made from left-over Cocoa)	Cream of Bean Soup (made with left-over Lima Beans) Bread and Butter Molasses
Bacon and Eggs Toast Coffee or Cocoa	Macaroni and Cheese Cold Slaw Bread and Butter Sliced Bananas	Graham Mush with Milk Toast Dates
Hominy Grits with Milk Bread and Butter Cocoa or Coffee	Meat Pie with Mashed Potato Crust Boiled Turnips Bread and Butter Graham Pudding with Raisins (made from left-over Mush)	Creamed Chipped Beef on Toast Rye or Whole Wheat Bread and Butter Sliced Oranges
Salt Codfish Cakes Cornmeal Muffins Cocoa or Coffee	Baked Beans—Brown Bread Pickles Apple Pie or Apples	Scrambled Eggs Bread and Butter Jelly or Preserves
Oranges Bread Crumb Griddle Cakes with Brown Sugar or Maple Syrup Bread and Butter Cocoa or Coffee	Corned Beef Cabbage with Vinegar Bread and Butter Tapioca Pudding	Bean Soup (made from left-over Beans) Fruit and Cookies

COLD LUNCHES

Cold Ham Bread and Butter Cheese, an Apple or Orange	Gingerbread and Milk Crackers and Cheese Fresh Fruit
Cold Meat. Bread or Crackers and Butter Green Pickles Plain Cake with Raisins	Hard-boiled Eggs Bread and Butter An Onion, sliced Cold Coffee and Milk

RULES FOR COOKING

Raw starch is very hard, often impossible, to digest. Foods containing starch should be thoroughly cooked. Dried peas, beans and lentils, potatoes, cocoa and chocolate, tapioca and sago and cereals, as oats, wheat, rice, corn, barley, etc., contain large amounts of starch and require thorough cooking to make them digestible and palatable.

Cellulose, or woody fiber, which is the supporting substance of all fruits and vegetables, legumes and cereals, is often very tough and stringy when raw, but may be softened by cooking and thus made more easily digestible. Many vegetables and fruits which contain no starch and which may be eaten raw are more easily digested when cooked, as baked apples, stewed celery and boiled carrots.

Foods like *milk, meat, eggs* and *cheese* are usually more easily digested when raw. They are cooked to kill any germs which may be on them and to make them taste better.

Cereals are among the cheapest and most nourishing of all foods and should form an important part of the day's meals. If well cooked they will be well liked. It takes plenty of water and a long time to cook cereals properly, even when, like cornmeal, they are finely ground.

Dried peas, beans and *lentils* are a cheap and nourishing substitute for meat.

Fresh vegetables are more wholesome than canned ones and if wisely selected they are cheaper. Beets, dandelion greens and spinach, tomatoes, lettuce, squash and oyster plant are all cheap at some period during the year. Strong juiced vegetables, like cabbage, turnips, onions and parsnips, are cheap even in the winter months, and may be made easily digestible by cutting in small pieces and cooking in boiling water in an uncovered pan and removing them from the stove and draining them as soon as tender.

Tender parts of meat are expensive, and are often less nutritious than the cheaper tough pieces. Tough meat may be made tender in two ways: first, by putting the meat through a grinder, and, second, by cooking it for a long time at a temperature just below the boiling point of water.

Eggs are made tough by cooking at a high temperature. They are more tender and more easily digested if cooked below the boiling point of water.

Skim milk has all the original food value of the milk except the butter fat. It is a nutritious food and may be used for cooking and for drinking.

Milk soups are wholesome, nourishing, good to taste and very easy to make. Not only fresh vegetables but yesterday's mashed potatoes or beans, or other left-over vegetables may be used to make them.

Cheese is a cheap and nourishing substitute for meat. When slightly cooked it is said to be more easily digested than when raw, but when overcooked it becomes tough and difficult to digest.

Drippings, oleomargarin, lard, olive oil, cotton seed oil, butterin, etc., if clean and well made are wholesome, nutritious foods and make economical substitutes for butter.

A home-made fireless cooker makes the cooking of cereals both easy and cheap. The cereal is cooked in the cooker kettle on the top of the stove for ten minutes. The kettle is then covered and set in the cooker for several hours or over night. It will be warm but not hot by morning and may need reheating. Such a cooker may be made from a box or an old trunk by fixing the cover to fit down closely, filling up all holes, lining the box with newspapers carefully tacked in, and then filling the box with hay, excelsior or finely cut up paper closely packed down to a depth of three or four inches. Then a pail having a closely fitting cover should be set on the bottom, and hay, excelsior or cut paper packed all around it. The pail can then be removed, and leaves a nest in which it can be replaced. A cushion is then made which should entirely fill the remainder of the box. If the box is large enough, two pails may be used and two nests made. There should be at least three or four inches of packing all around the pails and a cushion three or four inches thick to go over them.

PHYSICAL EXAMINATION AS A PRELIMINARY TO CHOOSING AN OCCUPATION

Much occupational disease might be prevented if the workman would learn to present himself to a physician or at a dispensary for advice as to his fitness for undertaking a particular occupation. In my experience with dispensary and hospital cases among the industrial workers, this simple precaution is usually left until too late. In many cases, of course, the workman has no choice and must take whatever "job" he can get, but I constantly see working people whose occupations are slowly but surely producing lesions which are bound sooner or later to incapacitate them completely. For example, a young man with a mitral heart lesion due to rheumatism should avoid trades in which he must do heavy lifting or remain long hours upon his feet. A nervous young girl with chlorosis should avoid

work in crowded workshops where there are confusion and hurry of "speeding up." A worker with poor chest expansion and a tendency to catarrhal processes should avoid occupations involving exposure to noxious dusts or fumes, such as file-cutting, glass or button-making, polishing, etc. Similarly he should shun occupations involving exposure to wet and sudden changes of temperature, such as those of pottery and paper-making, etc. Workers with weak muscles and narrow chests should avoid occupations involving stooping in cramped positions such as those of tailors, shoemakers, engravers, etc. Those having irritable skin should avoid occupations such as those involving handling dyestuffs, cement, acids, lime, etc. If the hands perspire freely the worker is unfit for such trades as bookbinding, engraving, fine leather work, sewing, lace-making, etc. Workmen who have syphilis or commencing arteriosclerosis are ill-fitted for employment with any of the poisonous metals, particularly lead. Those having incipient tuberculosis should, if possible, engage only in outdoor occupations of a mild sort which do not involve exposure to inclement weather or dust. An ideal occupation for such persons is gardening.

LEGISLATIVE CONTROL

The aim of legislative control of the occupational diseases is both prohibitive and preventive. The former field is naturally much restricted, as it should be; for it is undesirable and usually unnecessary to interfere seriously with an established industry, unless it can be demonstrated convincingly that such industry constitutes both a constant and serious menace to life. In this country the only actually prohibitive legislation thus far enacted is the recent (1911) Congressional action in placing a prohibitive revenue tax upon the white phosphorus match industry, which is described under that head. In many foreign countries, in addition to a similar prohibition, the use of white lead paint has been forbidden in certain industries, the non-poisonous zinc being substituted for lead. Thus far these are the principal illustrations of positively prohibitive legislation, but the list is likely to be somewhat further extended in a few more instances. For example, the use of wood alcohol in solutions of shel-

lac might well be forbidden in confined spaces, where inhalation of its fumes may cause death.

Preventive legislation, on the other hand, already covers a very wide field, and in this country twenty-eight States thus far have placed various preventive laws upon their statute books, designed to protect the health and well-being of the workman, upon the theory that industrial disease is really a more or less easily preventable accident, and as such may be entitled to compensation. There is, as yet, however, no uniformity of inspection of industries in the several States, although thirty-three of them have Factory Inspection Bureaus. Nor is there any uniformity as to penalties imposed for infringement of the laws, or, in fact, as to the regulations formulated. In general such penalties, chiefly imposed as fines, vary from $10 to $500, but the means for enforcing them are often inadequate. To illustrate, in ten States only are there regulations concerning the great hazard of dust from emery grinding, and in half of these the protective appliances are specified, whereas in the remaining half they are left entirely to the discretion and suggestion of inspectors. In some States the factory inspection bureau takes direct action in these matters, whereas in others the State labor bureau is the instrument of execution of the laws, and in a few instances the State health department (as, for example, in the control of bakeries). In twenty-one States the control of the health of miners is relegated to a separate bureau of mines. This lack of uniformity presents many disadvantages which will doubtless be rectified in time, but the subject at best is exceedingly complex and difficult to deal with, and it is most undesirable to enact hasty legislation which often does more harm than good. Dr. Alice Hamilton, in her intensive study of lead poisoning for the State Commission of Illinois, found, curiously, that in some of the best appointed smelting works the cases of lead poisoning were frequent and severe, presumably because the operatives relied too much upon being taken care of and took less care of themselves than in other places where conditions were notoriously bad.

The difficulty with all controlling legislation is to adapt it intelligently to the constantly varying needs of rapidly growing establish-

ments. An ideal plan would be to leave details entirely to the discretion and authority of inspectors, but this presupposes that they have been especially trained for their work (which is often not the case), and are always impartial and above suspicion of connivance with employers. Moreover, such a system involves great expense. On the other hand, a law which is just and efficient to-day may be useless in a year, owing to new protective inventions or changes in methods of manufacture. For example, in the case of emery-grinding, a law may compel the use of protective exhaust ducts to convey away injurious dusts, but such ducts may be placed above the grinding wheel when they should be below, or it may be necessary temporarily to move the grinding wheel into another workroom where there are no ducts, and an elaborate system of local ventilation becomes at once a useless expense. Yet if the law be not specific in detail, someone with discretion and authority should be empowered to supply the deficiency. To cite one more example: As a general proposition, the dust of dry paint which is sandpapered or scraped is most injurious. If it be required to moisten the dust, the moisture itself may become a hazard to the workman by rendering the atmosphere too damp or by escaping through walls and floors to other rooms, or it may injure machinery or goods in process of manufacture, or may interfere with the subsequent application of paint. Moreover, the great majority of all cases of lead poisoning arise among painters who work not collectively in shops, but as individuals in dwellings and elsewhere. To reach such conditions by any form of preventive legislation is extremely difficult, if not impossible. In such cases much more is to be hoped for from a campaign of education as to the special hazard than by laws which manifestly cannot be adequately applied. Two things might be done by legislation, however, in this case, either to compel the substitution of zinc for lead in the paint or compel the marking of each paint receptacle with a label setting forth briefly and distinctly the nature of the hazards involved.

Much controlling legislation has been enacted in various States as above mentioned, and an interesting summary of it has been collected by Dr. John B. Andrews and published in the *American*

Labor Legislation Review of June, 1911. This legislation comprises regulation, partial or complete, of such conditions as the following: The production of excessive heat, moisture, steam, vapors, fumes, gases, dust, odors and light; the daily dusting and sweeping or mopping of rooms; proper receptacles for dust; the wetting of dust in some cases; the removal of dust by aspirating ducts (Fig. 4, page 42); furnishing dry stands for the feet of those who work on wet floors; washing of walls and ceilings with disinfectants where animal substances are liable to decomposition; or washing walls and ceilings with lime; the making of flooring of cement, asphalt, etc., in certain industries; the construction of workrooms with a minimum amount of rough surfaces liable to collect dirt; the screening of vapors and dusts; the protection from gases and fumes by means of hoods, exhausts and blowers (Fig. 5, page 85); the proper arrangement and size of air inlets and outlets for general ventilation, and the volume of air to be supplied; the number of cubic feet of air space allowed per occupant to the workroom (not less than 600 cubic feet); the proper proportion of outside window and door area) which should be not less than one-eighth of the floor area); the protection from excessive light, in some cases by colored or corrugated glass, the wearing of colored goggles, etc.; the removal of electric lights when so placed as to injure the eyes, the use of respiration masks and inhalers, sponge shields, etc.; the abolition of basement or sub-basement workrooms.

In addition, for the general welfare of the workman there are laws requiring in many cases a full hour for the noon rest, to give time for washing before eating, etc.; forbidding the carrying of food into the workroom; the provision of adequate lunchrooms, of separate lockers for clothing and overalls; the furnishing of adequate washbasins (at least one for every thirty employees) (Fig. 6, page 86), of soft soap, towels, and running hot and cold water; a half-hour's rest interval before beginning overtime work; adequate cuspidors and waterclosets. In some cases seats or rests for the employees while at work are required. No food is allowed to be eaten where gases, fumes or dusts accumulate, and in some instances emergency medicine chests are required to be kept in readiness.

As will be seen from the above list, many of these laws are of general application for almost every industry, and in their enforcement attempts are made to secure the interest and coöperation of employer and employee alike, which in many instances is forthcoming, especially as most of the regulations either involve little expense or so far promote efficiency as readily to demonstrate their expediency.

It is beyond the scope of this work to give a detailed account of the multitudinous laws already enacted in many States for the protection of the industrial laborer from disease, laws which regulate hours of labor, prohibition of working in certain industries by women and children, prohibition of the working of pregnant women in factories within two weeks of expected confinement (and in Massachusetts and in New York for two weeks after confinement), and laws regulating many general and special hygienic conditions.

Unfortunately the scope of these laws in many cases far exceeds the provision made for their enforcement, which requires a large corps of inspectors and often involves difficulty or delay in imposing penalties for infringement. Following are some of the more important provisions of such laws as they exist in New York State, which may be taken as a fair sample of the type of evils which are under legislative regulation in other States. Child labor and the labor of boys and girls from 16 to 21 years of age are carefully regulated. Many occupations are prohibited to minors altogether, and children under 16 years are prohibited from working before 8 A. M. and after 5 P. M., and for more than 6 days a week. Women may not work in factories more than 54 hours a week or 9 hours a day, except under special provisions. Among the occupations prohibited for women and minors are those of machine-picking of wool, cotton or other upholstery materials, burnishing leather, metal-stamping machines, washing, grinding or mixing machinery. No girl under 16 is allowed to work constantly standing.

Sixty minutes is the required time for the industrial lunch hour, except under special provisions. Sanitary laws control the amount of air space per workman in factories, the light, ventilation, cleanliness of workrooms, toilets and washrooms, dust removal and

dust protection in certain industries, the supply of seats for women, of drinking water and individual drinking cups, use of cuspidors, painting or limewashing of walls and ceilings, removal of gases, vapors and steam, supply of receptacles for waste, number and cleanliness of washbasins and waterclosets, protection by hoods of grinding and buffing machinery with dust exhaust pipes, separate dressing rooms for women, etc. The present number of State factory inspectors in New York State to carry out the provisions of these laws and similar ones relating to industrial accidents is 125.

General legislation designed to prevent certain of the disease hazards of workingmen has been enacted thus far in the United States as follows:

Provisions for protection against: (a) *injurious dusts,* in twenty-two States; (b) *improper lighting,* in twelve States; (c) *poisonous gases, fumes and vapors,* in fifteen States; (d) *excessive temperature and humidity,* in eleven States.

In Germany, England and Switzerland the workmen's compensation laws include provisions for illness resulting from a number of hazardous trades, with pay amounting to 50 to 80 per cent. of the regular wage, which is continued during disability. Similar legislation for this country is at present being actively advocated, and the Kern-Wilson Congressional bill introduced in February, 1913, contemplates provision for the 350,000 federal employees for certain occupational diseases, such as lead poisoning.

Under the English workmen's Compensation Act the following cases were decided by the House of Lords to come within the scope of the Act:

(1) A stoker in a weak and emaciated condition received a heat stroke while raking ashes from beneath the boiler in a steamship, from the effect of which he died.

(2) A workman having an aneurysm strained himself while tightening a nut by a spanner, so that he fell dead from rupture of the aneurysm. In this case it was held that the ordinary work comprised a strain which was fatal owing to the diseased condition of the workman's aorta.

(3) A workman acquired a hernia while employed in turning the wheel of a machine.

(4) A workman sorting wool in a factory acquired anthrax through infection of the eye and died.

Cases have also been decided in favor of the workman where, owing to the state of his health, he has met with an accident while engaged in his work which he might have avoided in normal health. For example, such decision was rendered for a workman who had an epileptic fit while standing at his work at the hold of a vessel, into which he fell.

Quite recently the problem of deciding upon preventive measures and their enforcement under State laws has been met by the establishment of state commissions or boards to which such authority is delegated. This has been done in Wisconsin and New York. Thus far the system appears to offer satisfactory solution of some of the difficulties encountered in securing satisfactory prevention of disease hazards in certain industries, particularly in factory ventilation, dust control, cleanliness, etc.

II. TREATMENT

The following section deals with the treatment in detail of the more important diseases which the workman is liable to acquire through the risks of his occupation. As many different forms of irritation may give rise to the same diseases, and, therefore, require the same treatment, the latter is summarized here to prevent repetition. The less common ailments will be dealt with in connection with description of the hazards which produce them.

HEART DISEASES

The conditions of the heart which are brought about by occupation are mainly as follows:

(1) Tachycardia, from fatigue or toxic agents inhaled or otherwise entering the system;

(2) Bradycardia, from toxic agents;

(3) Cardiac syncope, from acute or chronic poisons;

(4) Cardiac hypertrophy, accompanying arteriosclerosis and resulting from long-continued physical strain, as in heavy lifting, or from toxic agents, particularly the metals, such as lead;

(5) In addition many persons having valvular heart disease or myocarditis independent of occupation are obliged to continue working, and the nature of their work may be such as greatly to augment the cardiac lesion.

Tachycardia.—The treatment of tachycardia of the type under discussion is by means of rest and such remedies as the bromids and tincture of belladonna. If necessary, codein (gr. $\frac{1}{4}$) may be given for a short time, or, if arterial tension is high, chloral hydrate (gr. v, 4 times a day) is preferable. If the patient can wear an ice bag over the heart, it is somewhat quieting. The bowels should be well evacuated, and it is important to determine that flatulent dyspepsia with a distended stomach crowding the heart is not responsible for much of the trouble.

Bradycardia.—Bradycardia demands elimination of the poison which has caused it, as speedily as possible. To this end an alkaline diuretic and cathartic should be given, and the patient should also be given strychnin.

Cardiac Syncope.—Cardiac syncope from poisoning demands active hypodermatic stimulation with such remedies as ether, camphor in oil, strychnin, citrated caffein (gr. ii) or strophanthin ($\frac{1}{4}$ milligram intravenously). If necessary, artificial respiration should be performed—in any event, fresh air should be secured. The patient's body should be kept warm with hot water bottles and blankets and a hot poultice of flaxseed meal may be placed over the heart. Black coffee and whiskey may be given by rectum if the victim cannot swallow; if able to swallow, all fluids should be given hot.

Cardiac Hypertrophy.—The treatment of cardiac hypertrophy is essentially that of arteriosclerosis, detailed on page 32.

Existing Cardiac Lesions.—Existing cardiac lesions, not occupational in origin, but made worse by overwork and strain of every kind, are very common. So many such cases are met with in my clinic that it has been found desirable to furnish the patients with

the following printed rules, formulated by Dr. W. H. Sheldon. They have proved so serviceable that they are given in full herewith:

DIRECTIONS FOR PERSONS WITH HEART DISEASE

Remember, with good care and by obeying instructions, you may live many years with little discomfort.

Instructions

1. Hurry, worry, hard work, drinking too much liquor of any kind, or beer, will shorten your life.
2. Get work where you never have to lift or strain, such as tailoring, operating machines.
3. Live on the ground or first floor, as climbing stairs is very harmful.
4. Never hurry. Do everything slowly. Don't run or walk fast. If you get short of breath, or feel dizzy or faint, stop and rest. Don't walk against a strong wind, or when it is very cold.
5. Never indulge in sexual intercourse oftener than once a month.
6. Rest all you can; lie down as much as possible. Have at least eight hours' sleep every night.
7. Be sure to get plenty of fresh air. Keep your windows open at night.
8. Wear flannels the year round, warmer in winter.
9. Avoid getting your feet wet.
10. See that you have one free passage of the bowels every morning, and never strain at stool.
11. Indigestion is very bad for persons with heart disease, as it is a strain on the heart. So eat very slowly, and chew your food well. Rest after meals. Do not eat so much that you gain weight.
12. Diet.

Meat.—Boiled, broiled, or roasted meat once a day.

Dairy Products.—Milk, cream, and butter in moderation.

Cereals.—Rice, hominy, Indian meal, barley, cracked wheat, oatmeal, cream of wheat, etc.

Bread, at least a day old.—Whole wheat, rye, Graham, corn bread.

Eggs.—Cooked in any way except *fried.*

Vegetables.—Potatoes, in small quantities, beets, carrots, squash, lettuce, spinach, tomatoes, peas.

Avoid.—Canned, salted, or fried meats.

It is better to eat small meals frequently than too much at one time.

Do not drink much water or fluid of any kind at one time, it overloads the stomach and strains the heart.

Drink water several times between meals, not with meals, and do not take more than a tumblerful at one time.

ASPHYXIA

Asphyxia results from irritation of a great variety of toxic gases, vapors and fumes, from the inhalation of smoke in burning buildings, from powder smoke of explosions, and sudden overwhelming of the respiratory system with dusts such as cement, dust of grains in milling, etc., where some accident has made the air irrespirable and choked the lungs. It results also from edema of the glottis due to inhalation of acid fumes, ammonia, etc. The victim becomes unconscious, deeply cyanosed, pulseless, and respiration ceases. The pupils are dilated. Prompt action becomes necessary to save life.

The patient should be laid flat, the clothing loosened about the neck and chest, and the angle of the lower jaw raised upward and forward, while the tongue should be kept from falling backward and thus blocking the posterior pharynx and cutting off possible entrance of air. A ready way to accomplish this is to force and hold the mouth open with a blunt stick and then pass a stout thread through the anterior part of the tongue with a sharp needle. The tongue is then drawn forward and kept well out of the mouth by tying the thread around the patient's ear, while the mouth gag prevents the tongue from being bitten. Artificial respiration should be performed by kneeling behind the victim's head and raising his arms to fullest extension above his head. His arms are then brought down parallel to his chest and pressed against it to expel the air. An assistant should simultaneously compress the lower part of the patient's thorax to aid in expelling air. These motions should be rhythmically repeated not oftener than fourteen times a minute, or somewhat slower than the normal rate of breathing. A brief pause should occasionally be made to see whether the respiratory act may not be normally resumed of itself. Further stimulation of respiration may be made by flipping the thorax vigorously with a towel wet in ice water and by passing ammonia before the nostrils. In many patients a coat rolled up and placed between the shoulders will throw the chest forward and facilitate the artificial respiration. If much mucus accumulates in the mouth it should be swabbed out.

Hypodermactic stimulation with ether, camphor in oil and strychnin should be given in all cases with much mucus. Atropin sulphate (gr. 1/100) should also be given. The attempts at inducing respiration should not be abandoned for fully half an hour, for remarkable cases of resuscitation have occurred long after the victim was apparently dead.

As a substitute for artificial respiration by hand, the "pulmotor" may be used to advantage, and in many places where accidents from asphyxia are to be anticipated, as in coal mines, powder and fulminate works, etc., this apparatus should be kept ready for instant use. The pulmotor is a patented form of rescue apparatus designed to perform artificial inflation of the lungs in cases of suffocation from smoke, cessation of breathing due to irritant cardiac or respiratory poisons, threatened edema of the lungs, etc. It is very useful as an emergency apparatus in fire departments and manufactories of chemicals, powder, etc., where workmen are liable to be overcome suddenly by irrespirable fumes or gases. It is much used in the rescue department of coal mines. I have used it several times in acute pulmonary edema with marked benefit. Seven firemen who had been overcome by smoke from sulphur and pitch used for insulating wires were recently revived by

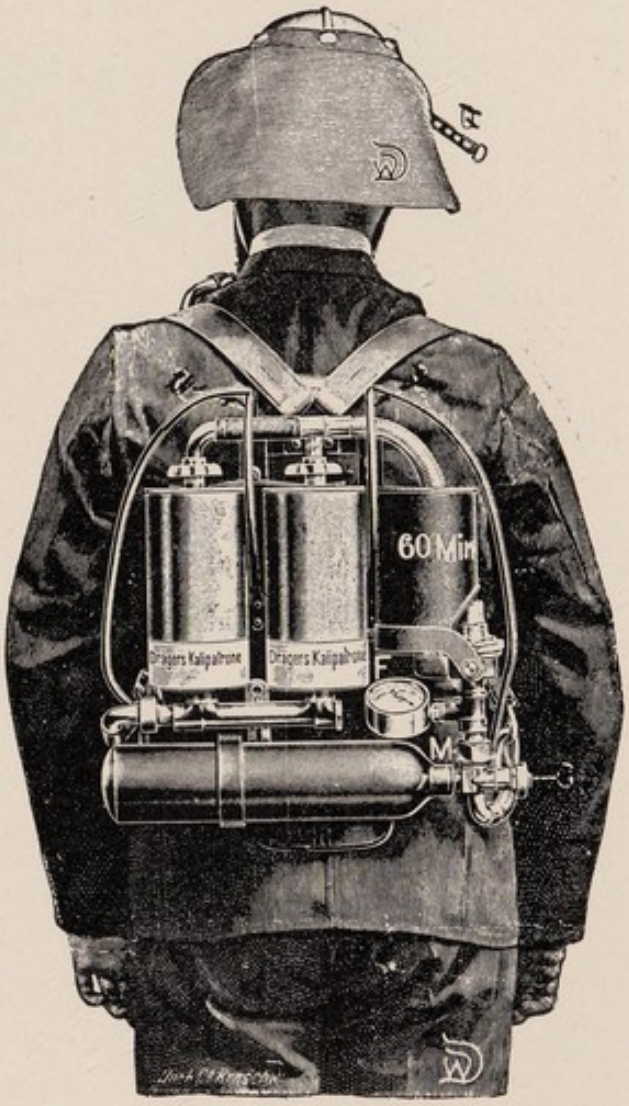


FIG. 22.—RESCUE APPARATUS, COMPLETE WITH SMOKE HELMET AND SINGLE CYLINDER. Rear view. (From the *Report* of the Illinois State Commission on Occupational Diseases, Jan., 1911.)

it at the Homeopathic Hospital in New York City, some of them several minutes after they were apparently dead from suffocation.

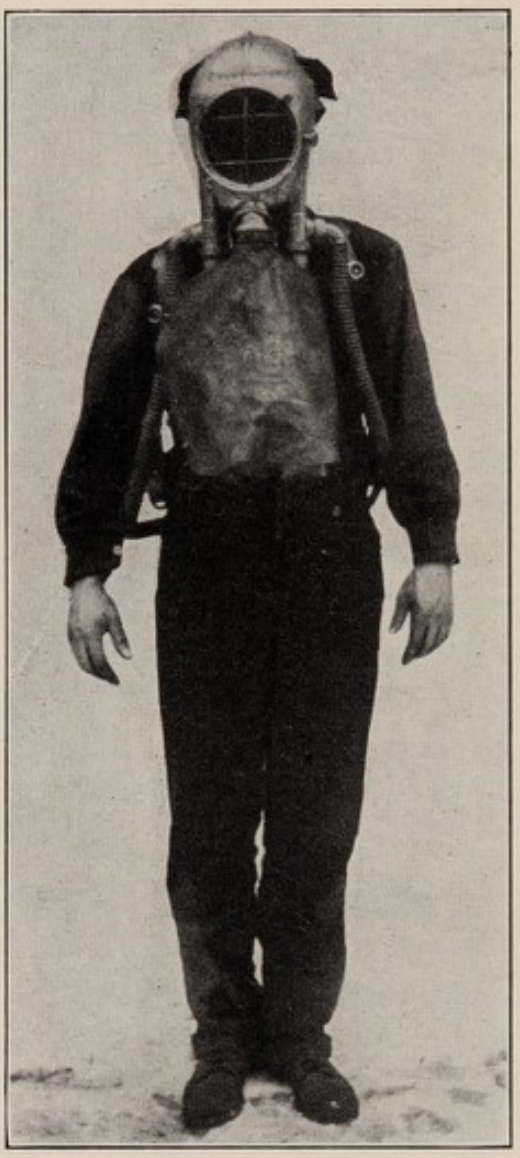


FIG. 23.—OXYGEN HELMET. Front view, showing breathing bag and flexible hose connecting with the oxygen supply and apparatus carried on the back.

The apparatus consists of a small tank of compressed oxygen and a motor, together with a bellows, springs, valves and an injector. A mixture of air and oxygen is pumped into the lungs automatically on opening the valves and starting the motor. When the lungs are distended to their full normal capacity the pressure within them reverses the motor, which automatically sucks the air out again. The apparatus then pumps air in again, again reverses, and so on, continuing to operate rhythmically at the ordinary rate of respiration until all the oxygen is exhausted. A flexible mask of rubber is strapped over the patient's nose and mouth, which is connected by rubber tubing with the rest of the apparatus.

In order to accomplish the rescue of asphyxiated persons from irrespirable atmospheres which might asphyxiate the rescuer, the oxygen or "smoke helmet" is used. This helmet is designed for rescue work in mines, smoke-filled buildings at fires, after explosions in chemical works, boiler rooms, etc. It is in use by the Rescue Corps of the Federal Bureau of Mines and by the United States Navy Department in case of submarine accidents, leakage or explosions from gas fuel tanks, bunker fires or powder explosions in turrets and magazines. The apparatus, shown

in Figures 22 and 23, consists of a tank of compressed oxygen with pressure gauge and valves, carried on the back and connected with the interior of a tight-fitting helmet mask. It may be worn for half an hour or more, and renders the wearer completely independent of any deleterious gases in the surrounding atmosphere.



FIG. 24.—OXYGEN INHALER. Compressed oxygen or air passes through the tubing in a strong current which is directed by the mouthpiece past the nostrils.

Another means of supplying oxygen to the rescuer or to firemen entering a smoke or fume-charged room consists of a curved plate which is held in the mouth so as to direct a stream of oxygen or compressed air in a strong draught upward past the nostrils and eyes, thus blowing away the smoke and supplying fit air to breathe simultaneously. (Fig. 24.) The oxygen tank is carried by a second person at a distance, or may be worn on the back of the operator, and a

simple hose with a valve conducts the oxygen to the mouthpiece. This apparatus is obviously less effective than the oxygen helmet, but has the advantage of being cheaper and less complicated. It is useful where the danger from asphyxia is less imminent and where only short exposure is required.

ACUTE RHINITIS

This condition, very common among occupational diseases from inhaling irritant dusts, gases, fumes, vapors, smoke, etc., is best treated by a warm nasal douche of normal salt solution, followed by topical application of adrenalin chlorid and menthol. Internally a rhinitis tablet should be given every hour or two for a few doses, and a saline cathartic. The nose, after irrigation, should be protected from further irritation by smearing liquid vaselin within the nares. The nasal douching or irrigation is particularly important at the onset in cases of occupational origin, because there is apt to be considerable irritant material clogging the nostrils.

CHRONIC RHINITIS

In chronic atrophic rhinitis the offensive dry crusts should be loosened and removed by a gentle nasal douche of warm bicarbonate of soda or boric acid (gr. x—ʒ i), or a weak solution of sodium salicylate may be used. This treatment should be followed by a protective albolene spray with menthol and eucalyptol. After a few days of such treatment, the nose being thoroughly cleansed, a topical application may be made of argyrol or

℞ Tincturæ iodi..... ♏ xx
Potassii iodidi.....gr. v
Glycerini .....fl. ʒ ii
Aquæ rosæ.....fl. ʒ i M.

Deep ulcers may be touched with nitrate of silver or aristol. As general "tonics," cod liver oil, Fowler's solution, and syrup of the iodid of iron are the most serviceable remedies.

SINUSITIS

For sinusitis, the sinuses should be thoroughly washed out with a mild alkaline, warm, antiseptic solution, such as

℞ Sodii bicarbonatis.....
Sodii biboratis.....āā ʒ i
Listerine..... fl. ℥ i
Aquæ destillatæ..... fl. ℥ vi M.

After cleansing, a 1/5000 adrenalin spray may be introduced.

ACUTE PHARYNGITIS

At the onset tincture of aconite may be given in minim doses once an hour, and the pharynx should be rinsed with a warm solution of sodium bicarbonate ʒ ii, glycerin ℥ ss, water ℥ iv. As in most of the acute inflammations of the upper air passages, a cathartic, such as a dose of calomel, should be prescribed.

CHRONIC PHARYNGITIS

This type of inflammation, so common in dusty occupations and those involving inhalation of acid fumes, may be treated by swabbing the wall of the pharynx with iodin or argyrol once in two or three days, or a spray may be used of sulphate of zinc solution in water (gr. x—℥ i) or

℞ Sodii boratis..... ʒ i
Acidi carbolici..... gr. x
Tincturæ iodi..... ʒ ii
Listerine ..... ℥ vi M.

ACUTE LARYNGITIS

This form of inflammation often results from irritation of toxic gases, vapors or fumes. It may be relieved by a gargle, such as:

℞ Sodii bicarbonatis ..... ʒ i
Spiritus chloroformi..... ♏ xxx
Aquæ camphoræ..... fl. ℥ vi M.

or

℞ Sodii biboratis ..... ʒ i
Glycerini ..... fl. ℥ ss
Aquæ ..... fl. ℥ vi M.

To be used once in three or four hours. An ice bag should be applied externally and a cathartic given.

Should there be much pain on swallowing, a spray which gives great relief consists of

℞ Iodoformi ..... gr. iv
Etheris ..... ℥ iv

This may be used briefly three or four times a day while the patient inspires deeply.

ACUTE BRONCHITIS

In the initial stage of acute bronchitis, when the bronchial mucous membrane is dry, tincture of aconite (♏ i) may be given with liquor ammoniæ acetatis (fl. ʒ ii) and camphor water (ʒ i). A cathartic, such as calomel or cascara, should be given. As soon as the muco-purulent secretion begins to form these remedies may be replaced with ammonium carbonate or chlorid or the common alkaline diuretic mixture, consisting of the acetate, bicarbonate and citrate of potassium.

Meanwhile the patient may use a spray of creosote ♏ xx in listerine and distilled water ℥ iii, inhaling it deeply. A mustard paste, made large and weak (1—8), gives considerable relief when applied over the upper sternal region or between the shoulders. The diet may be semi-solid.

CHRONIC BRONCHITIS

This ailment is one of the commonest among all those who are exposed to constant bronchial irritation or extremes of temperature

and dampness in their work. It is very difficult to cure while unfavorable conditions surround the workman, and often a change of occupation is essential to secure relief. It is a great mistake to give too much medicine, which may only destroy the appetite and digestion or cause depression. Drugs like heroin not only are depressant, but easily induce a permanent drug habit. If the cough is persistent and severe, causing muscular pains in the chest and interfering with sleep, the mistura glycyrrhizæ compositæ (℥i) with ammonium chlorid (gr. ii), or carbonate (gr. v), may be given three or four times a day and once or twice in the night. Or, if there is much pain or muscular soreness, codein may be given in the following mixture:

℞ Codein .....gr. iv
Syrupi tolutani .....
Aquæ .....āāfl. ℥ ii
Misce.: Sig.: dose ℥ i gr. 3 hrs.

But, as stated, the patient should be given as little as possible of remedies of this class. Should bronchorrhea characterize the condition, the watery secretion may be checked by tincture of belladonna (♏iv), given two or three times a day.

In many cases of chronic bronchitis the best results are obtained by the use of inhalations. Usually unable to use them during his working hours, the workman may do so, however, when he goes to his home in the evening, again on retiring and on rising. A pint of boiling water in a tea-kettle may be medicated and the steam inhaled through a paper funnel fitted over the spout. To the water should be added five drops of a mixture of pinol and eucalyptol, or ♏x of compound tincture of benzoin. The mistake is often made of using these remedies too strong, when they are irritating and nauseous. Properly used, they almost always afford marked relief.

It is customary in obstinate chronic cases, especially in those having arteriosclerosis as an important feature, to prescribe potassium iodid, and it sometimes gives relief, especially in elderly persons. Two or three grains per dose are better than larger quantities. Creosote carbonate or guaiacol combined with some simple syrupy

substance such as glycerin with a flavoring extract, or the *syrupus pruni* Virginianæ may be taken, and in some cases the patient may wear a nose inhaler saturated with four or five drops of creosote. A simple inhaler for this purpose which I have long used was designed by Beverley Robinson. It is made out of a piece of perforated zinc, such as is used for seives, bent to the form of a truncated cone, and the edges, after being trimmed to fit closely to the sides of the nose, are protected by binding with tape. A fragment of sponge is sewn in the apex of the cone to hold whatever medicaments are used. The cone should be deep enough to prevent the creosote from actual contact with the skin. I have several times seen serious eschars of the tip of the nose from carelessness in this matter.

Unfortunately, many patients will not wear inhalers or even take medicines during working hours, partly from the extra trouble and partly from the desire not to draw attention to their ailments from fear of being accused of "faking" or of losing their job. This is all the more true of late years, since every workman has been taught that tuberculosis is "catching," and he dreads to emphasize in any manner the fact that he has a cough.

Further treatment of chronic bronchitis consists in maintaining regularity of the bowels through the daily morning use of salines such as sodium phosphate or Rochelle salts, and taking a wholesome, nourishing diet, in which fats or oils predominate, such as butter, eggs and bacon, and olive or cod liver oil. In general, the patient does best without strong liquors of any sort, but in some cases malt liquors—beer, ale or stout—may be allowed. One must be guided in this matter by the patient's previous racial and personal habits. Counterirritation of the chest is always a useful adjunct to other measures. The chest may be rubbed with equal parts of turpentine and vaselin, or with mustard liniment.

Fetid Bronchitis, Pulmonary Abscess and Gangrene

These conditions require the same general treatment and differ only in that, in exceptional cases, an abscess cavity may have to be

opened and drained where it is not already draining sufficiently through a bronchus, or where a large cavity is held by adhesions and cannot contract satisfactorily.

It is a first requisite that the patient be removed from his work, if, indeed, he is not already quite incapacitated. What he most needs is rest and air free from the deleterious irritants which have been the primary cause of the trouble. Nothing so well controls the fever, in my experience, as a constant inhalation of steam vapor impregnated with turpentine (℥ xxx—Oi). This should be supplied through a croup kettle set on the floor, and the vapor directed under a tent over the patient's head, but with due regard to access of fresh air. A good rule is to give the inhalation for two hours, place the patient in fresh outdoor air for four hours, and repeat.

Creosote may be given internally in capsule (℥ ii, t. i. d.) or emulsion.

Everything should be done to maintain the patient's nutrition, and between meals he should take diluted cream, beaten eggs, custards, etc. As general tonics he may be given syrup of the iodid of iron or Fowler's solution and nux vomica.

ASTHMA AND EMPHYSEMA

True spasmodic asthma, due to inhalation of dust fumes, smoke and other respiratory irritants, is so common as to be known by workmen under various occupational titles, such as "miner's," "potter's," "miller's" asthma, and the like.

Treatment consists of giving a hypodermatic injection of ℥x of a 1:1000 solution of adrenalin chlorid, applying a large mustard paste (1:4) to the surface of the chest between the shoulders, giving a large cup of strong black coffee and an active purge, such as calomel (gr. iii) or blue mass (gr. x). As accessory measures a hot mustard foot-bath may be given and a stramonium cigarette may be inhaled. Between the attacks a tonic and tincture of belladonna may be given, and digestion should be well looked after to prevent dyspepsia, especially of flatulent type. For the latter, dilute hydrochloric acid (℥xx) and tincture of nux vomica (℥x)

should be prescribed, with a laxative pill at night. The patient should eat very little meat, becoming practically a vegetarian, and should drink water freely.

Many cases of asthma of occupational origin are almost impossible to benefit while the patient remains at work in the irritating atmosphere which has provoked the disease, and he should be urged strongly to undertake some other employment.

Emphysema may be acquired by glass blowers, workmen such as jewelers, who make constant use of the blowpipe, *et al.*, although it is more often the outcome of chronic asthma with arteriosclerosis. It gives rise to dyspnea and in advanced cases to chronic cyanosis. The symptoms are always much accentuated by attacks of bronchitis and asthma, and treatment consists in following the directions for these two conditions and seeking as far as possible to prevent such attacks by avoiding exposure to cold and wet, sudden changes of temperature, and attacks of dyspepsia. It is important also to keep arterial pressure from rising. (*See* Arteriosclerosis, page 42.) Potassium iodid (gr. iii t. i. d.) is often used for this condition, but I am not convinced that it proves of much value. It often disorders the stomach, and dyspepsia may precipitate asthmatic attacks and make matters worse.

EDEMA OF THE LUNGS

Pulmonary edema of occupational origin is produced by sudden overwhelming inhalation of toxic fumes, especially those of nitrous gases, etc. The condition is urgent and unless immediately relieved promptly ends in death. The respiration is labored and stertorous. The victim presents every evidence of intense air hunger. He is anxious, restless, and gasping for breath. Cyanosis is intense, the eyes are prominent, the pulse is quick and feeble, the skin is bathed in cold perspiration. Mucus rattles in the throat, and respiratory fremitus may be palpated all over the chest. Loud, coarse gurgling rales are everywhere heard, obscuring the heart sounds. The temperature may be subnormal.

The chest should be cupped energetically with dry cups, and

atropin (gr. 1/100) should be given hypodermically, together with ether, camphor in oil or citrated caffein (gr. ii). An enema of strong black coffee (½ pint) should be given. As there is tendency to relapse, the patient should be watched carefully for some hours. It may be necessary to employ artificial respiration. In several cases I have obtained marked benefit by use of the pulmotor. (*See* page 145.)

The subject of pulmonary edema is further discussed under Acid Poisoning.

GASTRIC DYSPEPSIA

This ailment in various types, but usually with flatulency, is very common as an occupational disorder. It arises from many causes, chief among which are foul air in the workroom, hurried habits of eating, worry over "speeding up," etc., and poor food or poorly cooked food. It is usually accompanied by constipation and a torpid liver due to lack of exercise, or cramped position while at work contributes to its origin.

The general rules for eating given on page 129 should be followed, but especially to be avoided are sweets of all kinds, fats and fried food, puddings, pastry and pickles.

For medicinal treatment many patients are greatly benefited or cured by taking ʒii of the mistura rhei composita of the Pharmacopeia before meals. In other cases, particularly those with excessive flatulency, the best remedy is ♏xx of dilute hydrochloric acid, with ♏x of nux vomica tincture and ʒi of compound tincture of cardamom given in a wineglassful of hot water directly after eating. Slow eating and thorough mastication should be insisted upon and the teeth should be put in good order. Cascara sagrada (♏xxx of the fluid extract) should be given at night, and once a week a calomel purge or compound cathartic pill should be given. The use of alcoholic beverages in any form is undesirable. Exercise should be regulated. A postman may walk too much and a shoemaker too little. In the one case the dyspepsia is due to fatigue and inhibition of gastric secretion; in the other it is due to inactivity of the liver, and in each case appropriate directions should be given. If the

patient has not time or energy to walk, he may take needed exercise at home with Indian clubs or some other simple expedient, like the "setting up drill," performed for ten minutes twice a day.

CONSTIPATION

Constipation is one of the commonest ailments among the working classes, especially among those who, like motormen or engineers, are obliged to have long and often irregular hours of work, or those, like garment workers, whose occupation is sedentary. This is a matter requiring strict attention by women and girls especially, whose sedentary work or irregularity of working hours is very likely to impair activity of the bowels. Chronic constipation leads to headache, anemia, neuralgia, dysmenorrhea, gastric dyspepsia and other ailments, and, besides impairing health, also impairs efficiency in marked degree.

Constipation is favored by improper diet and lack of sufficient supply of good drinking water placed in easily accessible places. It is also favored by fatigue and, in some cases, by excessive perspiration without exercise, which tends to diminish the fluidity of the natural digestive secretions. Certain poisons, particularly lead and its preparations, possess very constipating properties.

Constipation should be overcome, if possible, without recourse to medicines. For this purpose calisthenic exercises should be practiced night and morning; water should be drunk freely, six or eight tumblerfuls daily, or more if the nature of the work induces free perspiration; and fresh fruits, such as apples and oranges, should be taken between meals—as on rising and retiring. When thus taken with a glass or two of water their laxative effect is enhanced. Coarse cereals, such as oatmeal, hominy and Graham bread, should be eaten, and fresh green vegetables when obtainable.

Constipation is such a frequent cause of complaint among the working classes who frequent my clinic that the following printed instructions are given to all who suffer from it. They were prepared by my Chief of Dispensary Clinic, Dr. W. H. Sheldon.

MEDICAL CLINIC
CORNELL UNIVERSITY MEDICAL COLLEGE
OUT-PATIENT DEPARTMENT

WHAT TO DO FOR CONSTIPATION

1. Eat slowly; chew the food well.
2. Drink plenty of water: a tumblerful before each meal, and one more on rising and on going to bed.
3. Keep a regular time for going to stool each morning.
4. Exercise in the open air as much as possible. Practice exercises that will strengthen the muscles of the abdomen.
5. *Diet.*—The following foods are especially useful: Apples, oranges, pineapple, prunes, figs, dried stewed peaches, cabbage, onions, spinach, "greens," tomatoes, rhubarb, butter, olive oil, coarse Graham bread, rye bread, oatmeal, wheaten grits. Molasses, honey and gingerbread are useful for children.

   Foods to be avoided because they cause constipation are: Milk, cheese, eggs, sweets, pastry, pickles, fried foods and tea.

   It is better to eat fruits, green vegetables and coarse cereals than much meat.
6. It is better to cure constipation by careful dieting than to be always taking pills or medicine.

In the above dietary those foods are recommended which come within the purse limits of the average workman.

Constipation is often promoted by lack of attention to regularity in habit. When work begins early on cold, dark winter mornings the temptation is to neglect the normal function of the bowels until later in the day, and dirty, unhygienic closets in factory or mill further tend to make the workmen postpone the function and curtail it as much as possible. Hurried eating at a belated breakfast or luncheon, for which insufficient time is allowed, contributes to the habit, and lack of accessible drinking water in occupations which give rise to free perspiration is a common cause of constipation.

With regard to exercise, it should be remembered that over-exercise, as in the necessary overuse of certain muscles in various occupations, merely induces fatigue, and thus prevents the patient from taking the more wholesome types of exercise which favor

peristalsis. In the above rules "exercise in the open air" is recommended, but in some kinds of work, even in the open air, exercise is overdone and rest may be more needed during the non-working hours. This direction is intended chiefly for those whose work is sedentary and who live so far from their work that they always ride to and fro.

When medicines are needed to supplement the dietary, fluids such as fluid extract of cascara, or bitter-water or salts in the morning, are better, as a rule, than pills, because the dosage is more easily regulated, and the patient may be instructed to lessen the quantity of laxative as the effect of proper dieting begins to appear, and gradually to give up the use of medicines altogether.

KIDNEY DISEASES

The essential occupational renal disease is a chronic interstitial nephritis, induced by chronic metal poisoning or poisoning with some one of the toxic fluids or other chronic poisons. Acute parenchymatous nephritis is, however, not rarely met with, as in turpentine poisoning, etc. There are also cases of simple hematinuria and of acute suppression of urine, as in the caisson disease. The chronic nephritis of occupational origin does not differ in any manner from that so often accompanying chronic alcoholism and syphilis, and does not, therefore, demand detailed description here. The instructions for nephritic patients, however, are most important, and I append in detail the printed rules which for some time past have been issued to patients at my clinic.

DIRECTIONS FOR PATIENTS WITH KIDNEY DISEASE

Remember, with good care and by obeying instructions, you may live many years with little discomfort.

Instructions

I. *To avoid taking cold*

(1) Wear flannel underclothes all the year, warmer in winter.
(2) Keep the feet dry; wear warm socks.

(3) Do not get wet or chilled.
(4) Keep in the open air and sunshine all you can.
(5) Keep your rooms at an even temperature, not too hot.

II. *To relieve the work of the kidneys*

(1) Take a hot sponge bath every night at bedtime to keep open the pores of the skin.
(2) Keep the bowels open. Have at least one good passage every morning.

III. *Occupation*

Get work in which you never have to lift or strain, such as tailoring, operating, etc. It is harmful to lift heavy weights, walk too fast, stoop or climb long stairs. Rest as much as possible, with not less than eight hours sleep. Do not worry or get too tired.

IV. *Diet*

Dairy foods. Milk, cream, butter and a small amount of cheese.
Cereals. Rice, hominy, Indian meal, barley, cracked wheat, oatmeal, cream of wheat, etc.
Breads. Whole wheat, Graham, rye, corn bread.
Vegetables. Potatoes, beets, carrots, onions, turnips, squash, lettuce, spinach, tomatoes, peas.
Fruits. All fresh fruits except bananas.
Liquids. Drink no alcoholic liquors of any kind, not even beer. They are all absolutely poisonous to anyone with kidney disease and are likely to cause dropsy, shortness of breath or convulsions, and destroy your eyesight, besides shortening your life. Do not drink large quantities of water or other liquids.
Avoid all red meats, and eat eggs only in moderate quantities.
Avoid all salted or dried or canned meats and vegetables.

When acute parenchymatous nephritis is met with the patient should be put to bed and given a hot pack with a hot lemonade. Cups may later be applied over the lumbar region, followed by a hot flaxseed poultice. High colonic irrigation with a hot normal salt solution should be employed, or the Murphy drip may be used. The diet should consist of equal parts of milk and Vichy.

When strangury occurs in connection with hemoglobinuria or

otherwise it may be relieved by suppositories of extract of hyoscyamus (gr. i) with codein (gr. ss), given every six hours. A hot poultice over the lower abdomen may contribute comfort. It is best not to give morphin, but its use cannot always be avoided. In cases in which the arterial tension is very high the patient should be bled about sixteen ounces.

PART III

DISEASES DUE TO IRRITANT SUBSTANCES

I. TOXIC METALS AND THEIR COMPOUNDS

ANTIMONY

In the preparation of antimony products toxic vapors may be evolved, as they are, also, in the use of some of these products in manufactures, particularly the vapor of the trioxid (Sb_2O_3) and antimonious acid.

The various preparations are used in burnishing rifle barrels and steel ware (antimony chlorid), making type and stereotype metal alloys, hardening lead for ammunition, making Britannia ware and white metal, making fireworks, anilin dyes, vulcanizing and making red rubber, for which latter the pentasulphid is used. Antimonial preparations are further employed as mordants in cotton dyeing and textile printing. Cases of chronic antimony poisoning have been observed also among workers in chemical industries and paint-makers who are exposed to dust from the antimonial salts.

Symptoms.—The symptoms are both acute and chronic. Locally the antimony compounds give rise to dermatitis and pruritus, especially where the skin is perspiring. Inhaled as dust and in vapor, they cause acute symptoms such as rhinitis, inflammation of the pharynx, bronchitis, gastric disorder, and colic, sometimes with diarrhea. In serious cases of poisoning there are circulatory disturbances such as vertigo, palpitation, faintness and feeble heart action. Albuminuria is common.

Strumpf and Zabel, of Strassburg, have shown, both experimentally with animals and chemically, that much of the chronic

poisoning among typesetters is not due to lead, but to antimony. Type is often faced with a mixture of lead, 70 to 80 per cent., antimony 15 to 20 per cent., and tin 5 per cent. As the tin is inert, the cause of the poisoning must lie between the two other metals. In two patients these experimenters recovered antimony from the stools, and a number of typesetters were found to lack important symptoms of lead poisoning, such as granular basophilia, leukocytosis, albuminuria, biliuria and increased blood pressure.

The symptoms presented, however, were typical of chronic antimony poisoning as follows: frontal and occipital headache, vertigo, oppression in the chest, peripheral neuralgic and muscular pains, gastric disorder, constipation, insomnia, general nervousness, irritability, muscular fatigue and sexual weakness. Blood examination exhibited only moderate anemia, leukopenia, and an eosinophilia of 10 to 25 per cent. The urine appeared normal. Recovery usually took place upon a milk diet and laxatives, with regulated rest, exercise and fresh air.

Prophylaxis and Treatment.—Prophylaxis and treatment of antimony poisoning are practically identical with the measures described for Lead Poisoning.

ARSENIC

There are thirty or more trades in which arsenic is a menace to health in one form or another, as it is employed as a powder, a solution and in various compounds. The more important of these industries are: mining and smelting arsenical ores, hide curing and tanning leather, making paint and colors, making oilcloth, black metal plating, fur curing, dyeing fabrics, and glass making.

An American chemist lately analyzed forty-two samples of furs in eleven of which arsenic was present, in some cases to the extent of 170 grains to the square yard, thus constituting a serious menace to the wearer.

Arsenic contaminates some of the anilin dyes.

I reported a case of arsenic poisoning with peripheral neuritis in a tanner to the New York State Labor Bureau in the early part of

1912, and three other cases of industrial arsenic poisoning were also reported in that year.

Taxidermists employ arsenous oxid in proportion of a pound to the gallon of water, as a dipping or spraying protective solution for feathers and furs.

C. T. Graham-Rogers, in the *Report* of the New York State Commissioner of Labor, 1911, writes, "An analysis of a sample of



FIG. 25.—ARSENIC POISONING. An old and dangerous method of putting Paris green into a bolter. The workman wears a cloth protector, but much dust flies in his face, and he is without gloves. There are no ventilators and the unprotected belting is a distributor of dust. (From the *American Labor Legislation Review*, vol. ii, no. 2, June, 1912.)

dust secured in a room where Paris green was boxed showed .303 gram per cubic meter of air, and further analysis showed that of this .093 gram was arsenic. This dust is not only poisonous, but very irritating, and, as a result of spending several days at the plant, the mucous membrane of my nose, as well as that of Inspector Vogt, was inflamed for some days after our visit." (Figs. 25, 26.)

Many pigments are made with arsenical compounds, but the most familiar are Scheele's green or copper arsenite and Schweinfurth or

Paris green, which is an aceto-arsenite of copper. White arsenic or arsenous oxid is the preparation used by furriers and taxidermists to preserve skins from decay and moths. It is also used in shot-making and several other industries.

Arsenic was formerly employed in the manufacture of wall papers, colored paper boxes and cards, artificial flowers and leaves,



FIG. 26.—ARSENIC POISONING. Putting Paris green into a comparatively dustless bolter. Two types of respirators are shown, with protecting gloves, caps and overalls fitting close around the neck and wrists. (From the *American Labor Legislation Review*, vol. ii, no. 2, June, 1912.)

especially to form green pigments; and arsenical powders, especially Paris green, were dusted over the surface from a perforated box like a muffineer. Poisoning by such a very hazardous method was quite common. The introduction of anilins and other pigments has almost entirely replaced the use of arsenic in these industries.

In making artificial flowers the leaves are stiffened with paraffin or some similar preparation, and are then sometimes powdered with fine metallic dust such as that of aluminum or steel, instead of arsenical pigments.

M. A. Starr has reported a case of well-marked arsenical poison-

ing in a pregnant woman who was obliged to spend three months in bed. The room was papered and upholstered with green fabrics from which arsenic was derived on analysis.

In the dyeing of rugs and carpets in the United States both chrome and arsenical pigments, which were formerly much in vogue, have been almost entirely superseded by other dyes, such as the anilins. Moreover, much of the dyeing process which was conducted originally by hand is now accomplished by machinery. In Massachusetts a law was passed several years ago compelling a guarantee that no arsenical pigment was used in the dyeing of rugs made within the jurisdiction of the State.

There have been cases of arsenical poisoning among makers of insecticides used by farmers for dipping sheep to kill ticks. In many plant industries Paris green is employed as an insecticide on a very large scale, and arsenical poisoning may result from careless handling of it. This poison is spread over the leaves of the cotton plant to kill the army worm, and where several thousand acres form a single plantation large quantities of it are distributed.

Cases of arsenical poisoning were not infrequent among the negro plantation men when the old method was used. A negro rode a mule between the rows of cotton plants, holding in his hands a cross stick, from the ends of which cloth bags filled with the poison were suspended so as to shake out the powdered dust upon the plants. The modern method, under which arsenic poisoning now rarely, if ever, occurs was invented by Mr. Albert R. Shattuck. It consists of a portable blower, rotated by hand, by which the Paris green is blown by compressed air. The cloud of dust, sent with the air, rises to a height of ten or fifteen feet and is carried far away from the laborer, to fall upon the plants.

About forty persons were recently poisoned at a wedding by eating a lettuce salad, the lettuce having been sprayed with Paris green by a careless gardener. Arsenate of lead is used as a plant insecticide both dry and as a paste.

Orpiment is a yellow sulphid of arsenic which, among other uses, is added sometimes to adulterate the poorer grades of shellac to make them yellow and opaque. Such shellac is used in varnish-

ing brewery vats and casks, and has been found as an adulterant of candy, being added to give it attractive gloss. Handling it is not known to have caused serious poisoning, but taking it in food or drink may do so, and in England a number of cases of arsenical poisoning acquired from beer drinking were reported a few years ago. Shellac itself is non-toxic, being a resin-like material secreted by a scale-forming insect in the East Indies. In the beer cases above referred to, however, the arsenic was found to be derived from a process of manufacture of glucose which was used in fermenting the beer. The symptoms produced were those of peripheral neuritis.

Pathological Anatomy.—In fatal cases of chronic arsenic poisoning Professor Ekeley of the University of Colorado has shown that most of the arsenic is retained in the liver and kidneys, with traces in the brain, as Russell H. Chittenden long ago pointed out. In acute cases, due to fume poisoning, there may be commencing fatty degeneration of the liver and kidneys, with ulcers of the stomach and intestines and bronchopneumonia.

Symptoms of Acute Poisoning.—Inhalation of arsenical fumes in moderate concentration occasions irritation of the eyes, headache, nausea, vomiting, intestinal cramps, anemia, and jaundice. In time peripheral nerve and joint pains are complained of and nutrition is impaired.

In more serious cases resulting from stronger fumes the pulse becomes quick and feeble, vomiting occurs, there is a cold perspiration with cyanosis, drowsiness, and there is frequent micturition with hemoglobinuria. The patient may die from paralysis of the heart or with symptoms resembling cholera.

Symptoms of Chronic Arsenic Poisoning.—Primarily there is gastro-intestinal disorder. Nausea, vomiting, epigastric pain, intestinal unrest and sometimes diarrhea prevail. Nutrition is impaired, muscular strength weakens, and the patient becomes distinctly cachectic, with a grayish pallor and pronounced anemia. There is inflammation of the mucous membranes.

Arsenic irritates the eyes, causing conjunctivitis, with puffy eyelids. It gives rise to dryness, soreness and burning sensation in the mouth and pharynx, with gingivitis, and the patient complains

much of thirst. There may be hemorrhage from the gums. There is vomiting, accompanied by much straining. The skin shows dermatitis, eczema, and often fissures and ulcers, due to contact with arsenical solutions or powders.

The miners who work in arsenic-bearing minerals, such as cobalt compounds, etc., are subject to both the local and general effects of arsenic poisoning. The local corrosive effect of arsenic is manifest through irritation of the mucous membrane of the upper air passages, and such symptoms as nasal catarrh, nosebleed and sensations of burning and irritation in the nose are common. Ulcers may form within the nose and, as in chrome poisoning (page 183), they usually form over the anterior cartilaginous portion of the septum. The cartilage may become eroded, but it is rare for the bone structure of the septum to be involved. Perforation of the septum may result, and such cases have been described by Baumgarten and Toeplitz. The middle ear may become involved in a purulent inflammation. The larynx and trachea are also irritated, and bronchial catarrh with an irritant cough and blood-stained sputum is common.

In some cases there is gastro-intestinal catarrh. Chronic poisoning among the miners is characterized chiefly by multiple peripheral neuritis. Arsenite of copper or Paris green forms a very light volatile substance, which is highly irritating to both the skin and mucous membranes. It may cause ulceration of the nose, mouth and hands. Dr. Alice Hamilton refers to cases of ulceration of the feet which became wet with Paris green solution, and states that in the Paris green factories in Illinois the workmen are continually shifting on account of arsenical poisoning, and usually all are poisoned by the end of the season.

Two of the organic preparations of arsenic, namely, atoxyl and arsacetin, may give rise to optic neuritis as an effect of poisoning, thereby resembling the action of methyl alcohol. Traces of arsenic may often be obtained from the urine. There are dryness and falling out of the hair and nails, eczema and ulcers of the skin. Brown pigmentation of the skin may be diffuse or in patches, and is common. One of my patients, a dyer, had marked general bronzing of the skin,

and another had been employed for six years as a paint mixer, mixing Paris green and white lead. When seen he had chronic eczema of both hands and a diffuse mahogany brown pigmentation of the skin, but not, as in Addison's disease, affecting the mucous membranes. There were small areas of normal-colored skin in the brown pigmentation, which latter was most evident over the neck, chest and abdomen, being less so on the extremities. There were no symptoms of plumbism. There were no white areas of atrophy of the skin such as those seen in Addison's disease.

In severe cases of arsenic poisoning disturbances of the central nervous system obtain, rarely with convulsions.

Prevention.—To protect against poisoning by arsenical dust, especially that of Paris green, which is so very volatile, the employee's body should be covered as completely as possible. A cap, goggles, overalls, gloves and high boots should be worn, and clean cotton wool plugs should be placed in the nostrils after anointing them with vaselin. Some simple ointment, such as lanolin or cold cream, should be smeared over the face in order to prevent eczema.

In using dyestuffs or other fluid preparations containing arsenic, rubber gloves should be worn, and in spraying trees with arsenical preparations rubber suits should be worn and the eyes protected with goggles. Care should be taken that the spray should not fall upon vegetables or grass likely soon to be eaten by cattle, which are quite susceptible to arsenic poisoning.

Treatment.—Treatment of acute arsenic poisoning due to fumes consists in relieving the pains, cramps and nausea by morphin, and the use of cardiac hypodermic stimulation should collapse be threatening.

Chronic cases require treatment mainly for the multiple neuritis, which is more likely than lead to affect the peripheral sensory nerves. At first rest, applications of hot stupes or poultices and menthol or camphor liniment should be used. Milk diet should be given until the gastric dyspepsia has subsided, and large quantities of water should be drunk. Later, for paralysis of the extremities, massage, electricity, tonic douches and passive motion should be employed.

BRASS

Brass is a compound of the metals zinc and copper. When pure and yellow in color these metals exist in proportion of two parts copper and one of zinc, but in the so-called "regular brass," in distinction from "pure yellow brass," the common formula in percentages is as follows: Copper 92, tin 6, lead 1, zinc 1. A cheap yellow brass contains 40 to 50 per cent. of zinc. Other percentages are also used in various alloys, and the lead may be 7 per cent. In addition to the above substances brass-workers may be exposed to the effects of arsenic, phosphorus, antimony, nickel and the cyanids.

Processes of Manufacture.—The alloy is made at very high temperatures in crucibles which are plunged into sunken furnaces. The molten mixture is then poured into pattern molds to form castings. The castings are, when cooled, dipped into acid solutions of various strengths to remove oxidation products and impurities. They are then ready for burnishing or polishing on a lathe to acquire a smooth surface, and finishing or dressing, lacquering with shellac and bronzing, may be employed to make the finished product.

"In the process which involves the pouring of the molten alloy, zinc deflagrates, and a dense white smoke fills the casting room, which rapidly forms snow-white flakes and powder of zinc oxid. The fumes remain for some time in the air of the room, and, where ventilation is defective (as it usually is), collects upon rafters and ceilings in dense white incrustations." (Graham-Rogers.) The quantity of toxic fumes depends upon the amount of zinc used, the ventilation of the casting room and the density of the atmosphere, for foggy, moist air favors condensation.

The temperature at which copper is volatilized is about 237° F., and for zinc it is considerably lower; hence zinc fumes may become toxic before the copper is volatilized. In making brass a temperature of 2,000° F. is not usually exceeded. It is during the pouring of the molten metal mass from the crucibles into molds that the strongest vapors are evolved, and in this process most of the cases of "founder's ague" take place, while flocculent zinc oxid flies about the workroom.

Dr. C. T. Graham-Rogers, in the *Report* of the New York State Commissioner of Labor, 1911, writes:

"Accompanied by Inspector Vogt, some time was spent in a brass foundry for the purpose of securing samples of air during the periods of casting the metal; twenty-four hours later Mr. Vogt became quite ill, and exhibited all the symptoms of zinc poisoning, the illness lasting for several days. Analysis of the samples of air secured showed the presence of zinc and copper, which was definite proof of the danger from zinc poisoning, since the analyses were confirmed by the actual effects upon one exposed to the air. Inquiries made of the workmen in this and other brass foundries confirmed the fact, for all suffered from the symptoms known as 'brass-founder's ague,' which is zinc poisoning."

The air examined from the casting room was found to contain 75.2 grams per million liters, in which were 55.2 grams of silica, with traces of zinc and copper.

The smelters and casters, in addition to exposure to the fumes, are subjected to great variations of external temperature and experience thirst and perspiration.

In a report on the brass industry in the neighborhood of Chicago, made in January, 1911, by Dr. Emory R. Hayhurst to the Illinois State Commission on Occupational Diseases, he thus summarizes the disease hazards:

In this industry the dangers, other than accidents, are:

In the Foundry, Refining or Smelting Processes

1. Inhalation of metallic vapors (zinc, copper, tin, lead, phosphorus, arsenic, antimony, and nickel).
2. Inhalation of carbon monoxid and other gases of incomplete combustion from furnaces.
3. Handling of lead in some processes in its pure state (refiners, resmelters, babbitt workers, journal-bearing liners), while lead is an alloyed constituent of practically all brass and bronze compositions, and indeed in all alloys of soft metals.
4. Effects of fatiguing labor. Workmen complain that they are now required to do from one-half to double again as much as they were wont to do ten to twenty years ago.
5. Women, girls and boys are more susceptible to poisoning from metallic vapors and dust than men.

In the Finishing Processes

6. Inhalation of brass, emery and other dusts (grinding, polishing, buffing, rubbing, skimming, turning, burnishing, boring, etc.).
7. Skin irritations from fine brass dust.

In the Plating Processes

8. Inhalation of mineral acid vapors where castings are dipped into such acids for the purpose of cleaning them preparatory to plating. The acids commonly used are mixtures of sulphuric, nitric, and hydrochloric.
9. Inhalation of hot potash vapors (cleaning processes).
10. Inhalations from hot potassium cyanid solutions which are contained in large tanks or vats and are used as electrolytic solutions.
11. Shellac vapors are always very noticeable and are detrimental to health where wood alcohol or benzene are used as diluents or solvents.
12. Effects of dampness, standing on wet floors, placing hands and arms alternately in and out of water and various solutions.

Mode of Poisoning.—There has been much discussion as to which component of the brass alloy is responsible for the symptoms of poisoning. These symptoms may be either acute or chronic, the acute form being derived solely from the process of moulding or casting in which fumes are evolved. The chronic type is more often derived from finishing processes such as filing, polishing, etc., in which metallic dust is formed. (Fig. 27.) The acute symptoms resemble those of zinc poisoning, whereas those of the chronic form resemble those of copper poisoning. The arguments for and against the relative influence of the copper and zinc have been presented in a study of this subject made by two members of my staff, H. J. Schwartz and Montgomery H. Sicard, in the *Medical Report* of the Cornell University Medical College (January, 1905, vol. i). These authors state:

"(1) There is no evidence that the internal administration of zinc, even when given in large quantities, ever produces the acute symptoms known as brass-founder's ague (which are described below).

"(2) The malady has been encountered in men whose work in brass was other than that of casting.

"(3) It is not observed in other operatives, such as galvanized iron workers, who are exposed to the fumes of zinc oxid.

"(4) Zinc is rapidly excreted and does not, like copper, become fixed in the body and produce chronic affections."

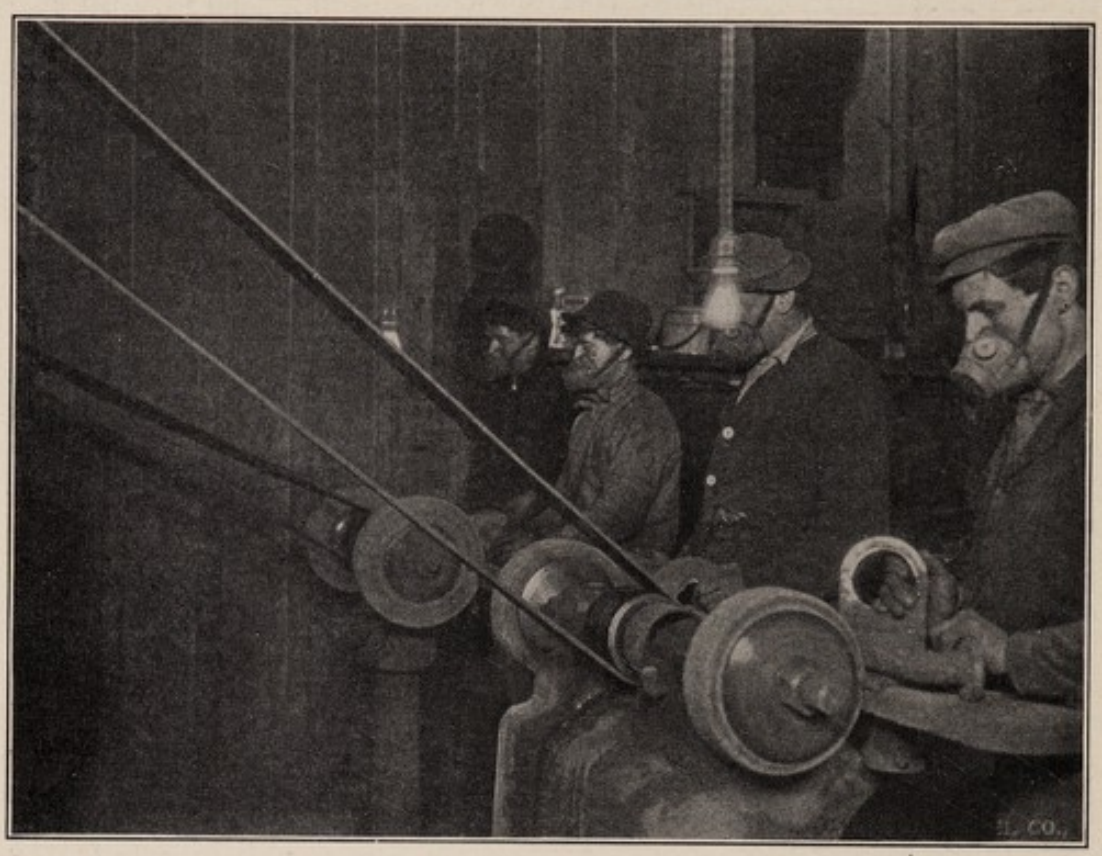


FIG. 27.—BRASS GRINDING. The men are wearing muzzles; but the emery wheels are unprotected, there are no dust aspirating ducts, the belting is unprotected and the unprotected light is in poor position for the eyes. (From the *Bulletin* of the Illinois State Department of Factory Inspection, 1911.)

It is possible, therefore, that the acute "ague" is due to admixture of the copper and zinc, whereas for the chronic affections copper alone is responsible. On the other hand, as against the influence of copper in producing the ague, "workers in refined copper do not have much trouble and never chills." Possibly much of the ill effects are derived from the lead of the poorer grades of brass. Sicard visited the largest copper smelting plant in the United States, and, apart from the smelters of the crude ore, which has a high admixture of lead and arsenic, the workmen were little affected. In brass smelting, moreover, the copper oxid is not volatile, but the

zinc oxid gives off dense fumes. These authors conclude that this is a strong point in favor of the zinc, and not the copper, being the cause of brass-founder's ague, a view which most authors advocate. On the contrary, in finishing processes involving the grinding or filing of brass, the copper may be inhaled in dust or conveyed to the mouth, and give rise to symptoms of chronic poisoning. (Described below on page 176.)

Kisskalt, in a recent study of "brass-molder's fever" in Königsberg, noted temperature elevations up to 101.5° F., with a pulse rate of 120 accompanying the chills. This author is disposed to refer all the phenomena of acute brass poisoning to inhalation of zinc vapor. Hayhurst states that from 70 to 80 per cent. of all brass founders are subject to founder's ague, and that tolerance is acquired by about 70 to 75 per cent. of steady workers. Rarely the attacks of ague compel the workman to abandon his job altogether. Recent experiments with injecting particles of finely pulverized metal into the circulating blood of animals have been found to give rise to chills and suggest the possibility of such a factor in brass chills.

Symptoms.—Acute Brass Poisoning or "Brass-Founder's Ague."—This was first described by Thackrah, an Englishman, in 1830. Two cases of brass-founder's ague occurring in my clinic have been studied in detail by Schwartz and Sicard. Their histories, which may be regarded as typical, may be summarized as follows:

Case I.—The patient, a man forty-two years of age, had been a brass molder for three years, during which period he had chills at irregular intervals, with chattering of the teeth and sweats. He had noticed that these symptoms were most liable to appear if he were constipated, or upon returning to work after a brief holiday. They also were more liable to appear in damp weather, when metallic fumes were heavy in the foundry. He stated that many of his associated workmen had the same symptoms from time to time, together with indefinite pains in the lumbar region, joints and extremities, but there was notable absence of colic or paralysis. The authors quoted followed the patient's own description of his attacks as closely as possible.

"Generally, toward evening, he feels languid, depressed and

very cold. He shivers, his teeth chatter, and there are profuse perspiration, severe headache, nausea, and muscular pains and cramps. On going home he takes a hot drink (usually milk) and goes to bed. He soon vomits, feels feverish, perspires profusely, and falls asleep. Next morning he feels weak, but may be able to return to work. He also has frequent flatulent dyspepsia, with acid eructations, but is not constipated."

Physical examination showed poor general nutrition. The right sciatic nerve was tender and painful. (He had had sciatica for three weeks.) There were no disturbances of special senses and the viscera were normal. The urine and blood examinations showed nothing abnormal.

Case II.—The patient, a man twenty-eight years of age, had also been a brass founder for several years, and had had many attacks similar to those above described, especially when he first began to work. "His first sensation is that of increasing languor. The prostration is soon extreme, the headache severe, sweating is accompanied by shivering, chattering of the teeth, with finally a hard chill, followed by a sensation of feverishness. Vomiting ensues. These symptoms, most common in damp or foggy weather, usually develop after leaving the factory and passing into the open air. The entire seizure lasts from four to six hours, and passes off after a night's rest, merely leaving the patient somewhat prostrated.

"As time progresses the new workers appear to acquire a certain degree of immunity, the attacks becoming less frequent and severe, but they recur at any time after an absence from work of a few days." Almost all the brass foundrymen suffer more or less from this group of symptoms, although in varying degree, but rarely are they finally compelled to seek another occupation.

In the symptoms of brass-founder's ague there is interesting analogy with the paroxysms of malaria, excepting the absence of high fever in the brass ague and the lack of definite periodicity. The attacks are so well understood by the workmen that they seldom seek a physician's aid, preferring to treat themselves by drinking hot milk, which may form an insoluble albuminate with such portion of the vapors of both zinc and copper as may have been taken into

the mouth, condensed, and swallowed. In fact, they often refer to the "chills" as no worse than an attack of seasickness. Predisposing factors in producing the ague are alcoholism, poor food and irregular hours.

Case III.—A personal case was that of a village blacksmith, fifty-six years of age, who had marked paralysis of both arms and hands, with atrophy of the extensor muscles of the hand and interossei, which had lasted for nine months when seen. He stated that he had never used lead, but I found that for many years he had been in the habit of welding brass implements of various kinds in his blacksmith's forge, leaning over and often inhaling metallic fumes. He probably also had swallowed much brass dust, for he was an inveterate chewer of tobacco and had no washing facilities at hand. He had devised a strap reaching from the arm to the back of his right hand to enable him to extend the hand and hold a hammer, but his grip was very feeble.

According to Dr. George M. Kober, as many as 75 per cent. of new workers in brass foundries, and of those who return to work after becoming immune, suffer more or less from "brass chills."

Dr. Emory R. Hayhurst, in the investigation of brass poisoning made in 1909-10 for the Illinois Commission on Occupational Diseases above referred to, found that among 189 workmen in 78 brass foundries, 146 had had illness of some sort referable to their occupation, and 45, or nearly one-third, had suffered from "brass chills." Of 1,761 workmen, about 10 per cent. only were more than fifty years of age. This, of course, does not mean an unusual mortality, but implies that, from illness, accident, or other causes, the men leave the employment.

In an investigation which I made in December, 1913, of three of the largest Bridgeport brass works, in company with Dr. Hayhurst and Miss Erskine, we found a number of casters and founders who had had brass chills repeatedly in former years, but several of them had remained more than thirty years in the employment. They attributed their present immunity to working chiefly with "red brass," which contains a larger percentage of copper than the cheaper grades of "yellow brass." In general the men thus employed appeared in

very good health, and the criticisms we had to make reflected more upon certain general unhygienic surroundings than upon anything inherent in the brass industry itself. We were told of the incident of three carpenters who were sent to repair a skylight over a casting room. The metal fumes rose toward the vent in the skylight, and at the end of the day all three carpenters had brass chills, although the casters on the floor were immune.

Chronic Poisoning by Powdered Brass or Brass Dust.—The inhalation of powdered brass, the dust of brass filings, etc., irritates the respiratory mucosa and lungs. The metal may also be swallowed after inhalation into the mouth, or conveyance to the mouth by unclean hands or food or plug tobacco. In this manner chronic poisoning in time results, with symptoms which differ considerably from those of the ague, above described. Chronic bronchitis is usually to be found, and sometimes fibroid phthisis and tuberculosis. The digestive system is deranged, and the victim complains of dyspepsia, anorexia, gastro-intestinal catarrh, nausea, vomiting, thirst, irregular action of the bowels, occasional intestinal colic, and a metallic taste in the mouth. The tartar on the teeth may become green from a deposit of copper salts. Headache and general muscular pains are common, and the patients often become neurotic, depressed and hypochondriacal.

Dr. E. H. Goodman reported, in 1911, a case of chronic brass poisoning, in which copper was isolated from the sweat and urine of the patient. The man had worked in brass for forty-seven years. His undershirt was stained green by perspiration and it was found to retain copper.

Twelve cases of chronic brass poisoning have been studied in my clinic during the past few years, several of which may serve to illustrate certain features of the hazard of brass working.

Case IV.—This patient, a man forty-six years of age, had been employed for eight years handling bars of brass and copper. He had a lead line on the gums, marked granular basophilia, and the blood examination further showed a hemoglobin count of only 35 per cent., erythrocytes 2,160,000 and leukocytes 12,000. He had also a chronic nephritis, arteriosclerosis and moderate cardiac hyper-

trophy. His chief complaints were of dyspnea and constipation. He had lost an eye from spattering of molten metal.

Case V.—This patient had been a brass polisher and buffer for ten years, using both the emery and rag wheel. He suffered from attacks of headache, coryza, rhinitis, persistent cough and recurrent bronchitis, with dyspnea. Examination showed chronic bronchitis and emphysema. It is probable that the emery dust, as well as metallic dust, was responsible for his condition, as he had none of the symptoms of lead poisoning which he might have acquired from the lead contained in brass.

Case VI.—This man also had been employed for six years in work identical with that of the patient, Case IV. For two or three years he had noticed that his fingers and toes easily became numb and cold, and slight abrasions did not readily heal. He was found to have endarteritis obliterans, and in the left radial and dorsalis pedis arteries pulsation was entirely lacking. An open cut on the left middle finger had not healed during a month's time. The hands and feet were cyanotic and were cold to the touch.

On the other hand, many brass workers remain unaffected by the metallic dust.

One of my patients, a brass polisher who polished small brass pieces by hand, used a respirator, and worked in a well-ventilated room, cleaned daily. He had good washing facilities. He came to Bellevue Hospital for treatment for acute rheumatism and had no signs of metal poisoning. He stated that 150 of his co-workers in the same hygienic establishment had maintained good health.

The sandblasting of brass castings is very unwholesome work, especially where the castings are so large that they cannot be handled in cupboards behind screens, but the workman must stand out in a cloud of sand dust in the room with the castings. (*See* Sandblasting, Figure 20, page 117.)

Prevention.—Prevention of the acute form involves strong ventilation and the wearing of respirators. Ague is rare where ventilation is good.

Treatment.—When an attack of ague commences the workman should drink a quart of hot milk, go to bed warmly covered in a

well ventilated room and take a cathartic and a teaspoonful of aromatic spirits of ammonia in hot water. If the attacks recur frequently, he should seek some other form of work.

The treatment of the chronic form comprises chiefly that of chronic bronchitis and indigestion. (*See* pages 150, 155.) Potassium iodid may be given in a cough mixture, and dilute hydrochloric acid with nux vomica and a simple bitter, such as gentian, may improve appetite and digestion. The precautions against conveying metal dusts to the mouth, formulated under Dust Prevention, should be observed strictly.

BRONZE

This substance is made as an alloy containing usually nine parts of copper and one of tin, but other metals are sometimes combined with the copper, such as aluminum. The manufacture of bronze castings does not produce much hazard, but the materials used in cleaning and polishing bronze, such as acids, various polishing and buffing powders, may give rise to poisoning, especially through irritation of the lungs.

Symptoms.—Workers in bronze complain of headache, rhinitis, conjunctivitis, a metallic taste in the mouth, anorexia, and anemia.

One of my patients had worked with bronze for twenty-five years, without acquiring any definite symptoms of metal poisoning, perhaps because his work was mainly outdoors, putting bronze railings in place. He had also handled much solder. He had arteriosclerosis, a slightly enlarged heart, blood pressure of 180 mm. and albuminuria. These symptoms were not necessarily due to occupation, but the man was only forty-eight years of age and gave no syphilitic or alcoholic history. There did not appear to be any other explanation of the symptoms, therefore, than some form of chronic metal poisoning derived from bronze.

"Bronze Powders"

The numerous so-called "bronze powders" contain a variety of poisonous metals, such as antimony, arsenic, chromium, etc. Gold

bronze contains copper and zinc, with impurities such as tin, lead or arsenic. Bronze powders are much used for making picture frames and mouldings, wall papers, Christmas and Easter picture cards, etc., in lithographic establishments.

Bronzing, to produce metallic effects on paper, wood, leather, etc., is done by both dry and wet processes. The surface is first covered with an adhesive paste, the powder is dusted on and any excess rubbed off after drying.

Dry bronze powders constitute a serious menace through irritation of the respiratory system. When dusted they should be applied by a compressed air atomizer, so that the dust may be blown away from the operator's face. In other cases they are made into solution with various more or less toxic solvents.

Symptoms.—Symptoms of bronze powder poisoning by inhalation are headache and digestive disorder, such as vomiting and diarrhea. There is anemia and the perspiration stains the clothing green.

In lithographic plants in Massachusetts, where boys feed the bronzing machines, they breathe through handkerchiefs held before the face.

CHROMIC ACID AND CHROME PIGMENTS

Manufacture and Uses.—The various salts of chromic acid, especially the bichromates of potassium and sodium, popularly called "bichromes," are manufactured by somewhat elaborate processes, involving concentration by boiling, evaporation, roasting, the breaking up of crystalline masses, pulverization by grinding, etc., together with the addition of such substances as lime, potash and sulphuric acid. The handling of these materials involves much exposure of the workmen to irritant fumes, dusts and solutions, with the result that practically all of them are sooner or later poisoned in some degree.

The bichromates have many uses in the arts, the most important of which are in the production of pigments, especially paints and dyestuffs. The making of chrome yellow paints involves the inter-

action of lead acetate and potassium bichromate. In dyeing cotton yarn and calico printing a similar reaction is utilized for mordant purposes. The yarn, after soaking in lime solution, is wrung out and placed in a vat of lead acetate solution. When bichromate of potassium is used the yellow color of the fiber is produced. In calico printing the cloth, after treatment with indigo blue, is printed with a forty per cent. paste of potassium bichromate which replaces the indigo, or the pattern may be printed with a paste of lead acetate, after which the cloth is treated with a two to five per cent. solution of the bichromate which fixes the yellow color. Bichromate is, also, a mordant for wool in an aqueous solution of from two to four per cent. In the making of carbon prints in photography, gelatin with a five per cent. (or less) solution of potassium bichromate forms a compound through the action of light which is insoluble in hot water. Chromic acid and potassium bichromate are ingredients of the emulsion which is spread upon the copper plates used for photo-engraving, and engravers of this sort are very subject to "chrome sores." Chrome compounds are used in making galvanic batteries, safety matches, acetylene, coloring artificial flowers, making anilin preparations and colored glass.

In the bleaching of oils, fats and wax and in the making of various coal-tar colors, potassium bichromate is employed. Chromates are also used in steel manufacture, tanning and matchmaking. These various processes, excepting that they may injure the skin of the hands and arms, are not particularly injurious, but they indicate the importance and extent of chrome manufacture.

This manufacture, as described by Sir Thomas Oliver, is conducted, briefly speaking, as follows:

Chrome ironstone is first ground to an impalpable powder, which, although somewhat irritating to the respiratory system, does not produce the diagnostic symptoms of poisoning. The powder is mixed with lime and potash, and the mixture roasted in a furnace for a period, which, in this country, is about four hours. The fused mass or "batch" of neutral chromate of calcium and potash, after cooling, is broken into fragments and shoveled into "keeves" or vats. This manipulation again stirs up much dust. Lixiviation

with water and a solution of potassium sulphate follows, with resulting slaking of uncombined lime, which evolves steam, impregnated with chromate dust. The mixture is boiled to concentration in successive keeves and finally pumped into evaporating pans. These pans should be covered by hoods with ducts leading to the open air, otherwise the fumes enter the workroom, as they sometimes are permitted to do. Sulphuric acid is now added, with formation of potassium sulphate and potassium bichromate. The sulphate is withdrawn and the bichromate, when concentrated, is pumped into lead-lined evaporating pans in which, after about three weeks, the bichromate crystallizes upon the sides and floor of the pans. The crystal masses are then broken with a pick, wheeled in barrows to be washed, dried in open stoves by hot air or steam pipes, crushed and packed in barrels, ready for commercial use.

Sodium bichromate is manufactured in the same manner, sodium carbonate taking the place of potassium carbonate. This salt forms a solid cake, which must be broken up, as it crystallizes less readily than the potassium salt. Being also more deliquescent, it is more easily absorbed by the skin or mucous membranes.

All the various processes of roasting, boiling down for concentration and tending the keeves expose the workmen to fumes, the more so as their work is arduous and constant. The shoveling, pulverizing and packing the crystals evolve much highly irritant dust, which is the chief factor in developing serious skin lesions. In the stage of the work in which steam is evolved the chrome dust is widely disseminated and deposited in yellow crystals of neutral potassium chromate on the rafters of the ceiling, and, even upon any flat surface a few feet above the evaporating pans, precipitation promptly takes place. Oliver states that "a stranger present only for a few minutes while the packing is being done has the mucous membrane of his nose acutely inflamed for hours, or even for days, afterward."

Dr. Heise analyzed the air in various parts of a chrome manufactory, and found that a cubic meter of air contained bichromate dust as follows: Near the breaking up of cakes of sodium bicarbonate, 6.30 milligrams of the salt; during 15 minutes of packing,

1.57 milligrams; over the evaporating pans, with steam evolution, 0.736 milligram.

It is an interesting fact that, although potassium bichromate and chromic acid produce deep ulceration, the former is sometimes successfully employed to heal malignant types of ulcer and alleviate new growths, being both antiseptic and corrosive in action. W. Gemmill reported in the *British Medical Journal* of 1909 (vol. ii, p. 1225) a rodent ulcer in a woman 82 years of age which was successfully treated with potassium bichromate. It has also been injected in sublimate solution into the substance of inoperable carcinomata. It is used as a caustic in hypertrophic rhinitis.

Symptoms and Lesions of Chrome Poisoning.—The symptoms are both acute and chronic, and are divisible into those affecting the respiratory system and cutaneous surface. The first definite description of the lesions of chrome poison was published in 1863 in France by Bécourt and Chevallier.

Acute Symptoms.—Acute symptoms are mainly those of coryza with sneezing, watery discharge from the eyes and nose, itching and burning sensations in the nose, and swelling and congestion of the Schneiderian mucosa. These symptoms attack those exposed for the first time to chrome fumes or dust, and last from a few hours to several days. The symptoms may subside after the workman becomes accustomed to the irritation. Conjunctivitis is common and keratitis may occur.

Chronic Symptoms.—These symptoms may best be described by citation of a typical case, that of a patient who was presented at my clinic and whose history was recorded by Dr. C. N. B. Camac as follows:

"The patient, a man 27 years of age, had been an assistant superintendent of chrome works for three years. This brought him into intimate contact with both sodium and potassium bichromate, to the fumes of which he was often exposed for twelve hours a day. Six months after beginning work he felt itching and soreness of the septum of the nose, and, on putting his finger into the nostril, found a hole in the septum. Shortly afterward he suffered from fullness in the head and a sensation as if the nose were 'stuffed up.'

On cleaning the nostrils, large plugs were removed which he analyzed and found to contain chromic acid. (The patient was a chemist.) He also found chromic acid in the urine. His breath became offensive and he suffered from nausea, after violent attempts to clear the nose and throat. Otherwise, there were no digestive disturbances.

"About a month before coming to the clinic the patient was afflicted with double vision, which occurred without reference to fatigue or food ingestion. On closing either eye the symptom disappeared. He also experienced difficulty in concentrating the attention, shown particularly in the simple addition of numerals. A short walk in the fresh air would enable him to overcome such errors.

"On examining the nose, a round perforating ulcer was disclosed on the nasal septum, 2 cm. from the orifice of the nostril, and measuring a little more than one-half a centimeter in diameter, with sloughing margins, but without tenderness or bleeding. The mouth and throat were negative and the teeth good."

Two and a half years later the patient was again examined, having continued at his work. The nasal ulcer had increased to $1\frac{1}{4}$ cm. in diameter and perforation was complete. The ulcer was round and at the upper posterior margin was a grayish gelatinous deposit. The mucous membrane of the nose was dry and glazed. The hard and soft palate were congested, showing plainly numerous small blood vessels. The faucial pillars and posterior pharyngeal wall were also deeply congested. The teeth were loosened. The patient stated that on rising in the morning his nose felt "stuffed up," and he usually vomited for ten or fifteen minutes, the vomitus containing undigested food and bile. Occasionally he was nauseated after eating. He stated that forty men were employed in the chrome works, all but four of whom had inflammation of the nose, and about half had perforation of the septum. Those who had escaped inflammation smeared vaselin in the nostrils each day. An office boy in the works had recently died, having severe vomiting, and his skin had turned yellow after death, presumably from chrome poisoning.

Hill has reported the case of a boy of thirteen years who was employed only twelve days in chrome works in Glasgow when he

acquired perforation of the nasal septum. Being somewhat proud of it, he wore a ring in it!

R. Fischer reports that, of 228 workmen in a chrome manufactory, 52 had perforation, 11 more had ulceration, and 6 nasal catarrh after a few months' work. In another manufactory in Germany, among 60 workmen 27 had perforation of the nasal septum. In one case perforation occurred after one week's work. Although the perforation is not painful, the inhalation of cold air excites disagreeable sensations in the nose. The excessive mucous discharge, sometimes hemorrhagic, which comes from the epithelial zone around the nasal ulcers may cause eczema of the upper lip.

A few cases have been reported in which ulceration of the tonsils and pharynx was observed.

Oliver examined 176 chrome workers and found 126 with perforation of the nasal septum, 20 more with ulceration, and only 30 with a normal septum. In 16 cases the sense of smell was impaired. In the cases with simple ulceration without perforation the workmen have usually been employed only a short time, and perforation commonly occurs between the sixth and twelfth month after exposure.

Oliver comments upon the relative immunity which some few workmen seem to acquire, particularly if they can pass the first few months without ulceration. On the other hand, he found perforation in one case after seven weeks of employment, and in two others it took place in less than three months. Simple ulceration may occur as early as within a fortnight.

The ulceration in the nose is usually confined to the cartilage of the septum and does not attack the lateral or upper cartilages or the bones of the nose. This is accounted for by the fact that the mucous membrane over the septum is adherent and less vascular than elsewhere. If this mucosa is ulcerated, the vascular supply of the septum fails and necrosis of the cartilage ensues. Owing to this limitation of the ulceration and necrosis, the bridge of the nose does not sink in, as it is liable to do after syphilitic destructive ulceration.

The notable absence of pain connected with the ulcerative process in the nose prevents the workmen from seeking medical care, and,

aside from the inconvenience of the mucous plugs which collect over night in the nostrils and occasional vomiting, there is little interference with general health. The strength remains unimpaired and rarely do the patients suffer from bronchial catarrh, although in a few cases attacks of asthma have been noted.

R. Fischer states that men having much hair within the nostrils, or the so-called "nose beard," and those using tobacco snuff are less subject to chrome irritation of the Schneiderian membrane, as these things act as filters. Catarrh of the middle ear and ulceration of the external auditory canal may occur.



FIG. 28.—"CHROME HOLES." Chronic deep ulcers of the fingers and thumb produced in chrome works. These ulcers are very painful and will not heal while work is continued. (From "Gefahren der Arbeit in der chemischen Industrie," Verband der Fabrikarbeiter Deutschlands, Hanover, 1911.)

CUTANEOUS LESIONS. —Almost all the chrome workmen sooner or later acquire ulcers of the skin, or "chrome holes," as they call them. (Fig. 28.) The French writers on this topic hold that the unbroken skin may become ulcerated by long exposure to chrome dust, but in the great majority of instances there is a preceding cut or abrasion which becomes constantly irritated either in the bichromate solutions or by the powder or fine crystals Hence the ulcers are most likely to form where the skin is liable to slight injury, in the creases over the knuckles or at the root of the nails. Scratches on the bared arms also may develop into ulcers. They have occa-

sionally been found upon the feet, legs, neck, eyelids, in the external ear and various other parts of the body. The ulcers are exceedingly indolent and intractable. The margins are indurated and elevated, and a tough slough covered by a thick crust may occupy the center. The granulation tissue at the base of the ulcers is of a yellowish green color. Unlike the mucous membrane ulcers, those of the skin are painful and quite often temporarily incapacitate the men from work. Owing to their depth, the ulcers are tardy in healing, even after the irritation has been eliminated, but they very rarely involve the tendons, bones or joints. They leave extensive white, irregular and depressed cicatrices after healing.

Hermanni, in a study of 257 chrome workers who had been employed 2½ or more years, found 45 who had chrome sores.

R. Fischer (*"Die Industrielle Herstellung und Verwendung der Chromverbindungen,"* Berlin, 1911) refers to one case in which a workman had 14 chrome sores on his hands simultaneously, and another in which there was suppuration of a joint in connection with a deep chrome ulcer. The lips and mouth are sometimes ulcerated.

Hyperidrosis of the hands and feet, followed by eczema, is observed in some persons who are new at the work.. (R. Fischer.)

Other Symptoms.—Other symptoms occasionally observed in chronic chrome poisoning are headache, tremors of the hands and tongue, spasm of the eyelids, speech tremor and asthma. A case of acute chromic acid poisoning in a straw hat presser is reported by Burghart, the material being used for coloring.

Prevention.—Preventive measures against chrome poisoning were instituted by law in England in 1893, and in Germany two years later, but thus far no such governmental control has been exercised in the United States, and the workmen are still at the mercy of careless employers, although in some instances partial protection is afforded.

The preventive measures which always should be adopted are as follows:

1. All keeves and evaporating pans, and especially the vats from which steam is evolved, should be covered by hoods connecting only with the outer air.

2. All dust should be removed by exhaust fans or otherwise,

and the bichromate should not be allowed to accumulate on the rafters or in other parts of the workroom.

3. In the shoveling and packing processes the workmen should be compelled to wear protective respirators and thorough ventilation should be provided.

4. Chrome salts in solution usually do not attack the unbroken skin. It is difficult to compel workmen to wear rubber gloves, which make the hands clumsy and cause them to sweat. Nevertheless, their use should be encouraged in dyeing processes in which chrome salts are used. If cuts or abrasions of the skin exist, however, ulcers promptly develop on exposure to solutions of the salts, or on continued exposure to chrome dust. Such wounds should be protected by antiseptic dressings covered by collodion, and Oliver suggests that foremen should be compelled to report all workmen having cutaneous lesions, so that the lesions may promptly be treated and the workmen, if possible, assigned to some less hazardous process until the lesions have had time to heal. Thick shoes should be worn and light, washable overalls.

5. Medical inspection of all workmen should be made compulsory at least once a week, so that those having commencing lesions of the nose or skin may be protected from further and more serious hazard.

6. Proper lavatories and luncheon rooms should be provided.

Treatment.—Treatment of the lesions comprises rest, cleanliness and the use of emollients and protective dressings. It is almost impossible for a mucous membrane or cutaneous ulcer to heal if the surface be constantly exposed to further irritation by chrome dust or solutions. The nasal passages should be kept smeared with vaselin and ulcers in the mouth may be washed with glycerin, boric acid and tincture of myrrh. Ulcers and abrasions of the skin may be dressed with a 40 per cent. ointment of aristol or ichthyol, or with balsam of Peru, covered with some simple protective such as antiseptic gauze, kept in place by bandages, adhesive zinc plaster or collodion.

The nasal ulcers may be treated with applications of argyrol or aristol in vaselin.

COBALT

In the Schneeberg cobalt mines it has been found that the miners sometimes acquire sarcoma of the bronchial glands and lungs. Cobalt is usually associated with other metals, such as arsenic, nickel, etc., and peculiarities of poisoning from such ores are described under the headings of the combined metals.

COPPER

Workers in copper mines and smelters sometimes suffer from poisoning, the symptoms of which are intestinal cramps and diarrhea, vertigo and a staggering gait. They acquire a greenish blue line at the margins of the gums and the hair may become tinged with green. It is still an open question, however, how far such symptoms are due to copper itself rather than to the other metals with which it is so constantly associated in ores, such as arsenic, lead, antimony and zinc. The same statement applies to brass poisoning (page 171) and bronze poisoning (page 178), both being alloys of copper. Baum and Seeliger have shown, however, that true copper poisoning may be produced in animals, and some of the salts of copper occasion very definite toxic symptoms, such as those described above as occurring in miners and smelters of copper.

L. Leurin, as a result of study of the workmen in copper and brass industries in Berlin and neighboring German establishments, concluded that acute copper poisoning may take place, but that there is no chronic form of poisoning. (*Deutsch med. Woch.,* 1901, 689.) The acute form is characterized by gastro-intestinal disorder, abdominal cramps and nervousness. The emetic effect of copper sulphate is well known, as formerly employed in medicine.

Further experiments and researches are desired to elucidate the questions involved in the contradictory statements of different authors. (*See* also Brass Poisoning, page 171.) The fact that copper itself exists in so many different combinations and so many other materials are added to it, or otherwise employed in its manufacture, gives rise to the confusion of statements as to genuine distinctive copper poisoning.

Auerbach has reported a case of neuritis from copper poisoning. (*Zeitschrift für Nervenheilkunde,* 1910, xxxix, 115.) The patient was a man 40 years of age who presented symptoms of pain and loss of power in the muscles of the right arm, thigh and gluteal region, with slight reaction of degeneration. The right knee jerk was lacking and there was partial anesthesia of the right hand and forearm.

A case of poisoning with copper oxid is reported in *Sozial Technik* (1912, vol. iv, no. 2), in an Austrian workman in an artificial fertilizer establishment. The man ate a luncheon of barley pudding after warming it on an oven which was covered with the copper dust.

GOLD

In the manufacture of articles of use and luxury of both silver and gold many different processes are resorted to, such as smelting, refining, beating, filing, engraving, galvanizing, polishing, making alloys, etc. At many of those processes the workmen sit down at benches and lean over machines and tables, hence they are liable to inhale fumes or dust not only from the metals chiefly worked upon, but from substances used for alloys, soldering, electroplating and etching, etc. Where blowpiping is employed, as in soldering small articles of jewelry, there is more or less strain of the lungs, for the workman must blow hard and continuously, and hence there is a tendency to the production of emphysema. (Fig. 29.) In gold refining concentrated sulphuric acid is used, the fumes of which are highly irritating.

In gilding by the galvanic process the ware made of copper or zinc or other metal is cleansed in benzene and then plunged into a solution of gold and potassium cyanid. The benzene vapor is very irritating, especially to young persons who are often employed in the cleansing process. Its effects are described under Benzene. The workmen occupied in the dipping process are subject to chronic eczema of the hands, face, nose and ears.

In gold plating a boiling solution of salt, saltpeter and hydrochloric acid is used from which chlorin vapor may arise. In another process of gilding and silvering mercury is used for a surface amal-

gam and a brass brush is employed. Mercury vapor may be evolved in the process. Lead vapor is given off in gold enameling. Hence the handling of gold and making of gold and gilded wares are more

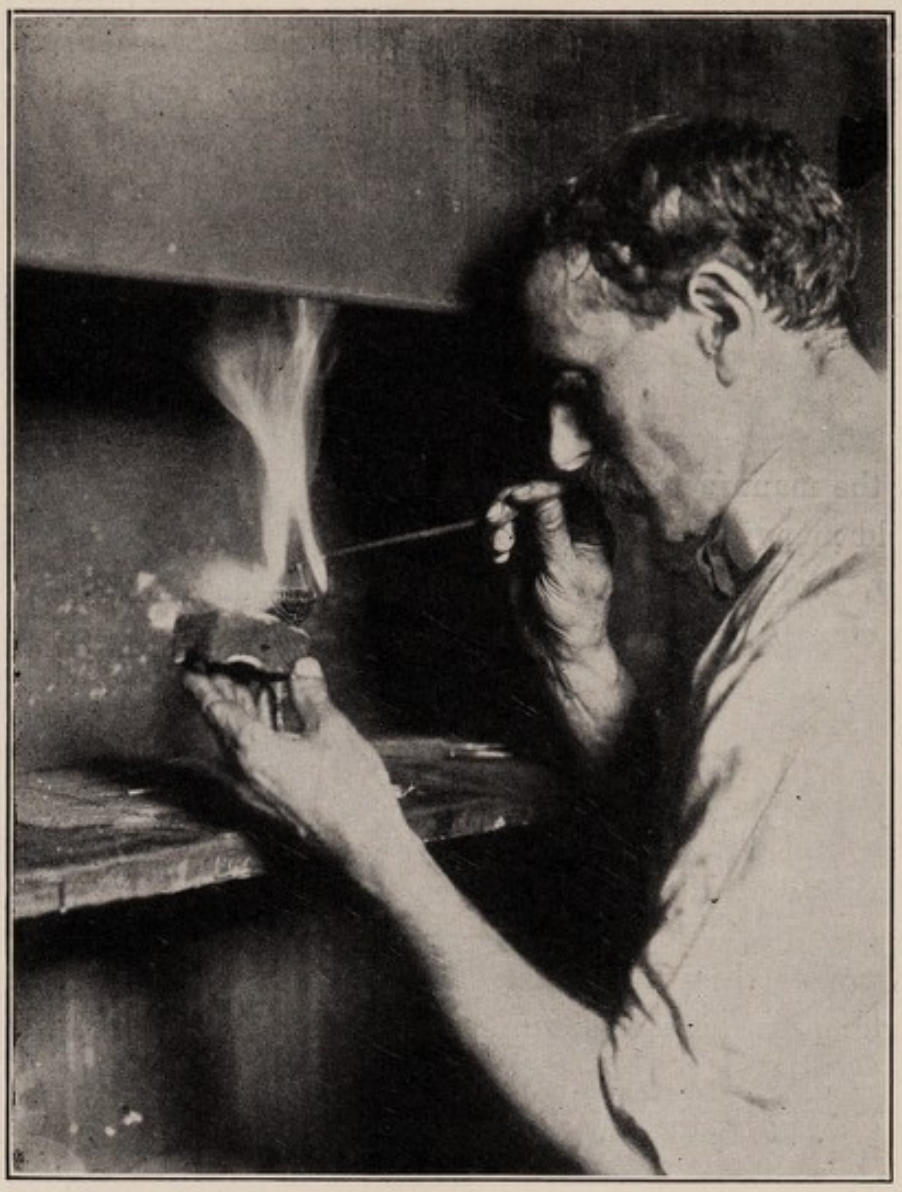


FIG. 29.—SOLDERING GOLD RINGS WITH BLOWPIPE UNDER EXHAUST HOOD. Hazards: inhalation of metal fumes and emphysema from constant blowing.

injurious from the hazards of other metals used—lead, mercury, etc., or acid fumes—than from anything especially toxic in gold itself.

This metal was formerly used for alleged medicinal effect and of recent years has figured in a "cure" for chronic alcoholism.

There is really no such condition as poisoning by gold alone. The symptoms which affect gold workers are referable to the above described conditions of heat, cramped positions in work, poor ventilation, the presence of irritant fumes, etc. Such conditions strongly predispose to tuberculosis. Owing to the value of the metal, where gold is being filed or beaten strong ventilation currents cannot be used without dissipating the precious gold dust. I know of at least one gold-beater's shop in which there are no general ventilators and the windows have to be kept closed, but at intervals small hoods are let down over the worktables and the room is then well aired.

IRON AND STEEL

Steel workers, i. e., foundrymen, rolling mill men, and the like, are exposed to toxic gases, especially carbon monoxid, to the hazards of excessive heat and the glare of excessive light, to irritation of the lungs from steel dust, causing pneumonoconiosis, and to chronic nephritis and arteriosclerosis.

It has been shown by German statistics given by Röpke, in 1903-5, that in steel mills, of the illnesses among the workmen, 20 to 22 per cent. concerned the respiratory organs.

Iron is in no sense a chemical irritant to the body, being a natural ingredient of the hemoglobin. Iron and steel dust, however, by virtue of the hardness and sharpness of the particles, are irritant to the bronchial mucosa when inhaled, and foster the development of fibroid phthisis and subsequent acquisition of pulmonary tuberculosis. The smelting of iron and steel and various hardening processes are capable of being injurious in several ways. Thus the workmen are exposed to great heat and perspiration which is often suddenly checked, especially in winter. The excessive heat and light to which puddlers and founders are exposed when the glare from furnace doors reaches them may injure the eyes permanently, and they may acquire superficial or more serious burns. Particles of steel or iron may be driven into the skin of the face and exposed upper half of the body, marking it like tattoo. The workmen, as a result of frequent extreme changes in temperature, are prone to

lumbago or myalgia and chronic rheumatism, and, from heavy lifting, frequently have sprains and muscle strain. In galvanizing sheet iron hydrochloric acid is used, the fumes of which are injurious. Various processes of steel hardening are liable to prove harmful through the action of other substances, such as the cyanids, ferro-

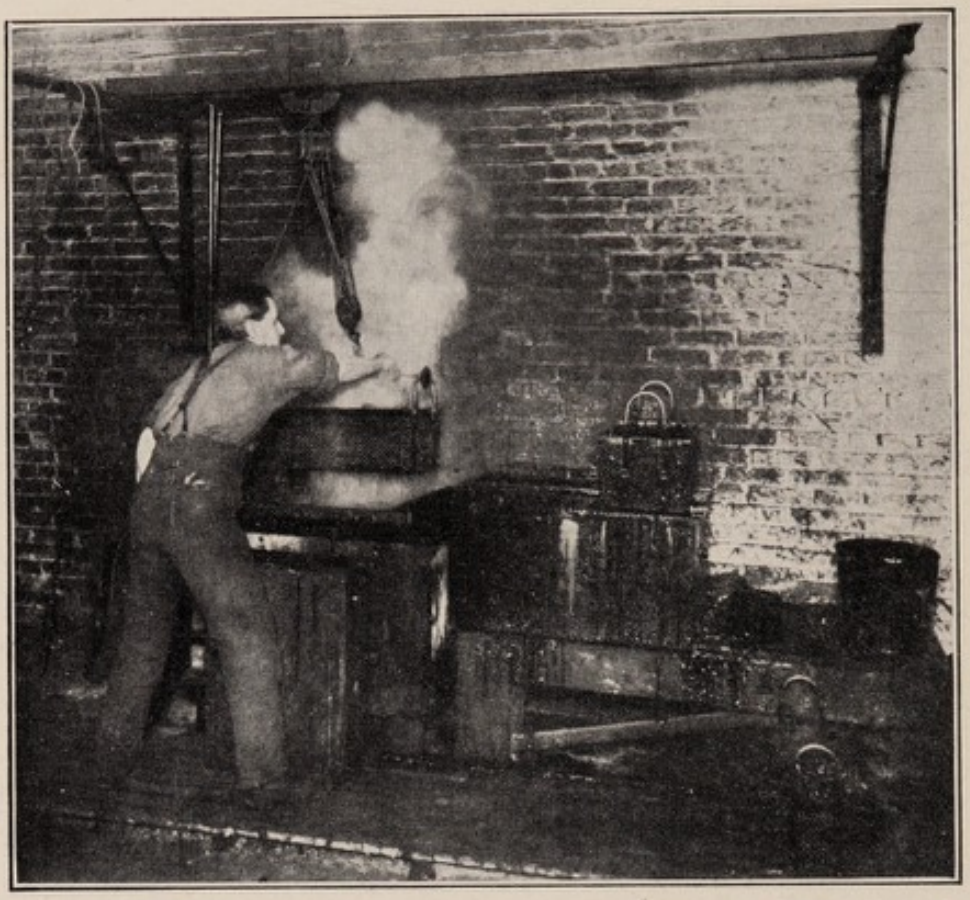


FIG. 30.—STEEL CUTLERY MAKING. Tempering shears in boiling oil. Hazard: fumes of hot oil and steam.

silicon, etc. Cutlery and other articles of steel manufacture are dipped into baths of molten lead or boiling oil (Fig. 30), the fumes from which may prove highly injurious. In the hot rooms in which smelting and hardening processes are conducted the workmen are subject to acute and chronic nasal catarrh, and Säger and Weickert have found otitis media as a further not uncommon result. Röpke ("Berufskrankheiten des Ohres") has described perichondritis of the external ear caused by the packing of hard metallic dust in the auditory meatus. He also found labyrinthine inflammation in some cases.

In smelting works the laborers are much exposed to inhalation of toxic gases from the ovens, especially carbon monoxid derived from coke or otherwise. In such cases headache, vertigo and tinnitus are complained of, and anemia and nervousness ensue. Kayser (*Wiener med. Woch.*, 1893, No. 41) reported a case of such poisoning in which the victim remained 36 hours in coma, and on recovery presented symptoms of labyrinthine disease. Such extreme cases are very rare. Rohrer (*Haugs klin. Vortr.*, Bd. I, Heft 3) reported 5 cases among furnace stokers who were subjected to inhalation of water gas, with the result of chronic carbon monoxid poisoning. They suffered from headache, nausea and disturbances of hearing which were both nervous and due to otitis. Erosions of the nasal septum and atrophic rhinitis were also observed occasionally.

The danger to the lungs of cleaning iron and steel castings is most serious, and is illustrated by Figure 30, page 194. In open-hearth processes and breaking up of iron molds of castings particles of coal or charcoal and iron rust are inhaled and the workmen sweat heavily. Thus they are exposed to nasal, bronchial and middle ear catarrhs. The sharp particles of dust accumulate in crusts with the nasal mucus and cause ulceration and epistaxis. There may be atrophic rhinitis with loss of sense of smell and uncomfortable dryness of the nose. The atrophy may involve the mucosa of the nasopharynx, which becomes reduced in sensibility so that mucus accumulates without exciting expulsive effort. This lack of sensation may favor the further entrance into the bronchi and lungs of irritant material. Graphite and coal dust were found by Merkel imbedded in the lungs in four autopsies upon men who had been employed as iron molders.

Particles of steel and iron dust which reach the pulmonary alveoli choke them up and become imbedded in their walls, where they excite perialveolar irritation with inflammatory products, chiefly fibrous. (*See* Fibroid Phthisis, page 33.)

Countless small articles of iron and steel, comprising industrial, agricultural and domestic hardware, surgical and other instruments, etc., require grinding, sharpening and polishing. These processes

are conducted in various ways upon stone, emery or steel wheels, and more or less dust is liberated, according as the wheel is used dry or

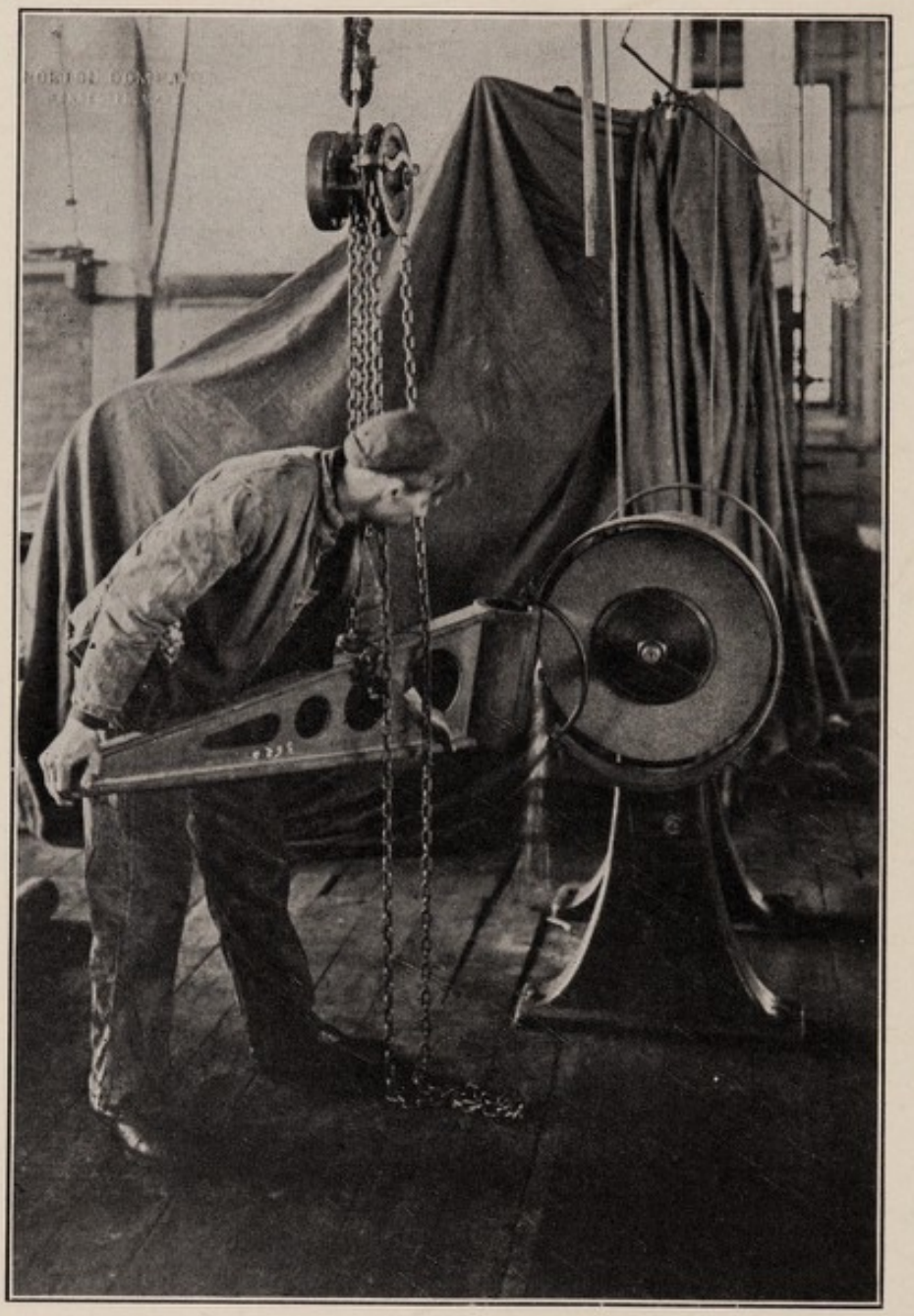


FIG. 31.—STEEL CASTING GROUND ON AN EMERY WHEEL. Note the downward direction of the sparks as in the German method. In the English method they are directed upward. Note the lack of dust aspirator, of adequate protection of the wheel, and of goggles to protect the workman's eyes. Hazards: steel and emery dust.

kept moist with a stream of water. Details of the hazard from these processes are given under Emery Dust.

Another source of dust irritation is connected with the industry of making handles of knives and other implements of horn, bone, ivory, mother of pearl, etc. The grinding and polishing of these materials add considerable dust to that of the steel and the grinding wheels.

In the New York subway much iron and steel dust is ground off by the attrition of the steel brakes against the malleable iron wheels. This dust, by the actual measurement of the worn-out brake shoes, according to Mr. Soper, the sanitary expert of the subway, amounts to no less than a ton per mile per month. It is blown about by the rush of the trains and enters the cars. Dr. T. M. Prudden, by passing a magnet along the window sills in some of the cars, accumulated a considerable quantity of iron dust. It was at first supposed that the trackwalkers, motormen and guards, who spent half their time in the subway, would become victims of pneumonoconiosis. Examinations of the employees made by Dr. James A. Miller showed "that they had no impairment in health because of their occupation; many gained in weight; in the common parlance, they gained 'subway fat,'" especially the motormen, whose occupation is sedentary.

In polishing and sharpening very small needles and similar objects they have to be held near the eyes, and water cannot be used to moisten the emery wheels, hence there is the double hazard of irritation of the respiratory passages by steel and emery dust and injuring the eyes.

In Sheffield, England, in eight years, from 1901 to 1909, the mortality among steel grinders and polishers in the hardware industry was 30.4 per 1,000 workmen, of which one-half was due to tuberculosis and more than one-sixth to other pulmonary diseases. In other words, two-thirds of all the deaths among this class of workmen were due to pulmonary disease. Considering the fact that such workmen belong to a selected group as to age and original strength, this is a very high mortality rate for lung diseases. In Solingen, Austria, where the same industries are conducted on a large scale, the same ratio prevails of one-half the deaths caused by tuberculosis, although the total death rate is considerably less than

in Sheffield. In Solingen, in 1910, while the general mortality from tuberculosis was 1.8 per 1,000, in the hardware industry it was 9.3 (Rambousek). Surely alcoholism, low wages, poor home hygiene and all the other etiological factors of tuberculosis do not account for such enormous differences in mortality rate, and the conclusion is inevitable that the cutlery industry is shockingly hazardous as at present conducted.

In Northampton, Massachusetts, are large cutlery and tool-making plants. In a *Report* of the State Board of Health of Massachusetts for 1907 the grinders and polishers employed in these industries showed a mortality from pulmonary diseases, including tuberculosis, of nearly 73 per cent., as compared with other diseases. A case of pulmonary emphysema was reported to the New York State Bureau of Labor which resulted from manufacturing steel wool.

In foundries, rolling mills, steel plate works and the like, the lifting of heavy weights tends in time to strain the circulation and give rise to cardiac hypertrophy. Excessive sweating in these occupations leads to lessening of the fluidity of the blood and induces excessive thirst, which the workmen often assuage with quantities of beer and other alcoholic drinks. The combination of vascular strain and alcoholism leads to early arteriosclerosis, which in turn results in hypertrophy of the heart. When large quantities of cold fluids are drunk acute gastro-intestinal catarrh is very liable to ensue.

In many steel finishing processes, as in gilding swords, etching knife handles, etc., sulphuric or other acids are used, the fumes from which greatly irritate the respiratory passages. (*See* Mineral Acids.)

LEAD

General Statements.—Plumbism and saturnism are used as synonyms for lead poisoning. Lead, like copper, has figured prominently in mechanical industry since very early history. In the third century B. C., Theophrastus described the use of white lead as a paint, and the Romans, in the first century A. D., operated lead mines in England.

Lead poisoning was first accurately described in the writings of

Tanquerel des Planches in 1839, although often referred to in general terms much earlier.

Although metallic lead may be the source of poisoning, as in handling lead bars or inhaling the fumes of molten lead, it is its salts or other compounds, such as alloys, which are the common toxic agents, mainly on account of their dissemination in the workshop as dust or their ready solubility in the blood and secretions of the body when introduced as dust or in any other form, especially that of either moist or dry paint.

The modes of entrance of lead into the body are several. As a fume it is inhaled, and as a dust it may be inhaled in the lungs or lodge in the mouth and be swallowed, or the dust may be conveyed to the mouth by unclean hands, with food eaten in the workroom, or with chewing tobacco. Moreover, the workman's clothing may become saturated with lead fumes or dust so that he carries the poison into his home. Lead has little if any action upon the unbroken skin, but it has long been used medicinally in the form of a diluted lotion or wash to relieve inflammations of the skin, such as erysipelas and ulcers, being somewhat soothing and antiseptic. It is also given sometimes by mouth for its astringent action in diarrheal conditions, hence the constipation of lead poisoning.

Lead poisoning, or plumbism, is one of the oldest known occupational diseases, having been described for many centuries. Hippocrates recognized lead colic, and Raphael, Correggio and Michael Angelo afford well known historical examples of plumbism acquired through mixing their own paints.

Lead poisoning has been more thoroughly studied than any other occupational disease, which is due in part to the great number of workmen employed in lead trades and the great variety of manufactures in which the metal plays an important, if not the sole, part. It is also due to the great variety of lead compounds, alloys and salts, and to the fact, no doubt, that the symptoms of serious plumbism, such as paralyses and colic, have become familiar to laymen and hence are easily recognized by workmen themselves and attributed to their proper cause, which is not the case with many other poisons.

Number of Occupations Involving Lead Compounds.—Among all

the toxic metals, lead gives rise to more than one-half of all cases of serious poisoning, and more than 150 different trades subject the workman to plumbism. Layet gives 111 processes in which lead or its salts is used in France, and Dr. Alice Hamilton found 70 in the State of Illinois alone.

Among these trades the most important, considered from the number of employees and the certainty with which some of them are sooner or later affected, are the following, which comprise about 85, or more than half of the total number of lead trades in which instances of poisoning have been observed:

List of Important Lead Trades

Lead mining, smelting and refining
Mining and smelting of various ores (copper, silver, antimony, etc.)
Making of alloys (brass, type-metal, etc.)
Making of sheet lead and lead pipes
Plumbing and soldering
Tinsmithing
Tinning of metals
Brass foundry work and brass manufacture
White lead manufacture
Paint, color and ink manufacture
Painting, sandpapering and scraping of paint
Red lead manufacture
File cutting
Type foundry work
Typesetting and printing
Litho-transfer work
Glazing, china and earthenware
Stereotyping
Tile and brick glazing
Glass cutting and polishing
Vitreous enameling
Electrical accumulator works
Shipbuilding

Tinfoil making
File making
Capping of beer and mineral water bottles
Shot making
Jewelry making
Watch and clock making
Tempering steel (in molten lead)
Making weights
Polishing cannon balls and shot
Weighting silk lace and thread
Putty powder
White rubber manufacture
Stenciling
Leather finishing and harness making
Cosmetics
Gas fitting (red lead)
Paper and wall paper making
Dyeing and varnishing
Calico printing
Cigar wrapping (in tinfoil)
Polishing type
Artificial flower making
Aluminum foil
Work of commercial artists and engravers
Mixing dentist's amalgams
Hollow tinware making
Enameling watch faces
Polishing marble
Piano making
Diamond cutting
Lacquering furniture
Horsehair brush makers
Friction match making
White glove and shoe making
Melting metal junk
Linoleum making

Making metal house trim
Architectural ironwork
Painting theatrical scenery
Steel wire tempering
Wire cloth making
Making false pearls
Flint and crystal glass making
Making of musical wind instruments
Coloring the heads of matches
Dyeing hair and bristles for brushes
Making playing cards
Making lead coffins and coffin handles.
Making aluminum foil (7 per cent. lead)
Labeling paint cans
Making white Masonic and other ribbons
Tempering spiral spring car buffers
Stopping and filling holes in woodwork with white lead
Cable splicing
Making metal picture frames
Making rubber toys and balls
Amber cutting
Recharging old battery plates
Polishing tombstones with lead discs
Soldering piano wire
Enameling watch faces
Lead wire for artificial flower stems
Finishing and dressing leather goods

Of all these trades the most serious in point of view of the number of victims and gravity of the symptoms are the following: Lead smelting, making and handling lead carbonate, making electric accumulators, special printing and electrotyping processes, removing dry paint by sandpapering or chiseling, and painting in general.

Karl Wächter ("Die gewerbliche Bleivergiftung," 1908) rates the hazards of different lead trades, based on 1,383 cases of saturnism in Prussia, as follows, commencing with the most hazardous, making

white lead, lead oxid and the amorphous oxid or minium, shot-making, painting, lead smelting, printing.

Number of Workers in Lead and Frequency of Lead Poisoning. —The number of employees in lead works and establishments in which there is a hazard from using paint or other lead compounds is very large. Some idea of this number may be gathered from the following data, which include, also, the percentage of victims of plumbism.

In Illinois there are 20,000 union painters and probably as many non-union ones. In that State there is much manufacture of railway cars, automobiles, harvester machinery, etc., which requires "enamel" and other forms of high class painting. As this work involves considerable rubbing and sandpapering, it affords a fertile field for poisoning. In this State also are many large plants for the manufacture of lead products. Upward of 25,000 persons are employed in the United States in the printing and bookbinding trades.

During the decade 1900 to 1910, under the British notification act, about 7,000 cases of lead poisoning have been reported in 18 industries, which would average nearly two a day! Some few of these, however, amounting to 4.2 per cent., were duplicate cases, more than one attack occurring during the decade in the same victim. (Oliver.) Of the total cases, 1,973 were among house painters and plumbers, with 383 deaths, according to the *Annual Report* of the Chief Inspector of Factories and Workshops of Great Britain. There were 200 cases of plumbism among printers during this period, including 17 deaths.

In England, in 1909, there were 1,257 cases of lead poisoning recorded, despite excellent protective laws, and there is an annual average there of about 70 deaths from saturnism. In Austria, in 1906, there were 765 cases, and in Germany 700 cases. In Great Britain, among the 63,000 potters, 11 per cent. are exposed to risk of lead poisoning, according to statements of Sir Thomas Oliver, and nearly 30 per cent. to the dangers of irritant dusts.

Of the Prussian lead smelters, in 1905, 17.7 per cent. acquired lead colic and paralysis. In Paris, where there are 14,000 painters

and as many more craftsmen whose work necessitates contact with lead, the average annual admission rate in the hospitals is 250 cases of plumbism.

In Vienna, according to Dr. Ignace Kaup, during a decade there were 944 cases of plumbism reported among painters.

Dr. E. E. Pratt, in a report to the Committee on Industrial Diseases of the New York Association for Labor Legislation, reported the finding of 376 cases of lead poisoning in New York City in 1909-1911. Of these a personal study was made by him in 110 cases. Some of these cases were in Bellevue Hospital.

Under the New York State physicians' reporting law there were reported, as occurring in the State from September 1, 1911, to August 31, 1912, 125 cases of lead poisoning, with one death (that of a painter), which are listed as follows by industries:

	TWELVE MONTHS, SEPT., 1911-AUG., 1912.
Manufacturing:	
White lead	7
White metal goods	..
Smelting	2
Paints, inks and colors	2
Electric batteries	21
Tinware	2
Brass goods	..
Wire and wire goods	3
Electric cables	1
Cut-glass	1
Rubber goods	..
Linoleum	1
Cigars (labeling)	1
Artificial flowers	..
Printing	1
Shipbuilding	1
Painting (in shops, etc.)	22
Carriages, wagons, automobiles and cars	14
Agricultural implements	4
Heating apparatus	1
Metal house trim	..
Pianos	1
Architectural ironwork	1
Theatrical scenery, signs, etc	1

	TWELVE MONTHS, SEPT., 1911-AUG., 1912.
Building:	
House painting, etc.	51
Plumbing, etc.	3
Other or indefinite	6
Total—Lead poisoning	125

In the two years 1909 and 1910 there were 60 deaths from lead poisoning in New York State, found by Dr. John B. Andrews, formally certified by physicians. The following excerpt is taken from his admirable research into the history of these fatal cases (*Bulletin 95,* United States Bureau of Labor, 1912):

"These 60 fatal cases, as officially recorded, were distributed among the following occupations:

"Thirty-seven were painters, 8 were laborers, 4 were printers, 2 were merchants, and there was one each from the machinists, molders, smelters, tinsmiths, salesmen, brush drawers, glaziers, porters, and coopers.

"The 1 glazier, however, was also a painter; the 1 salesman was in reality a paint mixer; the machinist packed parts of machinery that were still wet with paint; of the 2 merchants 1 was a painter and mixer of paints and the other sifted white lead in a factory; of the 8 laborers, 1 was a house painter, a second was a painter who had also worked in a white lead works, a third was a packer of machine parts still wet with paint, a fourth worked in a rubber toy factory, 2 worked in a lead smelter, and 2 in an electric accumulator or storage battery works; the brush drawer worked with pads coated with paint; the porter operated a press in a lead pipe factory; of the tinsmith little can be learned, but the cooper was a stack hand and filler of barrels in a white lead works. Of the 4 printers, one was a hand compositor on bookwork, one was a job printer doing all parts of the work of a printer, a third was a stereotyper, and the fourth a linotype operator on newspaper work.

"Briefly, then, 45, or 75 per cent. of the 60, worked with wet paint, 3 worked in a lead smelter, 4 in printing establishments, 3 had worked in white lead factories, 2 in a storage battery plant, 1 in a tin shop, 1 in a rubber factory, and 1 in a lead pipe factory."

Among these cases one is recorded as of "cerebral type" and four others presented hemiplegia. Only one patient was a woman, a brush drawer, 59 years of age, who had apoplexy.

In the eight years from 1903 to 1912 there were admitted 238 cases of lead poisoning to the wards of Bellevue Hospital and the Medical Clinic of the Cornell University Medical College in New York City. Of these cases 26 were acute. In an investigation of lead poisoning in Perth Amboy, New Jersey, in 1913, records of 94 cases were supplied by a single physician. In Philadelphia, within a recent period of 16 months, 97 cases of lead poisoning were treated in hospitals.

Dr. Alice Hamilton reported at the First National Conference on Industrial Diseases, June 10, 1910, that she had found lead poisoning among the workers in 33 out of 56 lead factories inspected in Illinois, and that in that State there was a yearly average of 665 cases. In six factories alone were 380 cases. She further writes as follows:

"One of the large white lead factories in England employs 182 men. No man was poisoned there during the year 1910. A Düsseldorf factory had 2 cases of lead poisoning among 150 men during the same year. On the other hand, an Illinois factory with about 142 employed throughout the year had 25 cases last year, and another employing from 70 to 80 men had 11 cases during two months' time, which, if kept up during the year, would mean 66 cases. The British statistics for 1910 show that, in the district of Newcastle-on-Tyne, 1,320 persons were employed in white lead works; 5 cases of lead poisoning were reported for that year, or one in 264 men employed. One case was fatal. The figures for the same year in Illinois are between 425 and 450 men employed; 63 known cases of poisoning, or one for every 7 men employed; 3 fatal cases."

She also states that the ratio of lead poisoning as reported for English pottery dippers was one case among 65 employed, but in Ohio it was one among 6.6.

The Illinois State Commission on Industrial Diseases discovered 640 cases of plumbism in that State in 1910. In some lead smelting

works from 25 to 40 per cent. of the workmen abandon the work every month on account of acquiring lead poisoning.

Of late years, owing to improved sanitation, legislation and inspection, the number of lead poisoning cases has been so far reduced that it is probably not more than one-half as common as it was some time ago. For example, Legge has stated that, whereas in England, in 1900, more than a thousand cases were reported, only 553 were reported ten years later, despite a more complete system of reports.

In England, moreover, in 1896, before the passage of preventive laws, the ratio of lead poisoning among 2,499 workers in lead plants was identical with what it now is in this country, i. e., 1 case to 7 employees.

Dr. Alice Hamilton makes the following instructive comparisons:

In an English white lead factory with proper modern standards of sanitation, during the year 1909-10, there was not a single case of plumbism among the 182 men employed, but in an Illinois factory at the same time, where fewer men were employed—only 142—there were 25 cases of plumbism. Comparing another English factory, with 92 workmen, no cases developed during five years, whereas, in an Illinois one with 94 workmen, 28 per cent. of the employees had had plumbism, and 40 per cent. of those working in the dustiest rooms. In Newcastle-on-Tyne, in 1910, among 1,320 workers in white lead, one case of plumbism developed per 264 men employed; but in Illinois, in the same year, one case developed for every 7 men employed, with a total of 3 fatal cases. This strikingly emphasizes the value of weekly medical inspection as conducted in England, compared with its usual omission in this country.

By a rational system of hygiene Germany reduced the incidence of poisoning among lead smelters from 73.7 per cent. in 1885 to 0.8 per cent. in 1892, but among painters in Berlin, in 1904 and 1905, there were 870 cases of plumbism and 17 deaths. (Karl Wächter, "Die gewerbliche Bleivergiftung," 1908.)

In the Government Printing Office in Washington only 9 cases of lead colic were reported in 1906, owing to improved hygiene.

Varieties of Lead and Its Compounds; Their Derivation and Uses.—The varieties of lead compounds are very numerous and possess varying degrees of toxicity for the organism. Its physical state may also vary; thus it is found in several compound ores, as a pure metal, in the form of dust, filings, etc., in dense fumes which arise in smelting works, in solutions, such as are used in the glazing of pottery, and in alloys with other metals, especially in brass, pewter, etc.

Metallic Lead.—Metallic lead, when mined, is found chiefly in impure form, being combined with a variety of other substances, especially sulphur, antimony, arsenic, phosphorus, tin, silver. Most important among these compounds is lead sulphid, or galena, and after the fragments of ore are separated and crushed, the ore is smelted with scrap iron, which combines with the sulphur, releasing the molten lead. Or the sulphur may be burned off in roasting tubes, leaving lead oxid and sulphate, which, on being further decomposed by greater heat, produce metallic lead and sulphuric acid. There is thus abundant opportunity for poisoning from several sources such as the gases of combustion, carbon monoxid and dioxid and the fumes of sulphur, acids and sometimes metals which constitute impurities. Lead oxid dust is carried off in the fumes to a considerable extent. Not only is the air of the roasting and smelting rooms polluted, but the outside air for some distance around the works destroys vegetation and acts deleteriously upon human lungs. Formerly lead smelters were very liable to serious poisoning, and they still are so where precautions are neglected, but modern methods have done much to mitigate the evils. Fritting the lead oxid from other metal compounds, especially silver, cleaning the flues and furnaces are occupations which even under most favorable conditions always possess great risk of begetting plumbism. (Fig. 32.)

Metallic lead is further molded, rolled or pressed into sheets, bars, pipes, conduits for electric cables, etc.

In roasting ore by the open or "Scotch Hearth" process the workmen rake out red-hot lumps of slag which are not wholly free from lead and emit toxic fumes. There is further hazard from dust in

crushing the cold slag and in cleaning the bags into which ventilating flues may conduct the furnace fumes.

The fumes of lead and zinc refineries deposit residue, on the walls of the furnace flues, of lead sulphid, carbonate and oxid, zinc

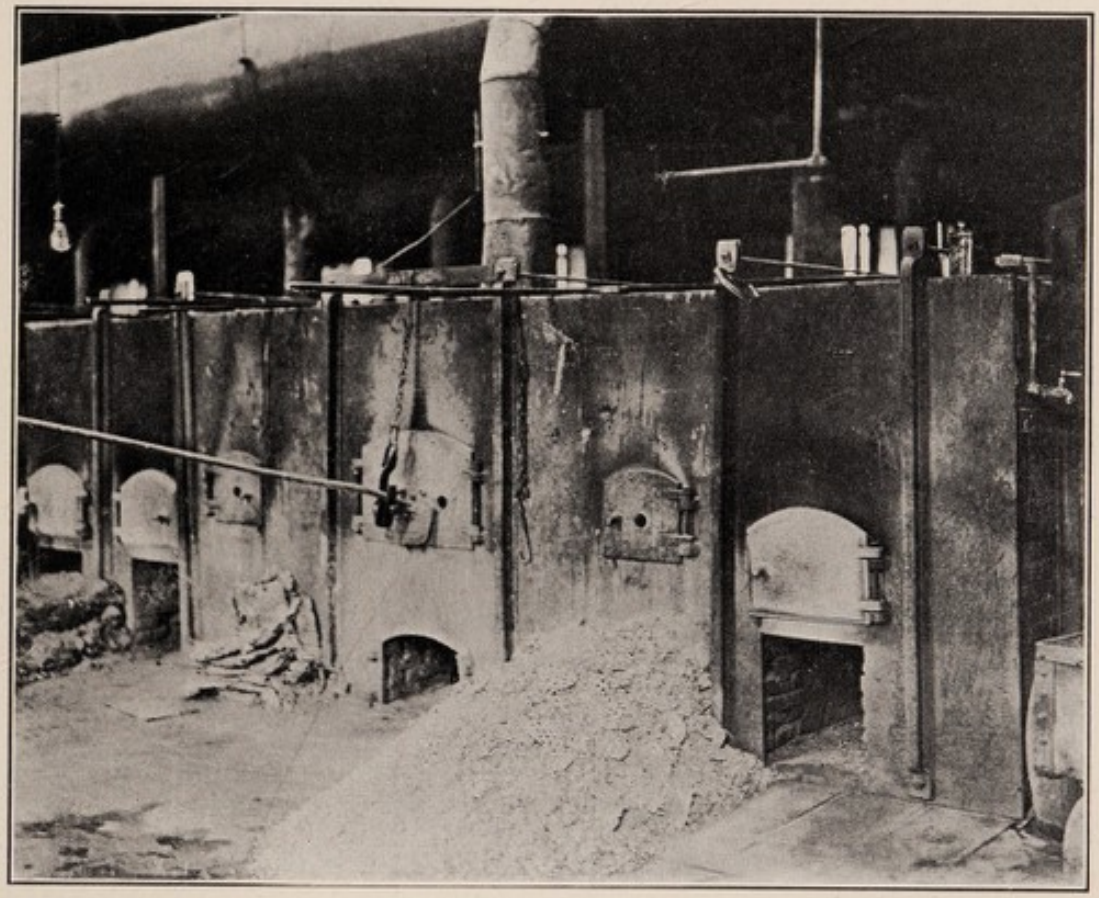


FIG. 32.—LEAD FURNACE. Old type, with pile of slag on floor; extremely dusty and hazardous. (From the *Bulletin* of the Illinois State Department of Factory Inspection, 1911.)

and antimony oxids, calcium carbonate, arsenic and silicic acid, etc. These substances are borne out into the surrounding atmosphere. Sulphurous acid fumes also are liberated, and this gas is harmful if present in the air in a strength of more than 0.004 per cent. To collect the poisonous fumes, as well as to recover from them some of the volatilized metals, the flues are made very large and long. They are usually high enough for a man to stand upright within when cleaning out the lead deposit, and may be curved, with a total length of several miles. In some cases steam or water is sprayed at inter-

vals within the flues, to cool and condense the vapors. In other cases they are forced through water tanks by aspiration.

According to Sir Thomas Oliver, 130 lbs. of lead oxid and sulphate may be given off in fumes from the smelting of a single ton of lead ore. Sufficient lead escapes into the air to poison cattle grazing near by such smelting works as those of Scotland and Belgium. In recovering the deposited lead the workmen should not remain longer than two hours in the flues, and even at the end of an hour they may become ill with vomiting and headache. In some of the Austrian smelting works the fumes are forced through water in bent tubes, and the open hearths employed are protected from back draft by double hoods, so that very little lead fume escapes and the work is much less dangerous. The arsenic and antimony which lead ores often contain add to the danger of the fumes.

Metallic lead is not very soluble by any of the body fluids, but when exposed to the air oxidation constantly produces a thin coating of fine dust of lead oxid which may adhere to the fingers or be blown about and inhaled.

Lead does not melt under a temperature of 633° F., and its fumes are composed of lead oxid and suboxid in a state of very fine subdivision. The skimmings or dross of lead melting pots are largely composed of lead oxids, and when they are disturbed on the surface of the melting pot, as by stirring with a ladle or adding pieces of lead plates, as in linotyping, the fine lead dust is liberated at temperatures considerably below the boiling point of the metal. Such skimmings, if thrown upon the floor, become pulverized by tramping feet and add their dust to the menace of poisoning.

Metallic lead is used by plumbers, in electric wire conduits, in tinsmithing, to imbed jewelry for polishing, files for cutting, and other small articles, in the production of lead pipe, sheet lead, as a molten bath for tempering steel.

In making shot metal metallic lead is fused in an iron kettle, covered with charcoal powder and arsenous acid, or metallic arsenic is added. The mass is then stirred, with evolution of both lead and arsenic fumes.

The Jacquard loom is often weighted with lead, which gives off

much dust from the warps. Iron is just as serviceable and should be used instead. The attrition of the weights suspended over pulleys wears off much dust which on analysis has been found to contain 56 per cent. of lead.

In polishing cannon balls and shells a revolving lead disc is sometimes used.

Lead Oxids.—There are several oxids of lead, PbO, called litharge or massicot, PbO_2, Pb_2O_3 and Pb_3O_4, or minimum, all of which are toxic.

The oxid known as red lead is produced by roasting the metal in ovens with a strong draft of air. During the process, which requires about 8 hours, the ovens are frequently opened and the lead is raked. There is considerable escape of lead fumes, and in England, among the reported cases of plumbism, two per cent. are among makers of this product. The men should use very long raking implements and the ovens should be shielded by hoods.

This form of lead, and also litharge, is much used for electric accumulators, dry color making, rubber making, pottery, tile and brick glazing, putty powder for polishing and enameling, plumbing, and for sanitary ware, signs, etc.

Putty is made by mixture of whiting, linseed oil, and usually red or white lead. The lead is added as a preservative to promote hardening in the air and to prevent rust. For fixing iron to stone, glycerin with red oxid of lead is used.

Lead Carbonate.—The making of white lead or basic lead carbonate is a process involving much time and danger. It is conducted in a closed chamber and requires about three and a half months. The chamber is filled with layers of earthen jars (Fig. 33), superimposed with layers of boards, with tan bark and sometimes horse dung between. Strips or "buckles" of metallic lead are laid across the mouths of the jars, which are filled with dilute acetic acid. The acid vapor arising converts the lead to an acetate, which in turn is made into a basic carbonate by the carbonic acid gas and warmth arising from the fermentation of the tan bark. The temperature of the fermentation chamber may reach as high as 140°-150° F. This process is known as the "Dutch process," and the layer of

jars and bark as the "blue bed." At the conclusion of the process, which lasts eight to ten weeks, the "blue beds," now become "white beds," are found to contain the basic carbonate of lead in dusty masses adherent to what remains of the corroded metal. The car-



FIG. 33.—EMPTYING "BLUE BEDS" OF LEAD CARBONATE WITHOUT USE OF RESPIRATOR OR GLOVES.

bonate is sprayed with water to lessen the dust, taken out, washed and ground to a pulp, and then placed in jars on shelves in rooms called "stoves." The stoves are heated to 70° C., or more, for 48 hours, or sometimes for as long as a week, to dry the preparation. Uncorroded fragments of lead from the beds are sifted out and either returned for further treatment with acetic acid or remelted. Handling these dusty fragments is a very hazardous occupation.

(Figs. 34, 35.) The carbonate is ground, washed and allowed to settle in large vats. (Fig. 36.) After grinding and drying, the finished product is dumped into barrels. The emptying of the stoves

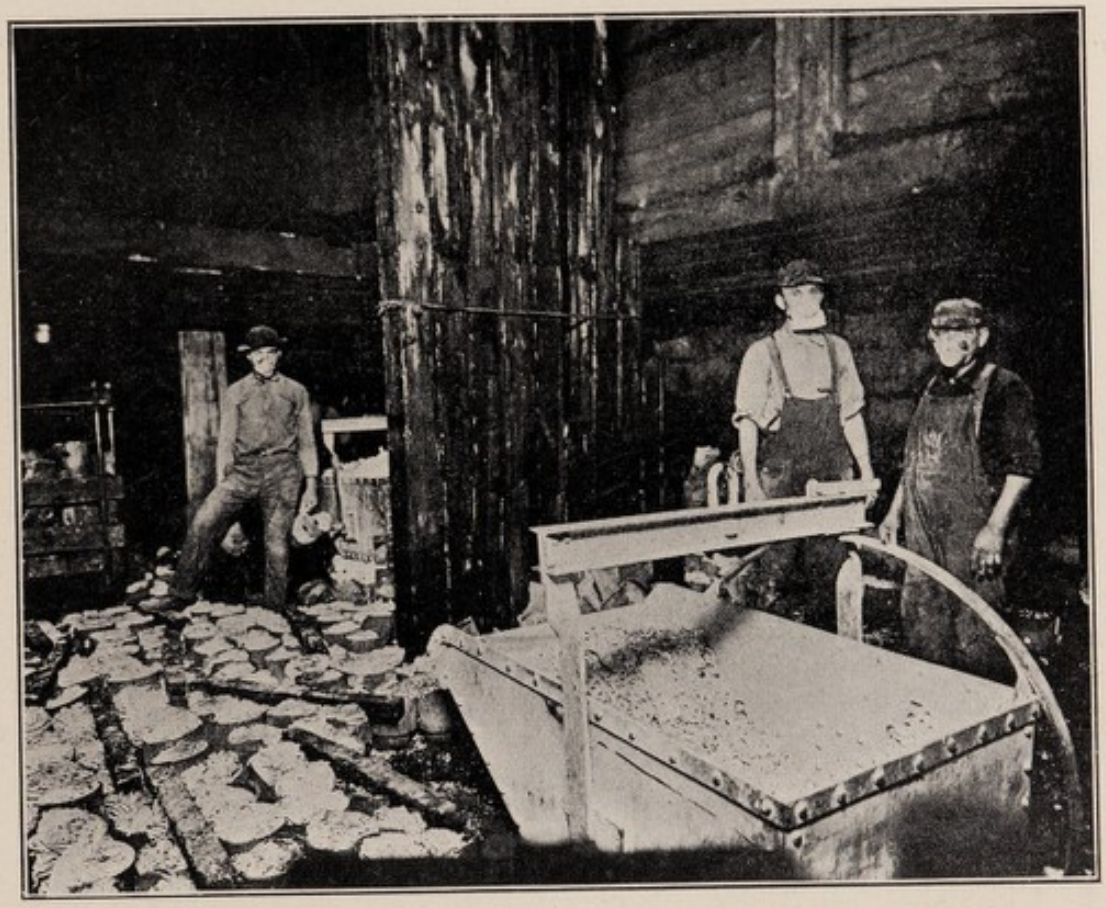


FIG. 34.—EMPTYING THE POTS IN A "BLUE BED" IN WHITE LEAD WORKS. Note the workmen's respirators. Hazard: chronic lead poisoning. (From the Illinois State Department of Factory Inspection.)

to remove the dry carbonate, the packing of it in barrels after re-grinding, and final mixing with oil to make paint are all dusty and dangerous processes. When women were permitted to work in the stoves (as they no longer are) they have been known to acquire fatal lead poisoning in a few weeks, according to Sir Thomas Oliver. By the Besançon process, as conducted in Paris, the water from the pulp is excluded by rollers on which oil is made gradually to replace the water present. In this manner oil paint is mixed by machinery and the whole process is freed from dust.

There are various modifications of the processes described above,

but the principle is the same in all. Dr. Hamilton found the foreign lead works far ahead of those in this country in details of machinery

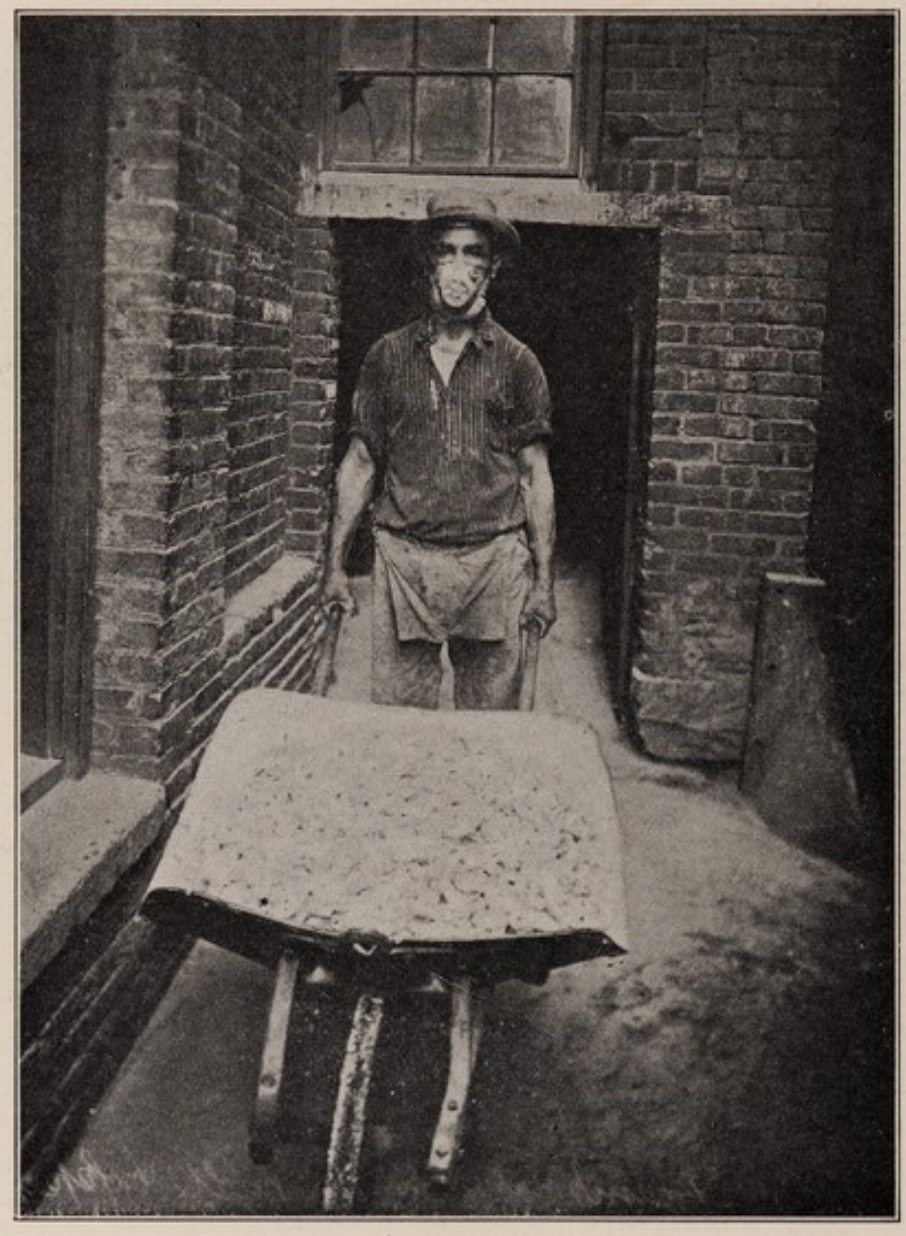


FIG. 35.—TAKING WHITE LEAD FROM THE "BLUE BEDS" TO THE MILL HOPPER FOR GRINDING. The man wears a good type of respirator but otherwise is poorly protected. Note the white lead on the wheel of the barrow being tracked and ground over the floors, and the absence of protecting sides or cover for the barrow.

employed, as well as in protection of workmen from dust. Water spraying is much more general and dry sweeping is prohibited.

Other methods of manufacturing lead carbonate have been devised, such as forcing a mixture of hot carbonic acid gas and acetic

acid fumes over metallic lead in sheets, or forcing CO_2 through basic acetate of lead solution, but none of these different methods, for various reasons, have met with the favor of the old Dutch oven process.

Sometimes grape and other fruit skins, in wine-making countries, are used instead of manure to evolve CO_2 by fermentation.

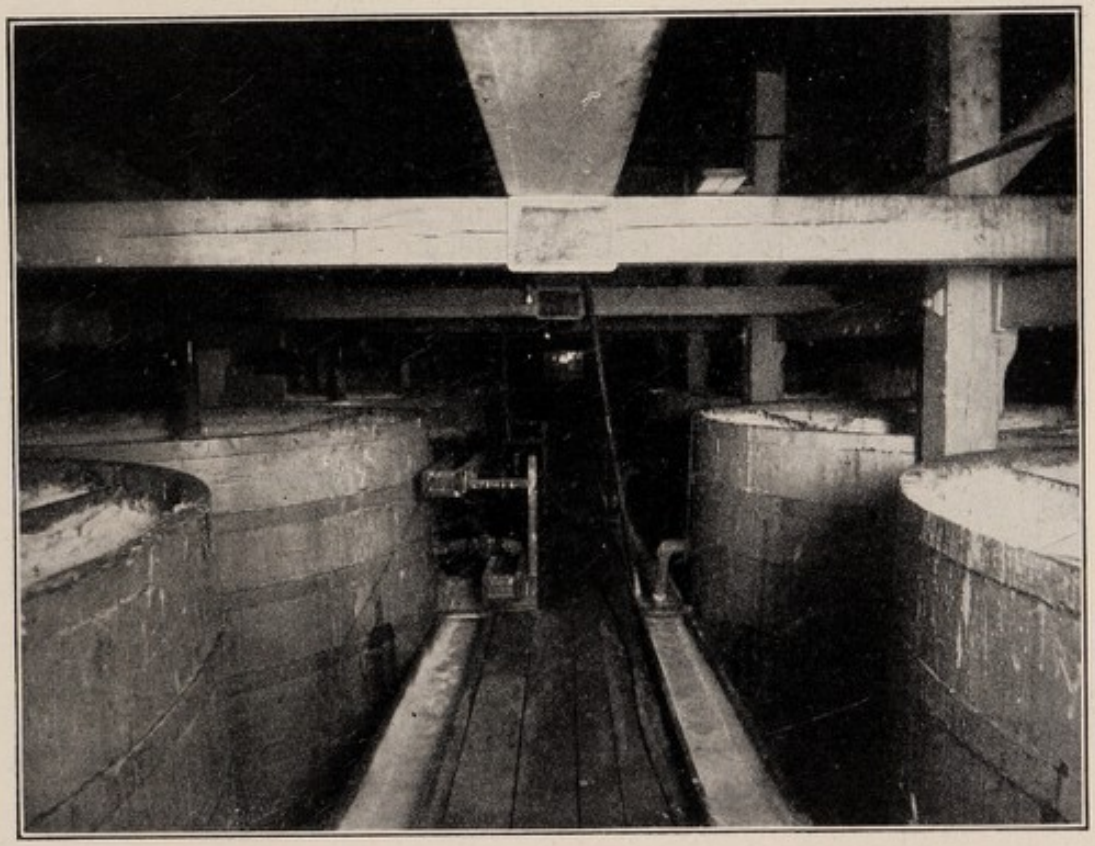


FIG. 36.—WHITE LEAD SETTLING TUBS. Here the lead carbonate is moist and the risk is from handling more than from dust.

Dr. Hamilton, writing of "The Hygiene of the White Lead Industry" (*Jour. of Industrial and Engineering Chemistry,* June, 1911), stated:

"In Belgium I saw an interesting device. The barrel—stronger and better built than ours—is already headed up and the lid has a round hole some six inches in diameter. Into this is fastened one end of a strong rubber tube, the other end of which is hanging from the bottom of the white lead hopper. As the powder falls into the barrel it is shaken down because each barrel stands on a platform

which is made to jump up and down by means of compressed air. I saw a whole roomful of barrels in process of filling and not a particle of dust. These of course need no heading-up, another great advantage. Heading-up is considered dangerous work, and all sorts of devices are being experimented with. In Germany, as in



FIG. 37.—PAINT MAKING. Grinding oil colors. Clearness of the picture is obscured by dust. Note the absence of overalls, absence of ventilation and the poor illumination.

some of our factories, each barrel is lined with strong paper which is folded down over the top before the lid is put on. In an English factory they are trying a lid with expanding leaves, which fits into place without hammering."

Lead carbonate is applied to lace to whiten it and add to its weight. It is also used to stamp stencil patterns on dark textures. It is used in powdered form by tanners in finishing leather. It is an ingredient of various cosmetics, in which form it has often given rise to poisoning.

In making many paints white lead is first dried, then pulverized

and diluted with oil and pigments. It is often possible to add the oil while the lead is still moist, thereby saving labor and greatly reducing risks from dust. (Fig. 37.)

Some paste paints are made with a rosin binder, glue and dextrin, or other adhesive materials, so that they may be diluted with water instead of with the usual agents, turpentine and oil, but they afford no less risk of lead poisoning, and possibly more than the commoner sorts of paint.

White and red lead, besides their extensive use in paints, are also employed in the making of glass, pottery glazing, the making of paper and rubber articles, and by gas fitters and plumbers in connecting the segments of pipes.

Enamel.—Enamel for iron ware is made in various ways. A common method is the following: An alloy of tin, 18 parts, and lead, 100 parts, is oxidized by heat and pulverized with glass. Other substances mixed with lead for enamels are barytes (barium sulphate), sodium aluminate, calcium phosphate, arsenic and silver chlorid. Cast iron ware is liable to rust. To protect it it is first cleaned with dilute sulphuric acid, then a glaze is added and some powdered metallic color is blown over the surface. The ware is then heated to melt the glaze into the iron. In enameling iron bathtubs, basins, sanitary closets, urinals, etc., white lead enamel is melted and pulverized so that it may be blown by compressed air in a uniform layer over the article to be enameled, which previously is heated to make it adhere. The dust thus blown is naturally a source of lead poisoning.

Dry Colors.—Dry colors comprise such lead compounds as the carbonate, acetate, oxid and chrome or yellow lead.

"Putty Powder."—Putty powder is three-fourths red lead and one-fourth tin. It is moistened and used on a wheel to polish cut glass.

Lead Acetate.—Litharge, when dissolved in vinegar, crystallizes into lead acetate or sugar of lead, which is used chiefly by dyers of textiles, in wall paper colors, in varnish, and for sanitary supplies. It is added sometimes to silk and linen thread to increase its weight, consequently seamstresses who form the habit of constantly

biting the ends of threads when sewing have exceptionally been known to acquire lead poisoning.

Lead Chromates.—Lead chromates, yellow, orange and red, are made by a wet process in which there is little dust and consequently little risk, but wool and cotton yarn dyed by these colors may disseminate poisonous dust when freely handled, and, according to a *Bulletin* of the United States Labor Bureau, 1903, many serious cases of poisoning are known as results of the above-mentioned color dust.

"Thus Leopold reports a case of severe lead poisoning in a weaver's family which had worked with yarn dyed in chromate of lead. To a nine-weeks-old child, which was exposed to the influence of the dust in the room in which the yarn was used, the poisoning was fatal. Considerable danger also threatens those employed in the manufacture and consumption of the other yellow lead colors, as cassel yellow (yellow oxychlorid of lead), and naphs yellow (antimonate of lead), which, however, since the introduction of chromate of lead, plays but a small part in the industries."

Lead Nitrate and Iodid.—These are used in calico printing, but, like many other minor lead salts, their employment is limited in the industries and rarely productive of harm.

Dr. Alice Hamilton, in her exhaustive investigation of lead poisoning in Illinois, places the toxicity of lead compounds in the following order, commencing with the most serious: lead carbonate, acetate lead, lead oxid and suboxid, red lead and litharge, chrome yellow and green, metallic lead.

General Etiology.—Sex.—Females are always more susceptible to lead poisoning than males. They have the symptoms earlier and acquire them with less dosage than men working under analogous conditions. Females, too, are more likely to present nervous phenomena, and the mental symptoms of hysteria and encephalopathy than the colic and other manifestations. Encephalopathy, for instance, is two or three times more common among them. Woolsey gave the percentage of plumbism among lead workers in Stoke-on-Trent, England, in 1898, as 4.9 per cent. of men and 12.4 per cent. of women employed. In foreign countries women formerly were

much employed in lead mines, lead refineries, white lead works, pottery glazing and other extra-hazardous work. Much of this work has now been prohibited for women by law. In this country, where women have never been employed in many of the extremely laborious and dangerous trades, lead poisoning is less common among them. Dr. Hamilton found only 18 women out of 578 victims of plumbism. In my personal series of 268 cases there was only one woman. Dr. Hamilton's reported Illinois cases were those of women employed in "polishing type with emery, making car-seals, dusting lead colors on litho-transfers, labeling paint cans in an atmosphere of white lead dust, working with aluminum foil, making artificial flowers, wrapping cigars in tinfoil; one was a commercial artist."

Women are more liable than men, when working in dusty lead trades such as pottery polishing, to carry lead dust home in their hair and clothing and thus distribute it in their own rooms.

Age.—Dr. M. Allen Starr, of New York, has reported two cases of lead paralysis, one of which was fatal, in young children of a painter who were permitted to play with paint; and children in general, when exposed to lead poisoning, are extremely susceptible to it.

In the copper mines of Queensland the ore contains much lead, and children who work there inhale lead dust, with the result that plumbism is exceedingly common among them. A. Turner, in the *British Medical Journal* of April 10, 1909, reported 262 such cases presenting at the Brisbane Hospital in a single year. Such children present marked gastro-intestinal disorders, nephritis, paralyses, including oculomotor types, and convulsions.

Young persons are more susceptible than adults to lead encephalopathy, and young children are especially prone to paraplegia from plumbism.

Season.—Lead poisoning is more serious in winter than in summer, in so far as it affects indoor workmen, for in winter windows and doors are kept closed and fumes and dust stagnate. Laureck claims that 71 per cent. of cases arise in winter and 29 in summer in Austria, but no such striking difference has been observed in this country. Several French authors, on the other hand, claim

that in France lead poisoning is almost twice as common in the midsummer months as at other seasons. This they attribute to greater thirst, which induces wine drinking, the cheaper grades of wine being clarified by lead or stored in leaden casks.

Idiosyncrasy.—Personal susceptibility to lead poisoning varies greatly. There are persons, especially painters, who can work with lead products for many years without presenting any subjective symptoms of poisoning. Others among their fellow workmen, with the same degree of exposure and approximately the same habits, are very easily affected. Hirt maintains that about 20 per cent. of all workmen are so easily poisoned by lead that they should never be permitted to enter the lead trades at all.

A case of serious plumbism in a workman employed only three weeks in a white lead bed is cited in *Bulletin No. 44,* 1903, of the United States Labor Bureau, and there are many other cases on record where very short exposure to lead in various forms has resulted in like manner.

Alcoholism.—The constant use of strong alcoholic beverages tends to lessen the resistance of the organism to many poisons, and particularly is this true in regard to lead. Many of the lesions caused by lead poisoning, such as arteriosclerosis, nephritis and neuritis, are closely akin to those caused by alcohol, and it is natural that the two poisons should possess strong synergystic action. Cesa-Bianchi has demonstrated experimentally in animals what he terms the "coöperation between the effects of alcohol and the lesions produced by lead." ("Atti del Congresso di Medica Interna," 1910.)

Tobacco.—Chewing tobacco, which is usually carried in the pocket of the lead worker, becomes soiled there, and when, by begrimed fingers, it is conveyed to the mouth, lead is certain to enter the system. In European countries the prohibition against tobacco chewing while at work is very rigidly enforced, but in this country foremen often encourage its use on the ground that chewing it cleans the teeth and expectoration rids the mouth of dust.

Especially Hazardous Lead Occupations in Detail.—Mining.—Sir Thomas Oliver, in his classical Report on Industrial Lead Poisoning in Europe, made for *Bulletin No. 95* of the United States Bureau of

Labor, 1911, states positively that "men mining lead ore, such as galena or sulphid, do not suffer from plumbism." This refers to the British industry, for he goes on to say:

"The freedom of the British lead miner is due to the fact that lead is present in the ore in almost a pure metallic state, whereas in some of the Italian mines and in those at Broken Hill, in Australia, the lead is found in the form of a carbonate, and, in consequence, the miners have suffered from some of the most serious symptoms of plumbism. The unloading of heavy volcanic lead ore from a ship at a British port was followed by seven cases of plumbism among the men. Such ore ought always to be well watered first."

Smelting.—Lead smelting gives rise often to most acute forms of lead intoxication, as the fumes from the molten lead may be inhaled in such quantity as to become almost immediately fatal. Many serious cases of poisoning are recorded as occurring within five or six weeks of beginning this work. Dr. Hamilton obtained the statement from physicians in Illinois in 1910 that in the previous three years they had seen an average of 270 cases a year in three large smelting plants. Many of the workmen employed in this unskilled labor are ignorant foreign peasants, Slavs, Italians or others. They speak little English, cannot read regulations, and receive no preventive instructions. They become ill, quit work and disappear, so that statistics regarding plumbism among them are much more likely to be understated than overstated. In one Illinois lead plant employing 450 to 600 men from 20 to 40 per cent. dropped out every pay day. (Hamilton.) The flue dust collects in places to a depth of several feet, and is removed in buckets by men who enter through manholes. Oliver found among the Derbyshire smelters, the flue cleaners, often after a few hours' work, had severe headache and vomiting, obliging them to quit work. The shovelers who feed the lead ore to the furnaces easily acquire tremors and paralyses. The fumes from the molten lead as it runs from the smelter may be so dense that a workman may inhale as much almost as a grain an hour of lead if he is exposed to them. The dross and slag, while hot, emit similarly dangerous fumes, particularly in the reverberatory type of furnace.

Apart from the volatile fumes, smelting works are always saturated with lead dust derived from breaking up the ore and slag, moving lead ingots, the condensation of fumes, etc.

In the Austro-Hungarian lead smelting industry much trouble has arisen from the poisoning of cattle grazing near the smelting chimneys, although the flues leading to them may be more than a mile in length, to favor deposit of lead dust. The dust of the fumes from the smelters contains "about 30 per cent. of metallic lead, together with lead oxid and a variable proportion of sulphur, arsenic and other admixtures." (Oliver.)

In illustration of the fatal hazard of work with molten lead, Dr. John B. Andrews cites the following case (*Bulletin No. 95,* United States Bureau of Labor, 1912):

"The workman of the death-certificate classification Case No. 50 was traced to a factory where for 18 years he had operated a lead pipe machine and at intervals had polished shot with black lead. Melted lead here flowed from a kettle overhead and was conducted through an open cylinder to the pipe machine or press through which the lead was forced under great pressure in the making of ordinary lead pipe. The man in operating the press stood directly over the molten lead and also breathed the dust which arose as the dross, when skimmed from the surface of the melted lead in the high kettle, was thrown into a barrel on the floor. The polishing of shot was particularly dusty on account of the use of graphite, small particles of which are so light that they rise and float through the air upon the slightest disturbance."

Solder casting is an especially hazardous lead trade. One of my patients who had thus been employed died in Bellevue Hospital from cerebral hemorrhage caused by an early arteriosclerosis.

White Lead Manufacture.—In the whole United States are 25 white lead factories. In the 16 months following January 1, 1910, Dr. Alice Hamilton found in 23 of these factories 358 well-established cases of lead poisoning, among which 16 deaths occurred. In one factory alone there were 60 cases of poisoning. More than one a week! The majority of cases, moreover, developed within two months of exposure. The exact time could not always be deter-

mined, but in 61 out of 89 cases symptoms developed within that brief period. One case developed in less than a week and 28 in less than a fortnight. Two cases of this series are so striking in showing the utter and typical neglect of the workingman that they are here quoted in full from the *Bulletin* of the United States Bureau of Labor, 1911, selected from a considerable number of similar cases:

"No. 1. V. O., Italian, speaking no English. He worked for 36 days in the stripping gang of a new, very well-built factory. Nobody gave him any instructions nor explained to him the dangers of the work and the precautions he must take. He never saw a respirator and did not know there were such things or that he had a right to ask for one. The stack men had only cold water to wash with, no soap or towels, and as the lunch period is only 30 minutes, they did not trouble to wash. He used to eat his lunch sitting on the tan bark in the stack house. He wore his usual clothes to work in. There was a great deal of dust in the stack, especially on windy days. One day an agonizing colic came upon him suddenly and he fell to the ground. He had not known that there was such a sickness as lead poisoning till an Italian doctor told him that he had it and sent him to the public hospital, where he remained for 2 weeks. After he returned home he had a relapse and was obliged to go back to the hospital. When seen, 3 months later, he was not yet strong enough to work.

"No. 32. Negro, 50 years. He worked for 6 or 7 months in this same factory. He had always been strong up to this time, and during the first part of his employment he worked outside. But after about 2 months he was sent to work in a very dusty room, where the men frequently become poisoned in a few days' time. He worked there for 3 days, then became violently poisoned, and was sent to a private hospital. After he came out he went to work again, but he was ill and became morose and slightly deranged. He was then sent to the public hospital, the record of which shows that he was brought there in convulsions, and was later confined for a time in the insane wards. He is now said to be quite sane again and is working as a sailor."

Of the 16 fatal cases, 8 belonged to one factory, a very dusty place without washing facilities or medical care.

White lead may produce poisoning very promptly in the absence of any precautionary measures against it. For example, Dr. Hamilton reports the case of a young Bulgarian who "went to work in a lead factory the first week he arrived in Chicago, and was put to emptying pans of dry white lead. He was given no respirator and had no idea that he had a right to ask for one. Nobody told him the white dust on his hands and mustache was poisonous. He had only one suit of clothes and wore his working clothes home. He had a severe attack of lead poisoning at the end of five weeks."

It is difficult to write calmly of such criminal neglect, for it cannot be characterized as ignorance in a matter so thoroughly and widely understood among manufacturers as lead poisoning.

Cleaning out lead carbonate blue beds, transporting, packing, grinding and mixing this compound often give rise to very acute and serious symptoms. Frequently the workmen are attacked within 5 or 6 weeks of beginning such work. In four white lead factories in Illinois Dr. Hamilton found records of 157 cases of lead poisoning which developed within three years.

Red Lead Manufacture.—Poisoning by red lead is even more hazardous than by white lead, but the number of men employed in its preparation is comparatively few, so that it fails to attract as much attention.

Oliver found that, in the 19 British red lead factories, the percentage of poison cases among the workmen was from 27.8 to 41.7 during the 10 years prior to 1910. Sixteen cases occurred among common laborers merely employed to sweep the floors.

Painting.—Paint is usually composed of 90 parts of lead carbonate with 10 parts of oil, to which pigments and sometimes turpentine subsequently are added.

By far the largest number of cases of plumbism are found among painters because they constitute so large a class of workmen; they mix and handle so much lead and oil, which makes it adhesive, and because they inhale or swallow the dust of old paint which they scrape or rub down with sandpaper or pumice. They rarely suffer

from acute plumbism, however, but often from slow poisoning, which may operate through many years.

In fact, painters, if they do not sandpaper dry paint, do not often develop serious poisoning, i. e., a degree of poisoning which incapacitates them from work, in less than four or five years, and I have records of many who had no symptoms for 20 years, and a few for 35 and even 40 years. If they continue long enough in the trade, however, it is exceptional for them to escape poisoning, particularly as they come to regard themselves as immune and grow careless in the matter of precautions. For example, they will hold the dirty handles of paint brushes in the mouth and rub lead putty in the palm of the hand. Recently a young man of only twenty-three years of age presented himself at my clinic with most advanced arteriosclerosis, cardiac hypertrophy and a loud Flint murmur, the result of working with lead paints since he was thirteen years of age. I have lately seen another case in a boy of thirteen years.

During the past eight years we have had in the hospital services in Bellevue and the Presbyterian Hospital, and in my Out-Patient Medical Clinic in the Cornell University Medical College, two hundred and sixty-eight cases of serious lead poisoning arising from various trades, but nearly 75 per cent. of these were furnished by painters. In Paris, among 300 hospital cases of plumbism, 233 were painters. Of the 125 cases of lead poisoning reported to the New York State Department of Labor in the year 1912, 95 were among painters in different trades. Dr. Hamilton studied the histories of 1,009 painters in Chicago, of whom 185 had had plumbism, 72 kidney disease, 77 "rheumatism" and 24 gastric disorders. ("Hygiene of the Painter's Trade," *Bulletin,* U. S. Dept. of Labor Statistics, No. 120, May 13, 1913.)

Painters often are obliged to work in unfinished buildings where water and heating supply has not yet been installed. As a result they have no suitable facilities for washing or changing overalls, and consequently are very apt to contaminate their food with lead at the noon luncheon hour. Sandpapering the interiors of sleeping cars and drawing-room cars is extremely hazardous, especially the ceiling work, where the dust falls down into the face of the operator. Dr.

Hamilton refers to three cases of plumbism which developed after four weeks' exposure in this manner.

Sir Thomas Oliver has met with cases of colic and wrist drop in men who painted iron coach frames which were heated.

A very fertile source of lead poisoning concerns the new industry of automobile painting in which sandpapering figures as part of the process.

In Germany and Belgium the sandpapering of dry paint in manufacturing processes is illegal, and in England also it is generally customary to moisten the paint. But in this country, which is usually the follower rather than the leader in matters hygienic, the hazardous dry method is still in vogue.

The use of pumice stone for smoothing painted surfaces is prohibited in Belgium by law. The lead thus rubbed off is in the form of an oleate, which is quite readily absorbed.

The burning process applied in removal of old paint is scarcely less hazardous, for fumes of melted lead are evolved. Caustic potash is sometimes used for washing old paint, but this is very irritating to the hands, especially if any abrasions exist.

In the making of enameled iron plates and hollow ware, such as pots and kettles, etc., a powdered paint which contains about 25 per cent. of lead, and frequently powdered glass, is applied by sifting over the ware. In stenciling for the painting of signs red and other forms of lead are used.

In the enameling process as applied to iron sheets or receptacles, lead, arsenic and antimony are used.

Pottery Glazing.—Pottery glazing is a fertile source of plumbism. This hazard is fully described under the heading Pottery Making.

Manufacture of Storage Batteries or Electric Accumulators.—In the making of storage batteries perforated or grooved metallic lead plates have their openings or grooves filled with a pasty mixture of red lead oxid and sulphuric acid. The work is dusty and extremely hazardous, both from dust and the adhesive paste. (Fig. 38.) The pasters sometimes are provided with glass screens, behind which they sit, passing the hands through canvas slits covering holes

in the screens. In this manner they may handle the plates with some diminution of hazard, but the protection is far from complete.

In many battery works fully 30 per cent. of the men employed in

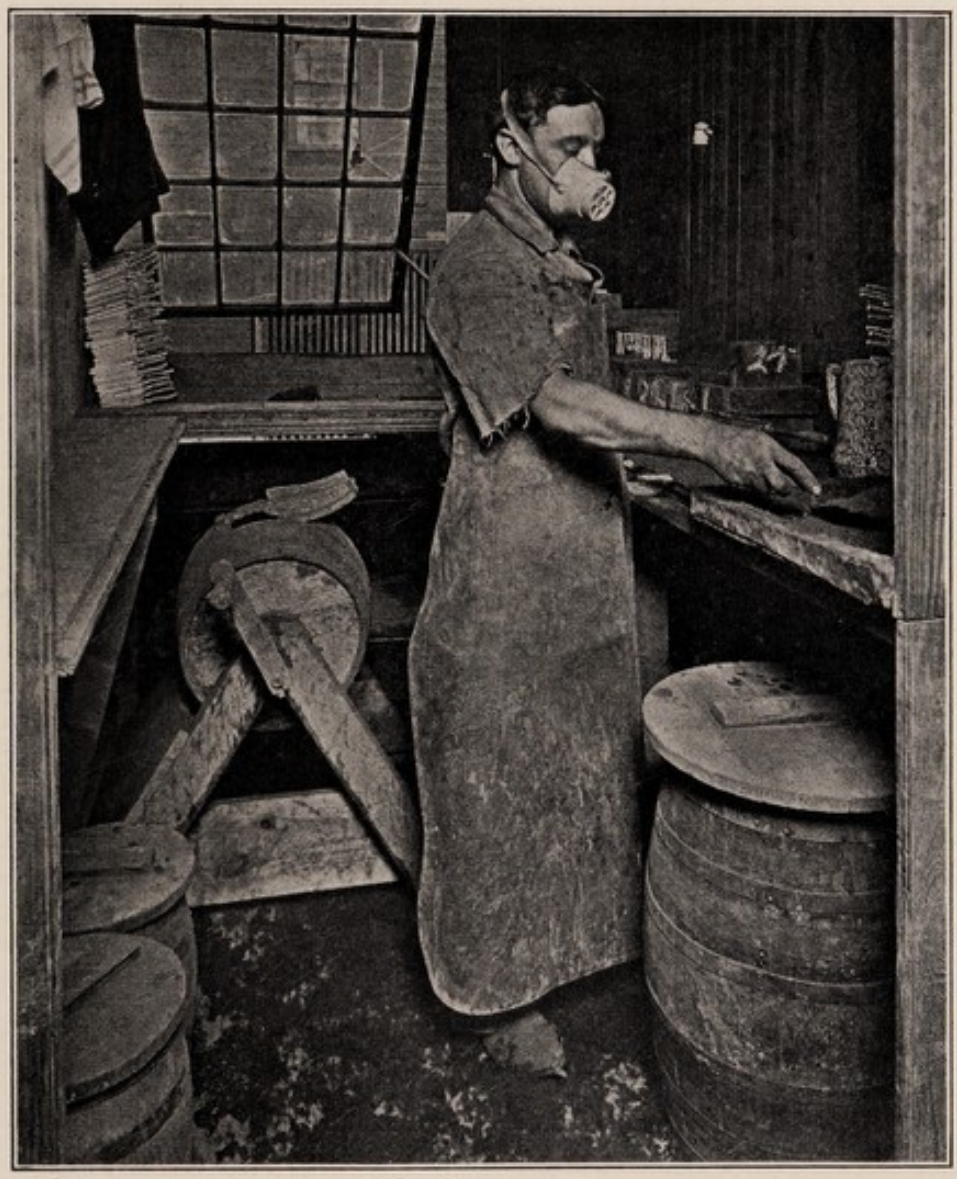


FIG. 38.—LEAD WORK IN THE MANUFACTURE OF STORAGE BATTERIES. Red oxid of lead and litharge are mixed together. The employee wears a respirator. He was unwilling to wear long-wristed gloves. Note the crowded, dirty, ill-ventilated room. (Reproduced with permission of Dr. William C. Hanson, Massachusetts State Board of Health, Aug., 1910.)

rubbing in the paste have acquired plumbism, which is liable to be of acute and very serious type. Dr. Alice Hamilton reported the case of a battery worker "who became violently ill at the end of 10 days." He was a "newly arrived Russian Jew who was set to work-

ing with the red lead paste and used to moisten his fingers in his mouth as he worked, because he had never been told that the stuff was dangerous."

In 1909, in a storage battery establishment in New York City, two men died within a few days of each other from acute plumbism, and many of the men developed symptoms of lead poisoning within a month of their beginning work, but, as the labor was unskilled, it was replaced without difficulty. After a fire this originally most dangerous plant was replaced by a modern sanitary one and cases have ceased to arise.

Twenty-one cases of plumbism from making accumulators occurred among the 125 cases of lead poisoning reported to the New York State Department of Labor in the year 1911-12, and E. E. Pratt found 7 cases originating in a single factory in New York City.

In England, in eleven years prior to 1910, there were reported among makers of electric accumulators 317 cases of plumbism and 6 deaths.

The plates are soldered together, a blowpipe being used for the purpose, and, in addition to the fumes thus evolved, much lead dust flies about while setting the plates in lead-lined boxes or jars. Usually a lead line may be found in half the men employed, and in some works 50 per cent. of the workmen become ill within a year. (I. Kaup.) One of Dr. Oliver's patients became ill with plumbism after $10\frac{1}{2}$ days' work as a paster of the "grids."

In the Milan Clinic, in 1911, among 29 cases derived from electrical industries were 4 cases of plumbism from working in electric accumulators. (L. Carozzi.)

Hollow Tin Ware Manufacture.—Hollow tin ware is sometimes lined by a layer of molten lead and tin which is swished around the inside of the pot or kettle while it is held over a furnace. The work should be done only under a well-fitting hood with strong suction draught. Dippers of this type of ware are usually an anemic, sickly set of men and plumbism is common among them.

Lead Shot Manufacture.—Lead shot is made of a molten compound of lead with arsenic which is dropped through sieves of different sizes at the top of a tall tower into water at the base, which

solidifies the round lead drops. The shot are then mixed with graphite and polished in revolving drums.

File Making.—In cutting amber articles and in cutting the ribs of files the articles are imbedded in a block of lead, which offers the proper degree of resistance or rebound when the cutting chisel is struck by the hammer. Much lead dust, besides iron filings, is thus produced, and the workmen have the habit of moistening the fingers in the mouth to obtain a firmer grasp upon the cutting instrument. Thus they both swallow and inhale much lead dust. Wooden or tin blocks may be used to replace the lead, but are less satisfactory. The increasing use of file making machinery is doing much to lessen the frequent cases of lead poisoning which characterize this trade, but as the machines strike from 400 to 1,000 blows per minute, they raise considerable lead dust.

Dr. White examined 100 English file cutters and found 74 with a lead line on the gums, 28 with colic and 20 with palsy. The mortality of this trade is excessive. Leaning over the work and raising the lead dust by constant hammering constitutes the special risk. Sometimes 3,000 or 4,000 lines must be made on a single file.

According to Sprenger, among 93 file makers in Berlin more than 5 per cent. were afflicted with lead poisoning within a little more than two years of work. The workmen sometimes strew sand on the benches to prevent the slipping of the file bed. The hammering of the files raises considerable sand dust.

For hardening the files are sometimes plunged into a molten lead bath. In Berlin the experiment was made of substituting tin cushions for lead, with the result that after two years' trial 55 workmen who used them remained in good health, but of the remaining 93, out of a total of 148 file cutters, 55 acquired lead poisoning. (Oliver.) File cutters also frequently acquire tuberculosis and chronic nephritis. Metallic lead slabs are used as supports in cutting certain articles of leather manufacture.

Manufacturing with Alloys of Lead.—Many alloys of lead are used in minor trades, as in making organ pipes, artificial fruit and flowers for decoration, tin foil, toy tin soldiers, etc., but cases of lead poisoning among workmen so employed very rarely arise.

For *diamond cutting* the stones are embedded in a molten alloy of 60 per cent. lead and 40 per cent. tin, so that they can be fixed and polished by iron wheels rotating several thousand times a minute. A grinding powder of lead is also used. The workmen are thus subject to fumes from the molten lead, tin, iron and diamond dust, and fumes of various varnishes. They thus may acquire colic, paralysis and other symptoms of plumbism.

Litharge is much used in glass making, owing to the ready combination which it forms with the silicates. It is thus used in making false gems, stained and enamel glass, crystal glass and optical lenses. As much of this glass ware must be ground in finishing, lead is disseminated in the dust and inhaled. The preliminary fusion processes also give rise to toxic lead fumes. Litharge is further used often in 50 per cent. strength in furniture lacquer. Subsequent rubbing with sandpaper and pumice produces fine dust which is highly toxic.

Brush and hair workers make use of a mixture of litharge, vinegar and water to dye horsehair and bristles black, for the natural sulphur of the hair forms a black lead sulphate. Such hair is capable of disseminating lead dust, and upholsterers and saddlers occasionally have been poisoned by it.

Lead superoxid is used in making friction matches, but does not produce serious risk of poisoning.

In the *textile industries* lead has various uses. Chief among these is the weighting of silk, lace, embroidery, etc.

It is also employed in making white gloves, shoes and straw hats.

In Vienna, of 41 samples of black silk thread analyzed, 32 contained lead, and of 12 samples of lace, 10 contained it. The lead is applied originally in solution as an acetate, but soon oxidizes in the air to a dusty powder. In foreign countries much weaving, spinning, dyeing, lace making, etc., is still done in the homes of the workers, a custom which in this country at the present date is almost unknown. But apart from the dyeing of silk, lace, etc., there is danger to seamstresses in working upon such material, and lead poisoning has frequently been discovered among them.

Typesetting and Printing.—*Type metal* is an alloy composed

usually of 75 per cent. lead, 20 per cent. antimony and 5 per cent. tin. The tin is inert, but the large percentage of antimony present has given rise to the belief of late years that many of the symptoms which affect type founders and typesetters are due more to that metal than lead. As they are often taken into the system together in considerable quantity, it is not always easy to separate the clinical findings, as many symptoms of poisoning are identical with the two metals, although lead produces the greater variety.

Type founders and makers of stereotype plates are obliged to work over the fumes given off from pots of melted lead.

Printers suffer in varying degree from lead poisoning. In many large printing establishments the men suffer very little from it, although they work for many years. In others examples of it are constantly observed. Much depends upon cleanliness and ventilation, and dry sweeping is a most pernicious process in this extensive industry.

The use of lye for cleaning the surface of the type sometimes irritates the hands, causing erosions of the skin, through which it is possible for lead to be absorbed. This latter danger, however, is a very minor one, compared with all the other risks of the trade. Tanquerel found the ratio of lead poisoning among type founders to be four times greater than that of typesetters, and Hirt gives practically the same figures.

Printers will sometimes hold type in their mouths while setting or sorting it, or moisten their fingers in their mouths to enable them to seize the type better. The water in which printers wash their hands was found by Dr. Van Eyk to contain from 6 to 15 mg. of lead per man. (Oliver.)

Dust from type cases has been analyzed by Rueszahegyi, who discovered in it 57.7 mg. of lead, 186.8 mg. of antimony and a small quantity of arsenic. Sorting old, dust-covered type is always hazardous. The type are sometimes polished with emery, by girls who are given this easy but dangerous employment.

The sort of plumbism which mainly affects printers is very insidious and of the arteriosclerotic variety, colic and palsy being less common among them than in painters. Many of them have

chronic nephritis and cardiac hypertrophy, and cerebral hemorrhage may develop at a comparatively early age.

It has often been stated that printers have a high rate of mortality from tuberculosis, due to the inhalation of dust impregnated with lead. Dr. James A. Miller, in 1908, examined 203 members of Typographical Union No. 6 in New York City, and found that 17 per cent. of them had tuberculosis, but he states:

"After very careful examination it was found that one half of them had cured tuberculosis; they had had tuberculosis, left their employment, took care of themselves, returned to their trade, and had no relapse. The knowledge they gained enabled them to return to their trade and keep well. It would seem, therefore, that the habits of the printers rather than their occupation were at fault."

European printers universally have a very high death rate from tuberculosis, despite the attention given to prevention of this disease during the past two decades. This death rate is so out of proportion to that of tuberculosis among other lead workers that it is explainable only on the ground that type dust is sharp and mechanically irritating as well as poisonous, or that the combination of the lead with antimony is particularly injurious to the lungs.

The general use of linotype machines (Fig. 39) in large printing establishments, which largely does away with the handling of individual type in setting or distributing, has accomplished much in reducing the number of cases of plumbism among the workmen. It is only in the melting and recasting processes by which the type are remade that there is any special hazard.

Other metals might be used in the form of alloys to replace lead in type making, but their cost or greater difficulty in handling make their general substitution prohibitive. Printers are subject to benzene poisoning, the substance used to clean the ink from type. (The effects of this poison are described on page 312.) Antimony poisoning also occurs among those who handle type metal.

Plumbing.—Plumbers use much less lead at present than thirty years ago, when waste pipes, traps and joints were universally made of lead. At present they are made of iron or brass chiefly, so the only hazard is in the dust from filing or handling the small amount

of red lead paste used to cement pipe connections. As these are comparatively slight risks, plumbism among plumbers is becoming more and more infrequent. A pernicious habit of chewing bits of



FIG. 39.—LINOTYPE MACHINE. Piping over the lead pots conveys fumes away. Hazard: chronic lead poisoning. (From the Illinois State Department of Factory Inspection.)

lead or solder is quite common among plumbers, who use it when their supply of chewing tobacco gives out. Sometimes lead poisoning arises in this manner.

ENGRAVING.—Artists employed in engraving establishments, in retouching photographs, often form the habit of moistening with their lips the fine brushes which they use. They usually are not informed that they are using lead paint, or are definitely told that they are not, but, even when they know it, it is difficult to prevent

them from forming the habit of mouth moistening. Dr. Hamilton found that white lead was in use in all except 4 of 74 establishments of this kind visited in Illinois, and there were 15 cases of plumbism in them. These artists also make use of a compressed air spray of white lead paint to cover the surface on which they are working with a thin, uniform layer, and subsequently the compressed air jet is employed to brush away any excess of dried paint.

Litho-transfer Work.—In litho-transfer work dry colors are ground and dusted onto paper which is especially made to hold them, very much as flour is dusted from a sieve. The colors are then transferred by contact to pottery or other ware. The girls who are largely employed in this color dusting sometimes do the work behind glass screens, passing the hands through holes covered by canvas flaps, but the risk is still very great.

Sir Thomas Oliver states that some of the severest cases of lead poisoning he has met with were in boys under 18 years of age, employed in litho-transfer work.

In *electrotyping* particles both of lead and arsenic have been detected in the dust of the workrooms.

Gilders use a paste of white and red lead mixed with turpentine and glue, as a foundation for the gold leaf or gold paint to be applied.

Unusual Sources of Lead Poisoning.—False pearls contain lead silicate. They are polished upon steel wheels revolving at great speed, and considerable lead dust is associated with the work. E. Gaucher and H. Bernard have reported a number of cases of plumbism acquired in this trade.

White lead is sometimes rubbed into white felt hats and into white gloves to cover seams.

Dr. Hamilton refers to the cases of two men who became "leaded" through the habit of "holding lead-covered nails in their mouths while shingling roofs."

In the manufacture of wire and wire cloth the wire is hardened by being drawn through hot crude oil, and subsequently is drawn through molten lead which is contained in receptacles inside of fur-

naces. From the latter lead fumes are evolved and constitute considerable hazard for the men who feed the furnaces.

One would scarcely associate lead poisoning with embroidery, yet a number of cases have been traced to this industry. For making embroidery patterns on a large scale stencils are used, and the marking should be done with inert substances such as powdered starch and gum-arabic. White lead powder, however, is sometimes employed, and the young girls who use it are very subject to lead poisoning.

Soda water syphons have tops made of block tin which contains lead. In London, in 1911, a physician's wife died from lead poisoning resulting from drinking soda water from such syphons, which was proved at inquest to contain the proportion of 1/20 to 1/16 grain of lead per gallon. One-fiftieth grain per gallon is considered poisonous.

Remelting the leaden sheets used for lining tea chests has been known to cause plumbism.

A case of plumbism is reported in *Sozial Technik* (1912, vol. iv, no. 2), occurring in an Austrian painter employed in retouching in an art photographic establishment. Despite repeated warning, he kept on moistening with his lips a brush dipped in lead colors.

Another case similarly reported occurred in a woman who made use of a hair dye containing lead.

Sir Thomas Oliver reports: "Two cases of plumbism occurred recently in shipbuilding yards owing to the custom of the men using white lead paint to mark off on the iron plates the sites of the holes preparatory to boring them with the punching machine. It is difficult to see why such unnecessary risk should have been run, since whiting or zinc white mixed with oil would have served the purpose equally well." He also cites the case of a woman who acquired double "drop-wrist" from washing the overalls of a house painter. Oliver recovered lead from the washtub water.

Fresh paint in closed sleeping apartments may cause serious poisoning by inhalation. On a French warship a number of cases of colic were accounted for in this manner. Oliver found lead in the urine of a physician who slept in a newly painted house and was

made ill by plumbism for several months. He cites several similar cases, and states that lead is contained in the turpentine fumes from the paint, as determined by spectroscopic examination. He refers also to two cases of serious plumbism which he traced to sleeping in rooms lined with wall paper which was found to contain lead. Dr. Charron has found similar cases in France. Deep yellow chrome and bright red papers were found to contain the most lead, and he poisoned animals by lining their cages with such paper. Pregnant guinea pigs aborted, and the fetuses contained traces of lead in their organs.

In Vienna, in 1906, several cases of plumbism occurred in women and girls who made fringe of silk which had been weighted with lead acetate. (Teleki.)

Edsall quotes two cases of lead poisoning in dentists who had the habit of mixing a lead amalgam in the palm of the hands.

A case of plumbism occurred in a drug clerk who was employed for some time in making lead plaster.

A case of plumbism was reported in 1912 by G. H. Snover, occurring in New York State, in a girl of 16 who, while employed in soldering condensed milk cans, was accustomed to hold sticks of solder in the mouth.

A case of lead poisoning was reported to me occurring in a railway track walker. He carried leaded torpedoes in his pocket together with his "quid" of tobacco and thence conveyed lead into his mouth.

It is not essential to be an actual worker in lead to acquire plumbism, and such workers sometimes needlessly expose their fellow workmen to hazard. For example, in the Puget Sound Navy Yard a man employed in laying iron floor plates in the engine room of a battleship became "leaded" in a week because he was in some manner exposed while painters were at work in the vessel's hold near by. Among other symptoms he had a toxic amblyopia.

Although not an occupational condition, it is interesting in this connection to note that a number of cases of lead paralysis and some few of lead colic have resulted from absorption of lead introduced into various parts of the body. Thus Ribierre and Flandin reported

in *La presse médicale* (June 14, 1911) the case of a man who recovered from a gunshot wound of the lung. The carbonic acid in the lung caused solution of some of the lead shot as a bicarbonate, which, on being absorbed, caused multiple paralyses. Lead was also detected in pus from the wound.

Brouvin has reported a case of poisoning by lead shot, and Ruva reported lead poisoning following the swallowing of ten shot grains.

L. Lewin reports (*Arch. für klin. Chirurg.*, xciv, no. 4) a number of cases of plumbism from swallowing shot or having a leaden bullet lodge in the tissues. In one case a woman was acutely poisoned from a shot which became wedged between the teeth. Curtillet and Lombard have reported the case of a boy of 15 years who died with symptoms of acute lead poisoning 25 days after receiving a charge of bird shot in the arm. Excessive edema which followed the injury, they think, facilitated solution and dissemination of the lead.

Diachylon lead pills have at times been taken by women desiring to produce abortion, but, like all of the so-called abortifacients, they act more irritatingly upon other organs than the uterus, especially upon the kidneys, so that very nearly fatal results have more than once been observed from their promiscuous use. The abortion sometimes produced in this manner, or by any form of chronic plumbism, probably arises from the lead attacking the embryo directly, for it has been found in its tissues, but it may, also, cause more or less uterine spasm.

Pathology and Morbid Anatomy.—Retention of Lead in the System.—Lead and its products enter the body through the lungs and by swallowing, and very slightly through the skin, as illustrated by the medicinal lead plaster, "lead and opium wash," etc. English writers favor the inhalation theory; Germans, the deglutition theory. Probably in very dusty lead trades both processes occur. Where lead fumes are given off, naturally inhalation predominates, but dust probably is more often conveyed to the mouth either directly in the air or by contact with food or tobacco put into the mouth.

The lead salts, such as the nitrate, chlorid and acetate, which are soluble in water, are those which are most readily absorbed by the

skin, although it is believed that the fatty acids of the perspiration may convert some of the insoluble into soluble lead salts.

When lead or its compounds enters the stomach soluble lead chlorid is formed by the hydrochloric acid of the gastric juice, and is readily absorbed. The presence of proteid food in the stomach tends to use up the acid and leave any lead products which may have been swallowed to pass undissolved into the intestine. The presence of albumin, moreover, forms with lead chlorid a dense coagulum, which is but slightly soluble. Hence, it is argued by Oliver, the chief mode of entrance of lead into the blood from the alimentary canal is not as an albuminate but as a chlorid. Peptone acts similarly to albumin in checking lead absorption. This line of reasoning explains why milk drinking, previous to or during working hours, is often prophylactic of plumbism. Lead salts dissolved in drinking water may form a bicarbonate or be converted into the diffusible chlorid. In some lead plants the employees are given a pint of milk or cup of cocoa with bread for a simple breakfast before beginning work, which has been found a good preventive of lead poisoning, at least, in so far as it might be acquired through swallowing instead of through dust inhalation. This is especially important for foreign workmen, who often have been accustomed to breakfast in the middle of the morning instead of before beginning work. Experiments made by Sir Thomas Oliver with a dialyzer showed that neither bile nor pancreatic juice alone aids the solution or diffusibility of lead carbonate. Hence it seems probable that, if lead fails of conversion to the chlorid in the stomach, it is not likely to be absorbed from the intestine, but is probably eliminated quite unaltered in the stools.

According to Mr. Kenneth Goadby (*Jour. of Hygiene,* vol. ix, no. 1, April, 1909), the solubility of lead salts in the gastric juice varies so much that the sulphate is almost twice as soluble as the carbonate and oxid. It is a popular notion among lead workers that a weak sulphuric acid lemonade, slightly sweetened, drunk in the workshop, causes solution of any lead which may have entered the system, and hence favors its elimination. Large quantities of fluid of any kind, such as beer, may aid in flushing the kidneys and

alimentary canal, but there is no special advantage in the sulphuric lemonade. On the contrary, continued use of such acid, even though it be in weak solution, tends to impair digestion and corrode the teeth.

Sir Thomas Oliver, in his Goulstonian lectures in 1891, pointed out that "lead carbonate which is inhaled as dust into the pulmonary alveoli is moistened by fluids rich in carbonic acid coming from the lungs, whereby the lead carbonate becomes converted into bicarbonate, which is fairly soluble." A similar change he suggests may take place in inhaled fumes of molten lead.

Litharge or red lead is heavier as a powder than white lead, and when inhaled experimentally by animals gives rise to expulsive reflexes such as sneezing and coughing. Other authorities hold that in the body lead or its compounds in contact with albumin and the various secretions, either acid or alkaline, form soluble albuminates which are readily absorbed, mainly by the lymphatic system, but also by the bloodvessels.

Prof. L. Devoto, in an essay on vascular and renal changes in saturnism ("Le alterazioni dei vasci, dei reni e delle articolazioni nel saturnismo chronico," 1911), finds that in some cases there is a preceding hyperchlorhydria, in others a chronic gastric catarrh which causes ventricular atony. Either of these conditions may favor the absorption of lead when swallowed. The elimination of lead through the kidneys, he states, causes vasoconstriction with retardation of functional activity. This results in augmenting the uric acid in the blood, causing uricemia. In time a chronic indurative nephritis develops with moderate albuminuria and arteriosclerosis. The pathological changes are thus linked together in a natural sequence as follows: gastric catarrh and atony, renal irritation with vasoconstriction and uricemia, albuminuria and anemia, vascular hypertension, arteriosclerosis and cardiac hypertrophy. The vascular and blood changes result in arthritic and nerve lesions with atony and paresis of muscles. In some cases the uricemia results in the manifestations of gout, the sequence of events being: renal irritation, vasoconstriction, fibrosis of the kidney, retention of uric acid, and finally production of gout. Devoto thus regards chronic saturnism

as a dyscrasia combining catarrh of the stomach, nephritis, articular irritation and gout.

According to Preti, writing of the catalytic action of lead upon the uropoietic system, lead behaves as a substance which disturbs the uropoietic fermentative functions, i. e., the uric acid formation, rather than by acting solely upon its elimination when formed through the kidneys. This he terms an endogenous uricemia, originating in functional chemotaxic change, in distinction from a purely exogenous influence acting by inhibiting uric acid elimination after it is produced. Probably the discussion should include not solely uric acid, but the other products of proteid waste.

Straub (*Deutsche med. Woch.*, August 10, 1911) experimented in animals with subcutaneous injections of insoluble lead salts such as the carbonate and sulphate. Minute particles from time to time were absorbed and finally produced toxic symptoms of the central nervous system, but no excessive accumulation of lead was found in the organs most affected.

Sir Thomas Oliver, in most of his personal cases which came to autopsy, found lead in the liver, kidneys, muscles and brain. In the brain in one instance as much as 99.7 milligrams was found, and 17.4 milligrams in the cerebellum, although usually only a mere trace is to be detected.

In the kidney, in chronic plumbism, there may be atrophy of the connective tissue and glomeruli with hyalin degeneration of the vessels. In general the renal lesions of chronic nephritis are those of chronic interstitial nephritis, but acute plumbism, as when a victim dies from inhaling concentrated lead fumes, may present an acute parenchymatous nephritis. Temporary albuminuria may appear in connection with each successive attack of lead colic in the same patient.

Heubel gave dogs various lead salts, and on analyzing their organs found it stored chiefly in the kidneys, liver and bones, very small traces only being observed in other organs or in the blood.

Lead is deposited in the gums, and more rarely in the mucous membrane of the lips.

It was for a long time taught that lead exhibited a selective action

for certain groups of muscles which become paralyzed with greatest frequency. There is a modern tendency, however, to explain the matter on Edinger's exhaustion theory. This is that certain toxins have a general depressing effect upon the nerves and muscles of the whole body, and when fatigue or exhaustion from overuse of any group of muscles or any special nerves occurs in addition, these particular groups first show the influence of the poison. Teleky has pointed out (*Deutsche Zeitschrift für Nervenheilkunde,* 1909, xxxvii, 234-304) that painters suffer most from paralysis of the pronators and extensors of the hands, muscles which are much used in their trade.

In other trades similar relationship to overuse of particular groups of muscles may be shown. This is a plausible theory, but is open to so many exceptions that it should not be too readily adopted. Thus Oliver has reported cases of "drop-foot" in painters (*See* Fig. 43, page 252), as well as "drop-wrist," and the latter symptom may occur in other types of lead workers who do not exhaust any one group of muscles by special use. Fatigued muscles, it is well argued, are more likely to retain their waste products, thereby possibly weakening their nerve endings and ultimately impairing their nutrition. It must be admitted that in porcelain painters, for example, and others whose trade requires constant use of the long extensors of the fingers and the thumb muscles, it is these muscles which show early and most extensive atrophy. The main objection to the theory is that in many lead trades requiring excessive use of one hand both hands or arms become almost simultaneously paralyzed. The paralyzed muscles gradually waste and the reaction of degeneration is present. The nerves of the affected muscles show the lesions of interstitial neuritis with increase of the connective tissue framework and degeneration of the fibers, and it is the belief of Oliver that in the paralyzed limbs "the lesion is primarily started in the nervous system, which is the more vulnerable." In support of this view are researches of Bernhardt which show that, weight for weight, the muscles in lead poisoning contain less lead than other organs of the body, and that the paralyzed extensors contain no more than the unaffected flexors, and "there is nothing to prove that lead has a

special predilection for any particular muscle or group of muscles." (Oliver.)

Vulpian has attributed the radial nerve paralysis of plumbism to degeneration and atrophy of the ganglion cells of the spinal cord, but such lesions are rarely to be found.

The encephalopathy arising from chronic lead poisoning has been much discussed. Harnach, as well as Sir Thomas Oliver, on the strength of autopsy findings which revealed traces of lead in the brain, inclines to attribute the direct cause to lead. Traube advocates the uremic theory, as in the cerebral cases the kidney functions are also disturbed. Others, like Rosenbaum and Heubel, believe the anemia to be the important factor. It would seem, however, that arteriosclerosis and degeneration of the cerebral vessels, restricting the normal brain circulation, are a sufficient explanation.

According to Oliver, the organs of those dying from acute lead encephalopathy may appear normal to the naked eye, but the brain may be pale and edematous as it is in uremia, or it may be pale, firm and shrunken. In one of his cases the dura mater was adherent in part and there was an excess of subarachnoid fluid. Sir William Gowers believes that a peculiar chemical reaction takes place, lead replacing some of the hydrogen in the brain tissue.

F. W. Mott has reported ("Arch. of Neurology and Psychiatry," 1910) the pathological findings in a case of chronic encephalitis due to plumbism. The brain showed disseminated punctate hemorrhages filling the perivascular spaces, resulting from both arterial and venous vascular degeneration. There was also considerable neuroglia increase in both gray and white matter of the cortex. The patient had been delirious and his symptoms and post-mortem findings simulated dementia paralytica. No lead could be found in the brain. Sicard and Bloch have reported a similar case observed in France with symptoms of dementia paralytica. They obtained a positive Wassermann reaction from the spinal fluid.

Duration of Retention of Lead in the System.—In chronic lead poisoning it seems that often a long duration of poisoning is a more potent factor than a large quantity of poison; for its effects certainly, if not its substance, are strongly accumulative. Very little

lead, not more than $\frac{1}{6}$ grain, if absorbed daily, before long gives rise to toxic symptoms.

Oliver states that lead has been found in the urine, feces and vomitus of patients with chronic saturnism 16 months after quitting work in lead. In rare cases lead may remain for years in the system and then be liberated owing to some subtle change, giving rise to more or less acute and definite symptoms. The administration of potassium iodid may be the causative factor of this phenomenon. Oliver cites a case in which lead symptoms reappeared 17 years after a previous attack, and another, that of a painter, in which the interval was 18 years since lead had been handled. He also cites the remarkable case of a patient who, as a girl of 19 years, had lead colic, blindness and paralysis. She recovered, quit work, married, and bore several children. Seventeen years later she complained of diplopia, headache and ocular paralysis, and lead was found in the urine. He explains the phenomenon on the ground that some unknown change in metabolism suddenly liberated lead which had long been stored in the system and gave rise to the return of acute symptoms.

In further illustration of long retention of lead in the body in toxic amount is the case of a woman of 46 years who came to the Cornell service in Bellevue Hospital with a history of having had double wrist-drop 5 years before, after painting some furniture with white enamel. There had been no opportunity since that time for exposure to lead poisoning, yet when seen the patient had a decided lead line on the gums, granular basophilia, abdominal colic and partial wrist-drop.

The *causes of death* from plumbism are various. In acute cases, as from inhaling concentrated lead fumes, the victim may die from suffocation, paralysis of the heart or acute parenchymatous nephritis. In chronic cases death may ensue from lesions incident to arteriosclerosis such as cerebral hemorrhage, aneurysm, etc., from uremia and convulsions consequent upon chronic interstitial nephritis, and more rarely from progressive anemia and emaciation, or from encephalitis. In many chronic cases death results from some intercurrent disease acting in conjunction with the patient's weakened

resisting powers incident to the chronic nephritis and advanced arteriosclerosis. Dr. Mosny, of Paris, has described subarachnoid hemorrhages, and lead may be found in the brain substance.

Symptoms.—The symptoms of lead poisoning are most often chronic, but may be subacute or very acute, according to the particular form of poisoning. Dr. Hamilton states that the most acute case she has known was that of a white lead worker who became poisoned in three days.

Acute poisoning has occurred exceptionally among workmen suddenly exposed to overwhelming doses, as when a cask of red or white lead is accidentally broken, enveloping the workman in dust, or when a back-draft drives fumes of molten lead into his face. In such cases he may die from asphyxia (*See* page 144), or pulmonary edema (*See* page 154).

The symptoms of chronic lead poisoning may advantageously be summarized in brief before detailed consideration. The most striking are: abdominal colic, paralyses of the hands and forearms, or "drop-wrist," increased blood pressure, a lead line in the gums, constipation, anemia, and granular basophilia. Other symptoms are: a fixed, drawn expression, light jaundice, the presence of lead in the urine, sometimes alimentary dextrosuria, levulosuria and hematoporphyrinuria, dyspepsia, increased tendon reflexes, vertigo, nausea, a metallic taste in the mouth, and finally emaciation.

Prodromata.—Acute attacks of lead colic usually are preceded by marked gastro-intestinal disturbance. The patient complains of malaise, a coated tongue, foul breath, constipation, nausea or discomfort after eating, and headache. All these symptoms, in fact, may proceed from a catarrhal gastritis and constipation.

Lead Cachexia.—When patients have recurrent acute attacks, as painters very often do, with intervals of months or years, they usually become cachectic, with a yellowish, pale complexion, coated tongue, dyspepsia, moderate secondary anemia, often granular basophilia, chronic moderate albuminuria, gradually hardening arteries and moderately increased arterial pressure. There are also intermittent neuralgic pains in the joints and nerves and progressive emaciation. (Fig. 40.) The breath is foul, the tongue constantly



Fig. 40.—Chronic Lead Poisoning with Double Wrist-Drop and Extreme Emaciation. This man was slowly recovering at the Cook County Hospital from an almost fatal illness involving intestines, heart, and kidneys, caused by lead poisoning. He had been a house-painter for 35 years. (From the *Report* of the Illinois State Commission on Occupational Diseases, Jan.. 1911.)

coated with white fur, there is either a sweetish or metallic taste in the mouth. There may be caries of the teeth and gingivitis is usually present in chronic cases. The gums, which are of purple hue, may bleed readily and are so retracted and everted as to make the teeth appear longer. The soreness of the teeth and gums may prevent the patient from eating sufficient solid food. Anorexia is often present, favored by a foul condition of the mouth and tongue and dyspepsia.

Lead Colic.—Lead colic is a very typical phenomenon which has received a variety of explanations. Sollman's theory is that the intestinal terminal nerves are stimulated by lead to cause undue muscular contraction, which is of the nature of continued spasm rather than a typical peristaltic wave. This exaggerated contracture results, he believes, in compressing and emptying the splanchnic vessels, which in turn raises the general arterial pressure and causes the local intestinal muscular spasm. In a further stage of intense colic, however, the pain, like all excruciating suffering, lowers the general blood pressure and almost completely inhibits the action of the heart. Both atropin and such vasodilators as the nitrites and chloral tend to relieve the colic, which fact affords some confirmation of Sollman's theory. On the other hand, Sir Thomas Oliver found, by injecting a solution of lead nitrate of a strength of 1 to 10 per cent. into the veins of dogs, that the general arterial pressure invariably fell, and with the larger doses the heart action gave out, but without immediate paralysis of respiration.

The colic is accompanied by restlessness and jactitation, the patient flinging himself about in bed or rolling on the floor in the vain hope of relief by change of position. The abdominal wall, especially the lower half, is tense and retracted. Many patients feel relief by firm pressure over the abdomen, but others will not tolerate any pressure, and, in fact, become hyperesthetic. The pain is relieved for a short time by movement of the bowels.

Attacks of lead colic are very often recurrent at intervals. After a first attack is recovered from the workman for a time heeds preventive warnings, but later becomes careless again, and accumulative absorption of the poison brings on another attack. Oliver refers to

a man who had 15 attacks in 10 years, and several of my patients gave a history of as many.

Attacks of colic are accompanied by most obstinate constipation, increase of pallor and arterial pressure and absence of perspiration—indications of vasomotor spasm. There may be accompanying strangury, and the abdomen is hard, retracted and often tender in the umbilical region, which is usually the chief focus of the pain. There may be accompanying cramps in the calves of the legs, and dyspnea, because movements of the abdominal muscles and diaphragm intensify the pain. Potain describes an accompanying contracture of the liver, but, owing to the abdominal rigidity, this is difficult to determine with accuracy; and, on the contrary, L. Devoto and L. Carozzi, of the Milan Hospital for Industrial Diseases, find that the liver usually is considerably enlarged.

Oliver has observed a unilateral predominance of abdominal pain in some cases, with tenderness to pressure of the vagus nerve and pupillary contraction on the same side. These phenomena I have never witnessed. Most patients describe their pain as central (umbilical), radiating bilaterally.

The percentage of lead colic is given very diversely by different authors, being all the way from 2.7 per cent. (Cosolo, of Trieste) to 30 per cent. (various British records). Among 43 cases reported to the New York State Department of Labor it was conspicuous in 29. In a series of 64 of my cases it was present in 45. It may be said, however, that practically all patients with chronic plumbism sooner or later have an attack of colic, whereas in many the attacks are numerous and constitute the most striking feature of the case.

The urine during lead colic attacks is very much reduced in volume, and often presents a faint albumin reaction and a few hyalin casts. After many attacks of colic the victim usually begins to show evidence in the urine of a chronic interstitial nephritis. Indicanuria is usually present during the attacks, as it is in constipation generally.

Tympanites often accompanies the chronic constipation, and especially the attacks of colic. There is often much soreness to the touch over the tense abdominal wall. Pallor of a yellowish white

hue is due both to anemia and vasomotor spasm. A slight subicteroid hue may be present.

"Burtonian Line."—The blue line, first described by Burton and hence called the "Burtonian line," is most decided upon the margin of the gums anteriorly and close to the teeth. It is a deposit, just beneath the surface, of lead which has been converted into a black sulphid by contact with sulphuretted hydrogen or such other sulphur compounds as are derived from certain proteid and vegetable foods, such as eggs, cabbage, etc. The fine lead granules are held within the large connective tissue corpuscles at the margin of the gums, in which they may be deposited by phagocytes, or into which they are absorbed when lead dust enters into the mouth, or lead previously absorbed may be resecreted by the salivary glands as a sulphid formed by the sulphocyanite of the saliva. Possibly, also, bacteria of decomposition lodged upon proteid food between the teeth may furnish the necessary sulphur for the lead sulphid (Oliver). Bedson has found traces of lead in the saliva, as well as in the gastric secretion, some time after the patient had ceased working in lead.

The lead line persists often for months and sometimes a year or more after cessation of work in lead. Toothless areas do not present this blue line, but, exceptionally, the buccal mucosa and more rarely that of the tongue may present bluish black deposits of lead sulphid, perhaps a centimeter in diameter. I have seen them most often on the inner surface of the lower lip. They usually occur in portions of the lip or cheek mucosa opposite a decayed tooth.

The frequency of the presence of the lead line is given by various authors as observed in from 10 per cent. in Italian records to 37.7 per cent. in Belgian records. In 43 cases reported in detail to the New York State Department of Labor it was observed 17 times. In a series of 64 of my cases 33 had a more or less distinct blue line. It is not usually observed short of at least six months' exposure to lead poisoning. It occurs quite independently of attacks of colic and is often observed in lead workers who have not themselves been aware of any symptoms of plumbism.

Gingivitis.—There is chronic gingivitis and the gums at the margins of the teeth become at first swollen, and then retracted so as to make the teeth, which are blackened, appear much elongated. A bluish film appears on the gums of those who have worked for some hours in lead fumes or dust. It is paler than the true "blue line," and, being wholly superficial, may be washed off easily.

Metallic Taste.—A metallic taste with a coated tongue is often complained of and gives rise to anorexia. Oliver states that the physiological sulphocyanite reaction observed with normal saliva is temporarily absent during attacks of lead colic, but this is a phenomenon of no clinical importance.

Heart.—The heart is often hypertrophied as a result of the increasing arteriosclerosis and high tension pulse. C. Lian and E. Marcovel, in *La presse médicale,* Feb., 1913, reported four cases of bradycardia in connection with lead colic. The atropin test indicated that the poison acted on the vagus nerve and its terminals in the heart.

Blood Examination.—A moderate secondary anemia is the rule in chronic lead poisoning. The hemoglobin usually falls to 75 or 85 per cent., but I have records of 50 per cent. The red cells are not often found to fall below 4,000,000, and are often 4,500,000 or more. Some of my records show a count above 4,700,000, and a few below 3,000,000 in advanced plumbism. The leukocytes are usually, but not always, somewhat increased. In 9 out of 17 of my cases selected for comparison the differential count placed the leukocytes above 12,000, the maximum being 17,300. The polynuclear count varied from 60 to 76 per cent., and the lymphocytes from 17 to 28 per cent.

A slight eosinophilia is sometimes present. The red cells become filled with the dark, fine granules which stain with basic anilin. These granular basophiles are often present in chronic lead poisoning. Among my cases of plumbism in special examinations of the blood, made in 25 persons, basophilia was observed 17 times. Biondi believes that the granules which may appear intermittently indicate new cell formation. They may number from 0.03 to 0.3 per cent. or more. In one of my cases they reached 1.8

per cent. If present in less than 0.01 per cent., they are of little diagnostic significance.

According to P. Schmidt, at least 100 out of 1,000,000 red cells must contain basophilic granules and a count of as many as 300 to 3,000 is usual in lead poisoning.

From the point of view of prognosis, their presence is favorable and absence unfavorable, but it is important to make repeated examinations, owing to their intermittent presence. Much depends, also, upon the skill of the observer, and it should be remembered that basophilia has been observed occasionally in malaria, carcinoma and tuberculosis. Nevertheless, taken in connection with other symptoms of chronic plumbism, the test is not without value.

L. Devoto and L. Carozzi, of the Milan Hospital for Industrial Diseases, regard both the polychromatophilia and granular basophilia as a sign of hematopoietic reaction against the poison, and to that extent it is favorable. They record basophilia as reaching 1.74 per cent.

Urine.—Authorities differ strangely as to the frequency with which traces of lead are demonstrable in the urine in chronic cases. Oliver believes the test to be very often positive, and consequently of great value. My own experience accords with that of many French and German writers, who find it very infrequently.

Albumin and granular and hyalin casts are very often found, and sooner or later the victim of chronic lead poisoning usually gives evidence of a chronic interstitial nephritis. Of 44 painters examined in 1910 by the Illinois State Commission for the Study of Occupational Diseases, 14 were found to have advanced chronic nephritis.

Feces.—Lead is sometimes eliminated by the feces long after the patient has ceased to be exposed to the risk of swallowing it, indicating that it may be eliminated by the bile or intestinal mucosa. J. Rambousek and Pieracci claim that it is more often to be found in the feces than the urine.

Weight.—Loss of weight is a marked feature of many cases of lead poisoning, usually of those which have obstinate constipation with attacks of colic, nausea and vomiting, or which develop a

marked secondary anemia. One of my patients, a painter who had chronic plumbism for 8 or 9 years, lost 56 lbs. in 5 years; another, also a painter, 52 lbs. in 18 months; one lost 12 lbs. in 6 months; one, 17 lbs. in 3 months, and one, 10 lbs. in 2 months. The face and neck particularly become thin, and the muscular atrophy may account for part of the loss of weight.

Fever.—Fever is a symptom not usually recorded in connection with acute exacerbations of plumbism, and Karl Wächter states positively that it does not occur, yet in my experience it is very common. It is apparently due to autotoxemia from chronic constipation, and usually accompanies attacks of colic. The temperature rises to 100° or 101° F.—the highest I have met with was 102.5° F.—and lasts from two to five days usually. One of my patients had a temperature which rose to 102° F. during 10 days, and slight fever was present in 13 cases during attacks of colic.

Diarrhea.—Diarrhea is very uncommon in chronic lead poisoning, but I have observed it in few cases, alternating with constipation. In such cases, moreover, the patient is often an alcoholic subject, so that the irregularity of the bowels may be due in part to that complication.

Facial Expression.—Facial expression changes in chronic lead poisoning. The muscles appear drawn and the expression is somber. The general pallor is particularly marked in the face and there are dark lines under the eyes. (Fig. 41.)

Effect of Sulphur Baths.—If a lead worker take a sulphur vapor bath or a fluid bath impregnated with potassium sulphid, the skin becomes blackened superficially by lead sulphid. Minra has shown, however, that the test applies only over portions of the skin which have been exposed to lead dust or solutions and not protected by clothing.

Wassermann Reaction.—The Wassermann reaction has been observed in non-syphilitic cases of chronic lead poisoning, according to Dreyer and Schnitter as reported in the *Deutscher medizinische Wochenshrift,* 1911, Nos. 17 and 22, but Robert Hilgermann, of Coblenz, writing in the same journal, 1912, No. 38, states that in



FIG. 41.—CHRONIC LEAD POISONING WITH WRIST-DROP AND PREMATURE SENILITY. This man was only 52 years old and had been totally disabled for 6 years. He was a painter for 20 years. (From the *Report* of the Illinois State Commission on Occupational Diseases, Jan., 1911.)

35 cases examined he was unable to retain the reaction in anyone. A positive reaction was obtained in several of my cases in which syphilis could be excluded.

Dr. Cyrus W. Field, of the Pathological Laboratory of Bellevue Hospital, reports (*Jour. Amer. Med. Assoc.*, June, 1912) obtaining a positive Wassermann reaction in 8 out of 12 cases of lead poisoning examined. In at least 5 of these syphilis could quite definitely be excluded.

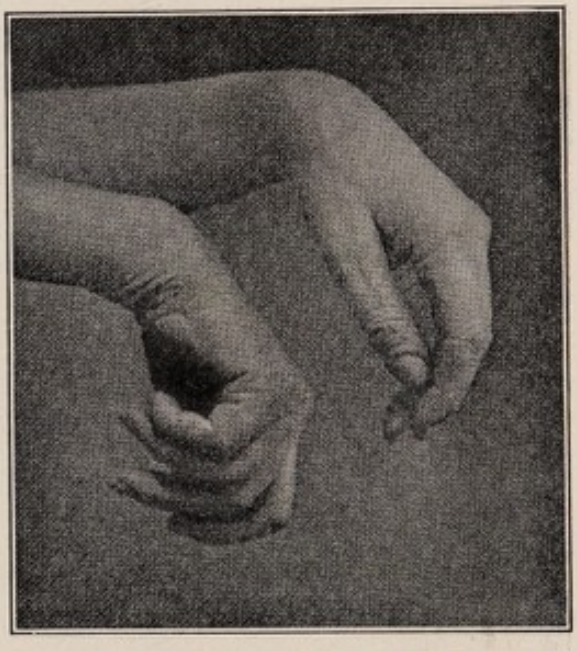


FIG. 42.—DOUBLE "WRIST-DROP." Hands of workman paralyzed for sixteen years as result of lead poisoning. Five of his fellow workmen were killed by lead poisoning before they were forty. Victims of lead poisoning are not compensated under American laws because technically an occupational disease is "not an injury." (Courtesy of Dr. John B. Andrews.)

Cuts and abrasions heal poorly in the subjects of chronic lead poisoning and furunculosis is common among them.

NERVOUS SYSTEM.—In chronic lead poisoning an important group of symptoms is referable to the nervous system. Such are cephalalgia, impairment of vision, abdominal colic and peripheral neuritis, lack of energy and impairment of ability for work, psychasthenic symptoms and encephalopathy. Headache, vertigo and tinnitus aurium frequently are complained of.

Lead palsy typically involves first the extensors of the third and fourth fingers, soon involving the extensors of all the fingers and wrist. The supinators usually escape. The hand thus falls, when the arm is raised at right angles in ulnar abduction, as shown in Figure 42.

The triceps, biceps, brachialis anticus and deltoid muscles are very often paralyzed, and sometimes, also, the supra- and infra-

spinatus. Exceptionally the quadriceps of the legs and the extensors of the foot and toes may be paralyzed. (Fig. 43.) The paralysis rarely has involved the muscles of the larynx, causing aphonia, and the diaphragm. In exceptional cases lead paralysis has been known to involve the muscles of the eyes. Sir Thomas Oliver cites 3 cases in which a rare form of paralysis *en bloc* ensued, i. e., in which all the muscles simultaneously became paralyzed, the patient lying helpless, unable to move or even to masticate or swallow. The rapidity of recovery in two of these cases suggests a very acute toxemia with possibly an hysterical element added, but there are recorded cases of death from paralysis of the respiratory muscles.



FIG. 43. — "ANKLE-DROP," TYPE OF LEAD PARALYSIS. (From Sir Thomas Oliver, *Bulletin No. 95* of the U. S. Bureau of Labor, July, 1911.)

The typical case of lead paralysis is unquestionably the double wrist-drop (Fig. 44), in which the victim is unable to grasp an object, button his clothing or feed himself, but one meets with many varieties, as above described.

Contractures in various groups of muscles may occur. One of my patients, a painter who worked with white lead paint, complained of attacks of cramp in the fingers of the right hand. He was saturated with lead, which was obtained from the urine. He had handled paint for 20 years, and it is quite possible that the cramp was an occupation neurosis rather than due to plumbism, for there were no symptoms of neuritic pain or palsy in the arm or hand.

Muscular pain and soreness, quite distinct from neuritis, some-

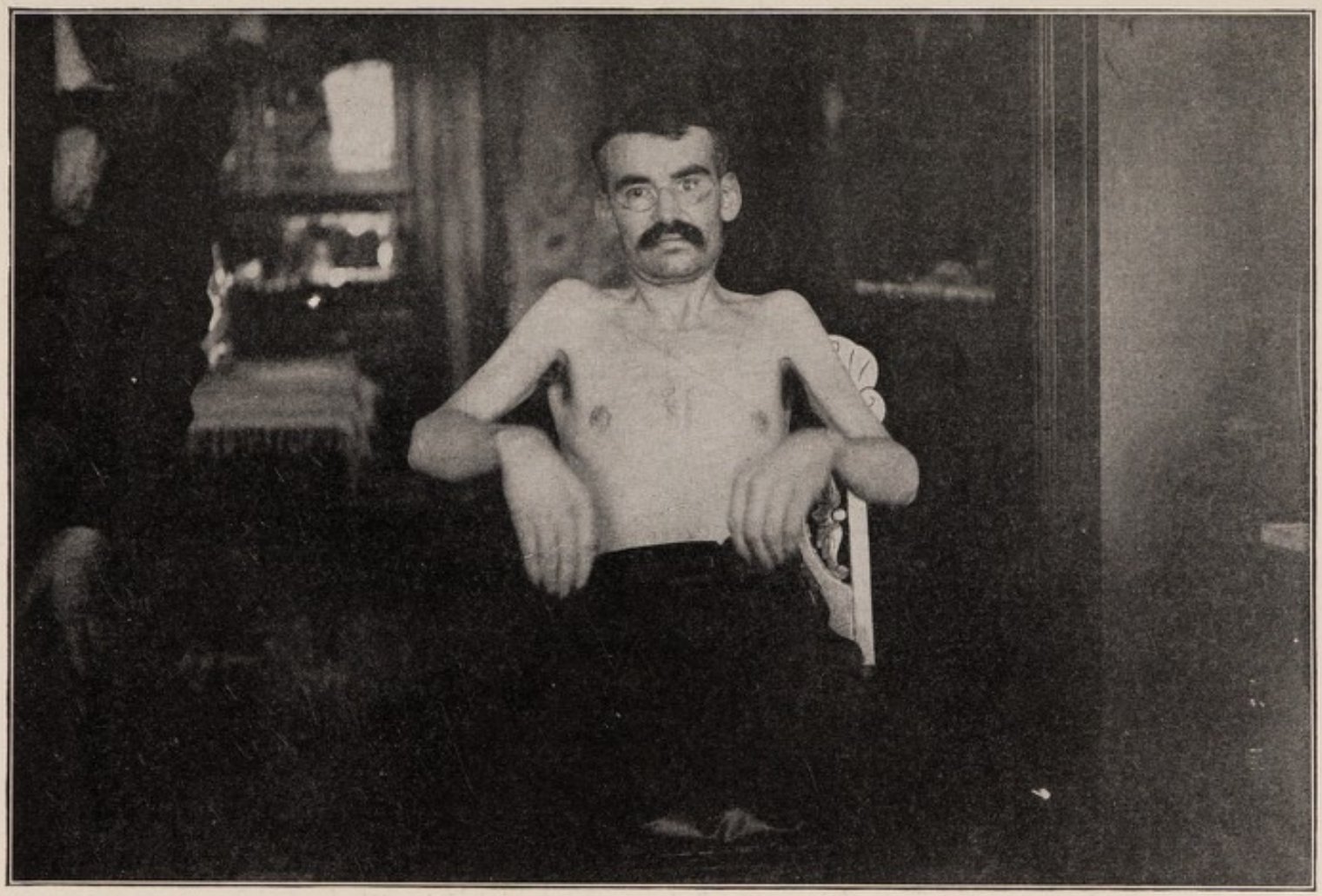


FIG. 44.—CHRONIC LEAD POISONING, WITH DOUBLE WRIST-DROP AND EMACIATION. This man was a painter for 25 years in Germany; weighed 205 lbs. when he came to America. After 1½ years' work here, part of the time sand-papering lead paint, he was severely poisoned. Weighs now 155 lbs. (From the *Report* of the Illinois State Commission on Occupational Diseases, Jan., 1911.)

times may be demonstrated in chronic plumbism, particularly in painters.

Pains in the joints, especially the elbows, wrists, shoulders and knees, are often present, and I have known them to be mistaken for ordinary rheumatism. The joints become painful with both active and passive motion and may be slightly swollen.

Lumbago also is common.

The *reaction of degeneration* appears after a time in the paralyzed muscles, but with prolonged muscular atrophy all electric reaction is greatly diminished or almost absent.

Neuralgic pains in various nerves are common. I have observed this symptom in the nerves of the face, back and shoulders.

Paresthesia or *dysesthesia* is not uncommon. There are frequently sensations of prickling, burning, or numbness in the fingers, and sometimes in the legs. Such abnormalities usually, but not always, are coincident with muscular weakness.

The *reflexes* are more often diminished than increased. I have several times found the knee-jerk entirely absent, and only once decidedly increased.

Tremors of the labio-facial muscles are common, and are best demonstrated by asking the patient to show the teeth or make grimaces.

Spinal Cord Symptoms.—Comparatively little has been written regarding spinal cord lesions in chronic saturnism, most of the nervous symptoms being referred to the peripheral nerves and brain, but H. Eichhorst (*Med. Klinik,* Feb. 9, 1913) has described a case of spastic spinal paralysis in a house painter. In two other cases he found multiple sclerosis of the cord and brain.

Cerebral Symptoms.—Lead produces, exceptionally, a considerable variety of cerebral symptoms, both acute and chronic. They may be of the nature of hysteria, delirium, convulsions, or paralytic dementia. The acute forms especially are much more liable to affect young subjects, especially females. *Saturnine encephalopathy,* as the cerebral form of lead poisoning is called, more often attacks women than men. It is usually preceded by severe headache for some days, when the patient may have sudden convulsions followed

by coma, often fatal within two or three days. There is almost complete anuria, and there may or may not be albuminuria. If the patient survive, he may have temporary or permanent blindness from neuroretinitis.

This strange type of poisoning occurs without the other more usual manifestations of lead toxemia such as neuritis or colic. Oliver states that he has seen it in young women not nephritic and who were not alcoholic, and he cites one fatal case in a young woman who had worked in a white lead factory only five weeks. M. Mosney, of Paris, attributes the symptoms to an acute meningo-encephalitis. In some cases a sort of toxic hysteria precedes the other symptoms.

This type of plumbism is rare in this country. With a considerable experience with all other forms of lead poisoning, I do not recall a case in which the cerebral symptoms could not have been accounted for by either alcoholism or uremia, or both, and such cases certainly are rare in the literature in the United States. Dr. Hamilton was able to collect histories of 52 cases, and two or three more have recently been reported to the New York State Labor Bureau. Her 52 cases "were divided by trades as follows: pottery workers (11 women, 5 men), 16; white and red lead (men), 13; enamelers (men), 10; painters (men), 9; printers (men), 2; glass-worker (woman), 1; paint mixer (man), 1."

In England and France, however, women are much oftener employed in various lead manufactures than in this country, and as they are peculiarly susceptible to saturnism this may account for the greater frequency of encephalopathy among them as compared with males.

In Italy lead encephalopathy is so rare, at least in chronic form, that the asylums for the insane have recorded no new case for several years. If recovery takes place, temporary or permanent blindness may result. In the fatal cases lead has been found in the brain as well as in other parts of the body.

The psychoses which accompany encephalitis are not to be regarded as other than phenomena of a dementia paralytica; that is, the so-called "lead insanity" is not a separate entity, but results from ordinary vascular degenerative changes in the brain. The

delirious patients may have maniacal raving, alternating with coma and epileptiform convulsions. There may be aphonia, amblyopia and amaurosis.

In *lead meningitis* lumbar puncture may show an increased pressure of the arachnoid fluid with lymphocytosis. There are severe, persistent headache and delirium, sometimes with vomiting, bradycardia and paralyses.

Lead blindness may be temporary or permanent. It is a much less common symptom than with certain other poisons. It may be due to optic neuritis or neuroretinitis, or to more transient conditions. Retinal hemorrhages are observed, and the eye fundus should always be examined in cases of chronic saturnism. The hemorrhages occur sometimes independently of any renal lesion, and may be due to direct irritation of the retina by lead particles, or, according to Leuber and Deutschmann, to the conveyance of lead molecules from the subarachnoid spaces of the brain to the sheath of the optic nerve. The optic disc may atrophy.

The area of blindness may be complete or partial. The muscles of the eyeball may become paralyzed, causing diplopia.

Menorrhagia.—Women workers in lead frequently suffer from menorrhagia.

Abortions and Miscarriages.—Oliver found that married women who formerly were permitted to work in white lead production almost invariably miscarried, or bore stillborn infants, or infants that died at an early age of convulsions. It was this circumstance which attracted his attention to the hazards of lead work and led to the admirable investigations which in England have resulted in so much beneficial parliamentary control of the entire lead industry. In the stillborn infants Professor Bedson determined traces of lead in the kidneys and liver.

Of 141 pregnant women who worked in lead factories in France it was found by Constantin Paul that 82 aborted, 4 gave rise to premature births, 5 to stillborn infants. Of the 50 infants born living at term, 35 died within two years. Thus only 15 children of 141 pregnant women lived beyond the third year.

In the French Department of Labor *Report on Industrial Poi-*

sons, made by M. Tardieu in 1905, among 1,000 pregnancies in lead workers, 609 terminated in abortion.

Sterility.—Males having chronic lead poisoning, although not impotent, often become sterile. P. Rudaux (*La clinique*, Jan. 21, 1910) found that among the wives of 75 lead workers having 442 pregnancies there were 66 abortions and 241 miscarriages.

Children of Lead Workers.—Oliver found that of the children of paint grinders, "40 per cent. die of convulsions during the first year of life."

Lead has been found in the placenta as well as in the internal organs of the offspring of toxic mothers. Idiocy and infantilism have frequently been observed among the children of lead-poisoned pottery workers.

In the Harz Mountains, among the lead smelting works, it has been found that cows, sheep and hares that graze in pastures near where the lead fumes are given off acquire hematuria and miscarriages (Oliver).

Associated Diseases.—Tuberculosis.—It appears to be everywhere the case, not only in this country but abroad, that the mortality among typesetters from tuberculosis is very high. The increasing use of linotype machines is making some improvement, for except in the lead melting process, which is occasional, not constant, work, the linotypist handles less dusty material. Statistics gathered by George A. Stevens, of the New York State Labor Bureau, show that during the semi-decade, 1901-1905, compositors died from tuberculosis in both New York City and State in double the ratio of the male population in general. As they are an intelligent lot of workmen and command good wages, this death cannot be attributed altogether to deficient home sanitation and must be due in great part to conditions in the composing room. In New York City, moreover, in 1905, the death rate from respiratory diseases was more than double that of Germany, where precautionary measures of sanitation have been in force for compositors for 15 years.

In a group of over 300 typesetters, printers and lithographers treated in the Milan Clinic, in 1910-11, there were 123 cases of respiratory disease, of which 56 were tuberculosis, 14 were cases of

pleurisy, 21 of arthralgia, 38 of diseases of the circulation, 31 of renal disease, 32 of the nervous system, 88 of the digestive system, 82 of liver diseases, 3 of diabetes, and 32 of chronic lead poisoning.

Gout.—Garrod has stated that one-fourth of all cases of gout are to be met with among lead workers, and in those parts of England where gout is very common it is very often associated with lead poisoning. Although, as many lead workers are drinkers, possibly there is some degree of accidental coincidence in this association, and Oliver points out that from difference in habit or climatic conditions lead workers in the north of England rarely suffer from gout. He found that the elimination of uric acid and of lead is inversely related.

A review of the cases of lead poisoning met with in the Johns Hopkins Hospital during a dozen years showed that about half of them, it was claimed, were associated with gout. My personal experience has been very different. I meet with many cases of true tophaceous gout among the laboring classes, and many of lead poisoning, but rarely find both diseases in the same patient. In a series of 64 of my cases of plumbism gout could be determined positively only in 5.

Insanity.—Dr. Robert Jones, reporting in 1900 upon 3,500 males admitted to the London County Asylum for the Insane, found among them 133 artisans who had been exposed to plumbism as follows:

"Painters	75
Decorators	13
Plumbers	18
Gasfitters	13
Laborers in lead works	6
Grainers	3
Gasmeter makers	2
Color grinder	1
File cutter	1
Tea-lead roller	1
Total	133

"Of the 133 cases the following is the analysis of their mental condition:

"Mania	37
Melancholia	33
Dementia	19
Dementia with epilepsy	10
Dementia with general paralysis	24
General paralysis	7
Alcoholic mania	3
Total	133"

The proportion of general paresis cases is relatively very high among lead workers The following table compiled by Legge in the *Annual Report of the Chief Inspector of Factories and Workshops of Great Britain* for 1909 illustrates the selective action of certain lead industries in the type of plumbism produced:

MAIN SYMPTOMS APPEARING AS THE CAUSE IN 264 DEATH CERTIFICATES OF LEAD POISONING

Industry	Encephalopathy	Bright's Disease	Cerebral Hemorrhage	Paralysis	Lead Poisoning	Phthisis	Pneumonia, Bronchitis, Heart Failure, Colic, Hernia, Aneurysm
Smelting of metals	1	6	.....	3	5	1	1
Brass works	.....	3	.....	1	1	.....	1
Sheet lead and lead piping	.....	1	.....	.....	1	.....	1
Plumbing, soldering	2	3	.....	1	2	1	2
Printing	3	3	.....	2	5	1	3
File cutting	1	11	2	2	2	1	.....
Tinning, enameling	.....	1	.....	.....	1	.....	.....
White lead	13	2	2	4	2	1	3
China, earthenware	8	24	14	3	6	2	.....
Glass cutting	1	6	.....	.....	1	.....	1
Electric accumulators	2	1	.....	1	.....	.....	2
Paints and colors	4	1	.....	.....	2	1	3
Coach making	1	8	5	6	10	3	4
Shipbuilding	1	4	1	.....	1	1	.....
Paints used in other industries	.....	3	1	4	6	1	2
Other industries	1	2	1	.....	11	.....	2
Total	38	79	26	27	56	13	25
Average age at death	32	43	47	43	44	38	40

Records of Personal Cases.—I have records of 268 cases of lead poisoning observed in the past 8 years in my personal service or

that of my colleagues in the wards of the Presbyterian and Bellevue Hospitals, and in my clinics in the Cornell University Medical College Dispensary and Bellevue Hospital Dispensary. In the Cornell Dispensary 25 cases were observed in six months, during the winter season of 1911-12, and were especially studied for me by Dr. Kenney.

One group of these cases, comprising a series of 64, may be taken to illustrate the relative frequency of the various symptoms of plumbism, and some of the cases will also be given in detail. By occupation the 64 cases are grouped as follows:

36 Painters. These were for the most part indoor painters of houses, carriages, automobiles, etc.

5 White lead manufacturers working chiefly in the converting beds.

4 "Scalers," or scrapers of red lead paint, from inside the double hulls of warships in the Brooklyn Navy Yard. These men were not in the service of the navy, but were common laborers employed under contract. They did no painting, but scraped off old paint with automatic chisels.

3 Laborers employed in carrying bars and sheets of lead, etc.

3 Plumbers

1 Lead smelter

1 Steel hardener, using molten lead

1 Wire hardener

1 Paint mixer

1 Laborer employed in handling refuse from a type foundry

1 Electrotyper

1 Enameler

1 Solder caster

1 Designer who moistened his paint brush in his mouth while retouching photographs

1 General mechanic

2 Typesetters

1 Housewife

Of these 64 patients 45 had abdominal colic; 33 had a more or less distinct lead line on the gums; 29 had attacks of nausea and vomiting; 23 had neuritis of the arm, leg and other nerves; 16 had

more or less decided palsy; 19 had chronic nephritis; 13 had slight febrile attacks accompanying the colic; 14 had moderate cardiac hypertrophy, 5 complained of vertigo; 4 of chronic conjunctivitis; 3 of distinct joint pains in the major joints of the extremities; and nearly all had arteriosclerosis. In 25 well-marked cases search was made for granular basophilia. It was present in 17; absent in 8. In a few of the cases the urine was examined for lead, and it was found in 3 cases. In a number of others, although there was almost every other evidence of lead poisoning, it could not be detected in the urine on careful analysis. In many cases the blood pressure was moderately increased; in one it was as high as 217 and, in another, 225 mm. This patient died of cerebral hemorrhage at the age of 45 years. In a large proportion of the cases considerable arterial thickening was apparent. Fourteen of the patients had had two distinct attacks of plumbism, i. e., of acute symptoms; 3 had 3 attacks, and 8 had 4 or more. Among the complications observed in this series of cases were single examples of nocturnal epilepsy (in a painter 43 years of age), emphysema, hemoptysis, hematemesis, tuberculosis (one case only), fatal cerebral hemorrhage and convulsions. Five patients had gout.

As showing the great variability in susceptibility to lead poisoning, the longest period of work in lead was 40 years (3 cases) and the shortest 2 months. One patient had been exposed 34 years; one each for 30, 28, 24 and 22 years respectively, and two for 20 years before serious symptoms compelled them to seek hospital or dispensary relief. In all, 22, or nearly one-third, of the patients had been employed more than 10 years. On the other hand, 6 had been employed less than 6 months, two of them, as stated above, for only two months.

Details of Illustrative Cases.—The following cases present special features of sufficient interest to merit more detailed report:

Case 2.—This case illustrates the onset of symptoms in the lower extremities. The patient was an Irishman, 42 years of age. For 5 months previous to admission to my clinic he was employed handling refuse from a type foundry. The work was indoors, where the air was always heavily laden with metallic dust of lead, zinc and copper.

After 4 months of this work he began to suffer from cramp-like pains in the lower abdomen, occurring more or less irregularly three or four times a day. The attacks were sometimes followed by vomiting, after which pain was relieved. Later they increased in severity and were induced by taking food or drink. A week after the abdominal cramps appeared the patient noticed weakness in his knees and legs. Two or three days later he felt shooting pains in the shoulders and gradually increasing weakness in his shoulder muscles. He next experienced difficulty in raising his hands. There was loss of weight and he was obliged to stop work because of progressive weakness. Becoming unable to walk, he sought relief in a hospital. His blood examination follows:

Red cells	5,744,000
Hemoglobin, per cent.	95
Leukocytes	10,000
Polynuclear cells, per cent.	79

Marked granular basophilia and polychromatophilia.

Case 4.—The patient, aged 48 years, had been a general painter for 18 years. When first seen he had granular basophilia, 4 per cent., albuminuria and considerable gastric disturbance. He had had acute articular rheumatism two years before and several attacks since then. He presented a splenomyelogenous leukemia with a leukocyte count of 270,000, and a very large spleen. Under treatment with the X-ray and Fowler's solution he greatly improved, the count fell to 38,000 and the spleen was reduced in size. Three months after leaving Bellevue Hospital he returned because of pain in the abdomen, dyspnea, and the reënlargement of the spleen, which filled half the abdominal cavity. The leukocytes then numbered 462,000, but the basophilia was only 0.3 per cent.

Presumably the leukemia was independent of the mild grade of lead toxemia.

Case 6.—This man, 30 years of age, had been employed as a general indoor painter for 10 years. He entered Bellevue Hospital in coma with hemiplegia. He had a decided lead line, marked

basophilia, an extreme degree of arteriosclerosis, moderate cardiac hypertrophy, blood pressure 215 mm., and an anemia registering 65 per cent. hemoglobin and 4,400,000 erythrocytes. Chronic nephritis was also present. He died without regaining consciousness.

Case 7.—This man had been a plumber for 24 years, handling both white and red lead. For two years prior to admission to the Presbyterian Hospital he had been constipated after an attack of colic, and for 7 months had tremor of the hands, especially when excited, and a reeling gait. For 6 weeks he had had pains in both knees; for 3 weeks severe pains in both elbows; for two weeks abdominal cramps, vertigo and headache; and for 3 days vomiting. There was slight fever on admission (101° F.), which lasted 4 days. The urine gave 5 per cent. of albumin, granular, hyalin and epithelial casts and red blood corpuscles, and a specific gravity of 1.030. The blood analysis showed on admission:

Hemoglobin	70	per cent.
Red cells	5,900,000	
Leukocytes	17,300	
Polynuclear cells	73.5	per cent.
Lymphocytes	17	per cent.
Mononuclear cells	6	per cent.
Transitional	3	per cent.
Normoblast	1	
Basophiles	0.5	per cent.
Color Index	59	

There was a lead line on the teeth, there was chronic conjunctivitis, blood pressure was 182 mm., and the heart was slightly enlarged. The abdomen was very tympanitic. Note: This case illustrates how a man immune for many years finally had a serious lead colic, lasting three weeks, which he disregarded, keeping at work and eating his lunch in his shop, until after two years more he presented all the classical symptoms of colic, neuritis, joint pains, chronic nephritis, arteriosclerosis with hypertension and cardiac hypertrophy, anemia, granular basophilia and a lead line on the gums.

Cases 9 and 10.—Both these men were painters and had been so employed for more than 25 years. They were among the 5 patients of the series of 64 who had had attacks of gout, which in one case had recurred at intervals for 16 years, and in the other for 10 years. One had tophi in the ears and fingers and the hands were much crippled.

Case 11.—This case, seen in April, 1910, further illustrates the coincidence of gout and plumbism. The patient, an American, 54 years of age, had been a general painter for 35 years. His family history was negative as to gout. He had been a free drinker of beer, porter and whiskey. Eleven years before coming to my clinic he was ill for a week with a serious lead colic. For 10 years he has had two or three attacks a year of gout. The first of these was only in the right great toe joint, but later attacks extended to the ankles, knees, elbows and finger joints. He had lately lost 20 lbs. in weight. On admission there was typical acute gout in both ankles, and there were moderate fever and evidence in the urine of chronic interstitial nephritis. There was no granular basophilia, and the case was rather one of severe gout complicated by a mild degree of plumbism than the reverse.

Case 12.—This patient was 52 years of age, but appeared quite senile. He had been employed for 15 years in stripping the converting beds of white lead. His first attack of constipation, vomiting and lead colic occurred after working for the first nine months, and the second followed 5 months later. Since that time he had had numerous attacks, but after recovery always resumed work. He presented a spastic gait, increased knee jerks, and sluggish pupils. He was not alcoholic or syphilitic and appeared to be developing a spastic paraplegia. He was very weak and feeble. A lead line was obvious in the gums and neuritis of the legs was present. He was constipated and dyspeptic. Arteriosclerosis was marked, the heart was slightly hypertrophic, and emphysema was present. He ate his luncheon in the workroom. A small poster advised cleanliness, but it was too faded to be read, and washing facilities were of the poorest. He stated that many of his 60 fellow workmen had plumbism.

Case 13.—This man, 47 years of age, was a steel hardener, employed in plunging magnetized bodies into molten lead, the fumes of which he inhaled, as ventilation was poor and the workroom rarely cleaned. He lunched in the workroom. Six months after beginning work, in January, 1911, he had an acute attack of vomiting, constipation and abdominal colic. He worked for 4 months longer, when he acquired double wrist-drop, and in the 18 months after beginning work he lost 52 lbs. He presented a lead line, increased blood pressure (150 mm.), slight cardiac hypertrophy, emphysema, dyspepsia, constipation, moderate secondary anemia, neuritis and general weakness.

Case 16.—This patient, although only 27 years old, had worked for 11 years under adverse conditions as a painter and interior decorator, using white lead paints, putty, and sandpapering dry paint. He illustrates the toleration which many workmen acquire for lead, for he had none of the symptoms of plumbism, but had a well developed tuberculous lesion with tubercle bacilli in the sputum.

Case 17.—This man, 62 years of age, also illustrated insusceptibility to lead poisoning. He had been an inside and outside house painter for 40 years without ever having lead symptoms or presenting any of the phenomena of plumbism. He came to my clinic for symptoms of a gastric carcinoma. He attributed his immunity to the habit of drinking 2 or 3 pints of milk daily, which he had done for many years.

Case 18.—This patient also had been a general painter for 40 years. Beyond a moderate arteriosclerosis, he presented no symptoms of plumbism nor had he had any such trouble at any time.

Case 19.—This patient was the only woman of the series. She was a housewife and attributed her double wrist-drop to the careless use of paint in painting her furniture. She had had 5 miscarriages.

Case 20.—This man, 52 years of age, had been a carriage painter for 25 years, and his only lead symptoms were attacks of cramps in the legs. He attributed his comparative immunity to careful cleansing of his hands with oil and soap.

Case 22.—This man, 36 years of age, had worked four years as a furnaceman, making red lead and in the drying rooms of white

lead. His first attack of acute colic, vomiting and constipation occurred shortly after beginning work, in 1909, and was followed by another in 4 months and two more two years or more afterward. In each attack he was incapacitated for work for from 2 to 4 months. He presented a deep lead line, granular basophilia, hemoglobin of 65 per cent., advanced arteriosclerosis and moderate cardiac hypertrophy, neuritis and chronic nephritis. He was not syphilitic or alcoholic. Emphysema was also observed. He ate his luncheon in the workroom. Warning notices were posted, but few of his 100 co-workers could read them and no prophylactic instructions were ever given them.

Case 36.—This patient, a man 59 years of age, had been employed as a painter for 25 years without acquiring any symptoms of lead poisoning. Then for 5 years he had frequent severe attacks of lead colic. One attack incapacitated him for 51 days. When I saw him he was much emaciated, and stated that he had lost 56 lbs. in weight since his attacks began.

Case 39.—This man, 28 years of age, had been a painter for 12 years, and five years previous to admission to the Presbyterian Hospital had attacks of neuritis in both legs. Subsequently he had severe pains in the shoulder and elbow joints, and paralysis of the right arm and hand. He had abdominal cramps for six months, vertigo, headache, constipation and general weakness. During one day the temperature was 101° F., accompanying an attack of colic. In this case the localization of the pains in the major joints of the upper extremity was a marked feature. There were decided lead line, arteriosclerosis and a slightly enlarged heart. There was chronic conjunctivitis, so often seen in indoor painters. Basophilia was not present, but the leukocytes numbered 12,500, and lymphocytes 28 per cent.

Cases 40 and 41.—These two men had been employed, one for 4 months, the other for 5 months only, in white lead converting beds and a dusty press room. Both had severe colic, vomiting, constipation, lead line, and the one who had worked only 4 months had well-marked neuritis with numbness and tingling in the right arm.

Cases 47-50.—These patients were all laborers who had been

employed in scraping old red lead paint from inside the double bottoms of warships where no effort had been made to furnish protection. The space between the inner and outer shells is about 3½ feet in depth, and it is divided into compartments 4 or 5 feet square. The red oxid paint is originally laid on very thick, being nearly ¼ inch in thickness. The "scaler," crouched on his knees and aided by an electric light, strips off the old paint, preparatory to applying fresh layers. In single compartments several men are sometimes simultaneously working, and the dust, which cannot be moistened, becomes so thick that they scarcely can see each other. Forced air drafts are used in summer, which merely stir up the dust and make matters worse. No precautions had been given the men, and they were allowed to eat their luncheon on deck without washing their hands and to go home without changing their clothes. The men were not enrolled in the navy, but were employed under contract. All had had colic attacks with vomiting and constipation. One complained also of vertigo, headache, drowsiness and weakness. One, who had been incapacitated from work for 4 months by plumbism, returned to work, and 3 months later was obliged to give up on account of loss of power in the right hand and wrist-drop. One of these men, when he came to my clinic, had also persisted in returning to work after repeated attacks of colic until his right hand and arm became so weak that for six months he had not been able to grasp a tool, and other employment which he had sought he had always been obliged to abandon on this account. These men were not alcoholic or syphilitic. It was suggested to the officers in command that the men be warned of their hazard, periodically inspected by a physician, and required to wear some form of respirator. Also that fresh compressed air be forced into the hold and the dust aspirated by an exhaust worked by the ship's engines. This work, from the nature of the confined space, entered only by manholes and lying beneath the water level, is necessarily hazardous, and the only radical means of prevention of poisoning consists in the substitution of zinc oxid paint for the red lead. There should be no radical objection to this change. In addition to these 4 cases, records of 16 other victims were found by Dr. E. E. Pratt, two of whom had died. These cases

are cited in his *Report* to the New York State Factory Investigating Commission for 1912.

A case of lead poisoning from burning scrap tinfoil in a tinfoil factory was reported to me by Dr. Floyd, from the Out-Patient Clinic in Bellevue Hospital. The man had received no warning as to the hazard of his work, and after a year he had abdominal cramps, a lead line and wrist-drop. He stated that among his 14 fellow workmen two others had had wrist-drop.

Prognosis.—Death is rarely immediately caused by lead poisoning, but it may follow within a day or two after inhalation of strong lead fumes.

Whereas the immediate effects of lead poisoning usually merely incapacitate the artisan from work, the remote effects may prove fatal from advancing arteriosclerosis, cardiac hypertrophy, aneurysm or hemorrhage, or chronic nephritis. A few years ago I published an analysis of two hundred cases of gastric ulcer admitted to the wards of Bellevue and the Presbyterian hospitals which showed a striking prevalence of the disease where it occurs in males, as affecting metal workers or those employed as metal polishers, painters, typesetters, etc. Fully twenty-five per cent. of the cases among middle-aged males were in men of such occupations. It is possible that an early arteriosclerosis affects the gastric arteries among others and thus favors the occurrence of localized necrosis and ulceration. In some cases, without causing lethal lesions, the poison so lowers the patient's general health and power of resistance that he falls an easy prey to intercurrent infections such as pneumonia and particularly tuberculosis. The patient may have visual and auditory hallucinations which are always of serious prognostic import. Some patients having general paralysis with marked tremors, incoördination, exaggerated patellar reflexes, and almost complete dementia may recover in time.

Lead colic, serious though it is, rarely is fatal. Tanquerel reports 9 deaths from it in 1,217 cases, and Andrali 5 deaths in 500 cases. On the other hand, it is very obstinate, liable to recur, and, with varying intensity, may last for months. Among the 82 painters who died in Milan in 1909-10 there were 19 deaths from tubercu-

losis, 14 from nephritis, 5 from apoplexy and 6 from lead poisoning. (L. Devoto, "18 mesi di clinica dei verniciatori di Milano.")

L. Devoto and L. Carozzi, of the Milan Hospital for Industrial Diseases, have reported a study based upon 2,567 compositors and 1,053 printers in Italy ("Assoc. internat. pour la protection légale des travailleurs," 1912). Among the cases which proved fatal the causes of death gave the following percentages: Pulmonary tuberculosis, 32 per cent.; acute and other chronic respiratory diseases, 9.4 per cent.; cerebral hemorrhage, 9.2 per cent.; cardiovascular diseases, 8.1 per cent.; renal diseases, 4.8 per cent. In 1909, in Italy, the general mortality rate from tuberculosis among typographers was nearly double that in other industries collectively grouped. This has been a frequent experience elsewhere.

In Germany, among 26,580 printers who reported illness to their Federation in 1909, 25.5 per cent. had diseases of the respiratory system, 10 per cent. of the digestive system, and only 10 per cent. of the nervous system, thus forming a marked contrast with painters.

Of the compositors and printers who die from all causes, more than half do not live beyond the 44th year, so as a class they are short-lived. In the semi-decade, 1901-1905, in the United States, the total deaths of compositors were 2,488, of which 992 were caused by respiratory diseases, 293 by diseases of the circulatory system, and 95 were due to apoplexy—a very high percentage.

In an English table of occupational disease mortality, rating all occupied males as 1, leadworkers are rated at 211 and filemakers at 75, and in general the mortality rate of lead workers is from 90 to 100 per cent. above that of other industrial employees, and their comparative mortality is 3 times greater than that of agriculturalists. Fully one-third of it is due to respiratory system diseases.

Diagnosis.—The diagnosis of lead poisoning is often overlooked by physicians unaccustomed to deal with its more chronic manifestations. Prof. M. Allen Starr (*Med. Record,* Feb. 3, 1912, p. 205) writes that "many cases of loss of vigor and so-called neurasthenia are actually due to chronic lead poisoning." The fact that arteriosclerosis and chronic interstitial nephritis may be produced alike by chronic lead poisoning, syphilis and alcoholism may give rise to

some confusion or difficulty in determining whether lead is the more important influence in a given case. Frequently, if a patient has neither blue line on the gums, colic nor palsy, he is not regarded as a possible victim of lead poisoning, although in reality sclerotic changes due to it may be well advanced.

Lead colic has been mistaken repeatedly for acute appendicitis, but in the former the absence of fever and leukocytosis, and the central rather than unilateral location of the abdominal pain, with possible presence of a blue line on the gums, should make the diagnosis plain.

Pyloric spasm with epigastric pain, tenderness, vomiting and constipation may also be mistaken for lead colic. In such a case the patient's history and occupation should carefully be considered, and with colic there may be basophilia, anemia and a blue line on the gums, and possibly a trace of lead in the urine, to aid diagnosis.

Gall-stone colic has been mistaken for lead colic. In the former bile is usually to be detected in the urine and jaundice may be more or less evident; moreover, the pain, tenderness and rigidity over the gall bladder region do not correspond with the central distribution of lead colic pain, and there is noticeable absence of bile pigment in the stools

In all these doubtful cases an extremely careful examination of the abdomen should be made as to tension, rigidity, pain on pressure, etc. Dr. Hamilton reports the case of a man who had four abdominal operations performed in error, the correct diagnosis being lead poisoning; and, in 1911, I saw a similar case, with, curiously, a record of the same number of operations; the first for supposed gall stones, a second for supposed appendicitis which did not exist, and two others for "adhesions" (!). The victim had had severe lead colic and had, when seen, well marked evidences of lead poisoning. Women sometimes refer the pain of lead colic to the ovarian or uterine region. Diagnosis is easily made when the typical symptoms of abdominal cramp, weakness of the hands and forearms, and a lead line upon the gums are present. It is, however, important to make it earlier, before the victim is incapacitated from work. To this end the urine should be examined for traces of lead, and

the blood for basophilia. Other symptoms to be sought for early and taken in connection with the patient's occupation are evidences of arteriosclerosis and chronic interstitial nephritis, persistent constipation, with a foul, coated tongue, secondary anemia, progressive weakness and emaciation, occasional vertigo, and pains of a neuritic type, especially in the arms and calves of the legs.

Rarely lead poisoning with partial leg paralysis, incoördination on attempting to stand with the eyes closed, etc., may simulate locomotor ataxia, but the ocular symptoms and alteration in reflexes which characterize ataxia are absent from saturnism.

Prevention.—In England legislation has accomplished great good in reducing the hazard of lead poisoning. Regulations formulated by the Home Office, including compulsory weekly medical inspection of lead works in the 7 years from 1899 to 1906, reduced the number of lead poisoning cases 50 per cent. In smelting works in the vicinity of Newcastle these cases have been reduced to one among 276 workmen, whereas in Illinois, without any restrictive legislation, the ratio was one case among every 7 workmen! (Hamilton.)

In England, wherever red and white lead are produced, the laws require that the walls be kept smooth, dust free and clean, that the cement floors be frequently washed, and, where lead dust is abundant as a necessary outcome of handling, that it be moistened by sprinkling. These laws further comprise provision for weekly and monthly medical inspection, prohibit the employment of women and children in white lead beds or stoves, packing rooms and all other especially hazardous places. Respirators, caps, overalls, gloves, etc., must be provided by the employer, who must keep them cleaned and in repair. Before eating the hands must be washed in a weak solution of acetic acid, which forms a soluble lead acetate. Time must be allowed for washing before lunch, and good washing facilities with running hot and cold water, and in some cases shower or other baths must be provided, together with soap and individual towels, nail and tooth brushes. Separate lockers are ordered for each man's clothing and overalls. A lunchroom apart from all work rooms must be maintained. The lead drying stoves must be ventilated, and no man is allowed to draw Dutch ovens more than two days in a week

or more than two hours at a time. The white beds must be watered before emptying and all rooms must be kept as clean and dust-free as possible. Workmen must be warned as to the risks they incur, and not be permitted to disobey the rules of personal care or to continue at work after once being seriously "leaded," or until cured. No food or drink is to be carried into the workrooms and the use of chewing tobacco is similarly prohibited while at work, and the men are urged to refrain from the use of alcoholic beverages.

Dr. Hamilton, after a personal inspection of the lead industries in England, states (*Jour. of Industrial and Engineering Chemistry,* June, 1911):

"The men have usually individual towels, numbered with each man's number to prevent stealing. There are long porcelain-lined sinks with no stoppers, so that a man must wash in clean running water. Usually big cans of soft hand soap are provided. There are sprays for the head attached over the sink, and long nail brushes are fastened to the wall just above the basins. The great difference between our arrangements and these does not lie in equipment, but in the fact that the foreign workman's personal cleanliness is compulsory, his employer is held responsible for it; the American workman, usually a Slav, Italian, Greek or negro, may wash or not as he sees fit."

In a smelting establishment in Hungary the incidence of lead poisoning cases among the workmen was reduced by proper ventilation and cleanliness in 18 years from 46.5 per cent. to 3 per cent. A similar experience, according to Boulin, was had in Silesia, where in the same period of time the percentage fell from 64.3 to 0.8.

The following illustration of the necessity of thorough factory ventilation is given by Sir Thomas Oliver in an article on "Industrial Lead Poisoning in Europe" (*Bulletin No. 95,* United States Bureau of Labor, 1911):

"On one occasion in a dye works in Scotland during a severe winter the female workers closed, unknown for a time to the foreman, the ventilators on account of the cold, and they also stopped the running of the fan. An epidemic of acute lead poisoning, as unexpected as it was at first inexplicable, broke out among the women,

one of whom died from saturnine encephalopathy. With the restarting of the fan and the reopening of the ventilators no further case of plumbism occurred."

All employees, as soon as they evidence the least sign of plumbism, should be removed to some less dangerous type of work in the factory or advised to seek some entirely different form of employment, for one attack of acute plumbism often predisposes to others, although this is not always the case, especially if the workman, being warned by one attack, learns to take better care of himself.

In *Bulletin No. 44,* 1903, of the United States Labor Bureau, this statement regarding lead works is made: "The thoughtlessness of the workman is very great. Men eat their lunches with unwashed hands in the factory itself, when a dining room is provided for their special use. Implements covered with white lead are held in the mouth because they are too indolent to lay them down. Hands covered with white lead are used in filling pipes and cutting off chewing tobacco."

It is very important to allow lead workers sufficient time for a substantial breakfast, for many of the foreign employees are accustomed to different hours, eating a breakfast in the middle of the morning; hence they tend to carry sandwiches or other food with them to eat in the workroom, after beginning work, the stomach being empty.

Medical inspection of the workmen in some of the lead works of this country is now provided by the employer, but, as "leaded" men are often permitted to continue their occupation, it does not accomplish all that it should.

A complete system for the safe handling of white lead from the drying pans until it leaves the chaser as lead-in-oil paste has been perfected, and is now being regularly operated by the National Lead Company. In some of the lead industries in which dust is a very serious menace it is feasible to allay it by wetting, and in some of the processes in which lead paint is removed by chiseling or sandpapering it is possible to spray the surface first with some form of non-drying mineral oil. In Belgium a national law prohibits the dry sandpapering of paint.

It is important to separate the dusty work of all lead plants from the non-dusty. For example, mixing of dry lead colors should not be done in the same room in which cans or boxes are being labeled. It should not be permitted to ship leaky or dust-covered barrels of white lead.

The introduction of modern machinery for handling white lead in the drying, grinding and packing processes is doing much to minimize these hazards, and Dr. Hamilton, as a result of her investigations in Illinois, writes (Amer. Assoc. for Labor Legislation, *Publication No. 10*): "It is rather paradoxical and yet entirely understandable that we have been able to find a larger number of cases of lead poisoning in the well-managed factories than in those badly managed. In the former the situation is faced frankly, the cases are sought out and treated, in the latter the dangers are ignored or minimized, and there is no effort to discover cases of poisoning, rather the contrary."

Whenever possible carriage, wagon, automobile and similar kinds of painting should be done out of doors, or at least in open sheds. Oliver states: "In one large factory, in which 80 tons of white lead were used annually in indoor work, there were 163 cases of lead poisoning, while among the men employed in outdoor painting, and who used during the same period 237½ tons of white lead, there were only 50 cases of plumbism."

In the distribution of type in the numerous small sorting boxes much dust accumulates which may be removed by using a jet of compressed air. Benches and tables may similarly be cleaned.

A good illustration of the lack of interest of employers in caring for the health and efficiency of their employees sometimes met with is the following, reported by Dr. C. H. Snover (*Jour. Amer. Med. Assoc.*, June 17, 1911): A young girl of 16 years was employed, together with 15 others, in soldering cans in a condensed milk establishment in New York State. None of them had received instruction as to the risk of the work. This girl was attacked by vomiting and abdominal cramps, with weakness of the arms and hands, but managed to keep on with her work for two months until she no longer could hold the soldering iron. When seen by Dr. Snover

she had pronounced granular basophilia and secondary anemia, albuminuria, gingivitis and double wrist-drop. He reports: "On questioning I found that another girl 'dropped' the solder, and it was not until next day that she told me about 'playing with the solder,' as she expressed it, by which she meant that she kept three or four of the smaller pieces in her mouth and chewed them nearly all the time during working hours. Occasionally she swallowed some of the smaller particles."

As a further illustration of the way in which plumbism is often overlooked by failure of physicians to inquire into details of occupation is the fact that when first attacked by gastric disorder she was treated by another doctor who did not recognize the cause and made an erroneous diagnosis.

The cases of lead poisoning for which damages were awarded in England, in 1908, under the Compensation Act for Occupational Diseases numbered 421, of which 191 were in metal extracting or working, 100 in the pottery industry, 16 in the printing trade, 4 in lead mining, and 1 in the textile industry. Of these 421 workers, 407 were employed in factories. Four-fifths of the cases occurring apart from the mining industry were due to white lead poisoning.

In Germany lead smelting was originally conducted without official regulation, and in 1885 as many as 73 per cent. of the workmen acquired plumbism. Seven years later, with the works under strict supervision by government inspectors, only 0.8 per cent. were poisoned.

In Austria experience has been practically identical. In the *Bulletin de l'inspection du travail,* 1906, the example is reported of an Austrian smelting works where a new tall chimney with proper exhaust ventilation reduced the incidence of lead poisoning from 70 to 3 per cent. In Austria, moreover, in lead factories without regulation, in 1886, 43 per cent. of the workmen acquired plumbism, but 6 years later, under governmental control, the percentage fell to 6.

In some of the Austrian lead color, majolica and metal composition works the workmen are required, before cleansing the hands with water, to use a 3 per cent. nitric acid solution which dissolves any lead adhering to the hands. When lead solutions must be

handled, as in dipping processes, vaselin should be smeared beneath the finger nails and rubber gloves worn.

To protect from lead dust, the workman, before eating and on going home, should wash thoroughly the face, beard, nostrils and hands with warm soap and water, and "the mouth and throat should be rinsed with a watery solution of tartrate of ammonia before eating or drinking" (Kober), or a 0.2 per cent. solution of sulphite of soda may be used, or a solution of ammonium acetate (Wächter).

Painters should keep the handles of their pails and brushes clean, and Kober suggests that they soften old paint with weak lye before scraping. A non-drying mineral oil may be first applied in some industries before scraping off old paint.

Rooms in which lead is melted in pots, as in type foundries, should be especially well ventilated, and fumes should be drawn away through hoods covering the pots and connected with powerful exhaust ducts connecting with a chimney. A current of air should be so directed past the workman as to compel the fumes away from him when ladling or stirring the molten metal.

The composition rooms should be constructed without exposed rafters, shelves or other places on which dust may lodge. The walls and floors should frequently be washed and the type cases cleaned, when possible by a bellows or compressed air. They should be made with false bottoms of perforated tin, so as not to retain dust.

Melting pots for the type metal should be well hooded and connected with an exhaust. The ordinary rules against promiscuous expectoration must be enforced rigidly. Close-fitting paper or linen caps should be worn as regularly as overalls in dusty lead trades, to prevent the hair from collecting dust which later is carried to the home. Cloths moistened with ammonium sulphid worn over the mouth arrest the lead fumes by formation of insoluble lead sulphid. Where lead has to be kept molten in open kettles, as in type founding, pipe molding, etc., the surface may be covered with tallow to check the liberation of fumes.

The medicines which, rightly or not, have long been regarded as preventive of lead poisoning are acidulated drinks, such as solutions of citric, acetic and other acids, the occasional use of Epsom salts

and of sulphur lozenges. According to Oliver, "sulphur is a preventive to some extent." Sodium hyposulphite in 5-grain chocolate-coated tabloids may be taken three times a day. They are recommended by Sir Thomas Oliver as a possible preventive of plumbism, being better than the sulphur preparations and sulphuric acid lemonade sometimes used by lead workers. Mucilaginous drinks are also used, and fat foods (butter, cream, bacon, pork, etc.) are recommended.

The English laws regulating the manufacture of lead products such as white, red or orange lead require that the manufactory shall provide the employees with a suitable sanitary drink, such, for example, as the following:

"Sulphate of magnesia, 2 ozs.; water, 1 gallon; essence of lemon to flavor." Drinking milk to the extent of a quart a day is strongly recommended by Karl Wächter ("Die gewerbliche Bleivergiftung," 1908) as a prophylactic against lead poisoning.

Individual drinking cups or, preferably, drinking water spouts should be provided and the employees should be cautioned particularly against drinking from any cup the rim of which has been soiled by contact with lead-besmeared hands.

The following rules, formulated by Dr. Kenney for distribution in my clinic, have been adopted by the New York State Department of Labor with the statement that "the Department wishes to circulate these rules as widely as possible among all workers who may profit by them. They will be sent free to individuals, to trade unions, employers or any others who can assist in their useful circulation."

MEDICAL CLINIC
CORNELL UNIVERSITY MEDICAL COLLEGE
OUT-PATIENT DEPARTMENT

Instructions for Persons Exposed to Industrial Diseases, Especially Lead

General Information

(1) Dusty occupations cause colds and infections, irritate the nose and throat, and weaken you.

(2) Fumes cause thin, poor blood, weak muscles, indigestion, and weak hearts.

(3) All workers exposed to dust and fumes should have good ventilation, open windows, and protective devices, as exhaust fans, hoods and blowers.

Metal Poisons, Chiefly Lead

(1) Lead causes more poor health among workmen than any other metal; leads to indigestion and "colic," chronic disease of heart, bloodvessels and kidneys, and paralysis of the hands—"wrist-drop."

(2) Young adults are easily poisoned by lead. Young women often get the worst forms of it.

(3) Lead acts slowly and silently by constant exposure, and causes illness without the workman's knowledge of his danger. He must, therefore, be most careful.

(4) Lead enters the system through the nose, mouth and skin; that is, it may be inhaled as dust, in fumes, swallowed with food and saliva (especially if tobacco or gum is chewed), and absorbed by the skin.

(5) In New York City those trades that specially expose the workers to lead poisoning are: white and red lead manufacturers, painters, plumbers, typesetters, file makers, storage battery makers, metal hardeners and polishers.

Rules for Prevention of Lead Poisoning Outside the Factory

(1) Keep general health always good by plenty of light, good food and fresh air in the home. Sleep at least eight hours every night.

(2) Personal cleanliness must be had. Wash with warm water and soap daily, always before eating, and take at least one full hot bath a week. Remove all dirt from under the finger nails.

(3) Never chew tobacco or gum when working. The lead dust on the fingers is sure to be swallowed.

(4) Don't drink liquor of any kind. Alcoholic intemperance causes attacks of lead poisoning, weakens the kidneys, and causes paralysis.

(5) Never eat when you can avoid it in the same room you work in.

(6) Always eat a good breakfast before going to work, especially drink milk.

(7) Do not wear the same clothing on street or at home that you work in. Use overalls.

(8) Have at least one good bowel movement every day.

(9) Exercise in the fresh air. Live, when possible, some distance from work, and walk both ways.

(10) Take good care of teeth and gums. A decayed tooth favors lead symptoms. See your physician before going to work in the lead factory, and at frequent intervals thereafter—at least once a month.

To these rules are added, in the State circular:

Respirators are very useful and should always be used when working among lead dust or fumes.

Keep the workroom clean. Do all you can to keep down dust. Do not get lead on your hands and clothes any more than you can possibly help.

How Men are Poisoned by Lead.

(1) Lead is poison to the body. It enters the body mainly through the nose and mouth. It may be inhaled as dust or in fumes. It may be swallowed with food or saliva (especially if tobacco or gum is put into the mouth with soiled fingers). Or it may sometimes be absorbed through the skin.

(2) When lead gets into the body, it leads among other things to indigestion and lead "colic"; to diseases of the heart, bloodvessels and kidneys; or to paralysis of the hands, known as "wrist-drop."

(3) Lead acts upon the body slowly and insidiously. Without knowing your danger you may be getting some lead poison into your body every day. If you are working with lead in any one of its many forms, you must therefore use great care so as to protect yourself against it.

(4) *On the very first sign of not feeling well, see a doctor or go to a dispensary. Do not wait until you are too sick to work. The earlier you go to a doctor, the easier it will be to cure you if you are being poisoned by lead. BE SURE TO TELL THE DOCTOR ALL ABOUT YOUR OCCUPATION AND ITS DANGERS.*

The above rules are printed on the reverse of cards on the face of which the following statements are printed:

Lead Poisoning

Information for Workmen

and

Directions for Prevention.

All doctors and hospitals are required by the law of 1911 to report all cases of lead poisoning to the Department of Labor. The results of the first year of reporting show:

That lead poisoning is one of the most common of the diseases due to occupation.

That two-thirds of the reported cases of lead poisoning occur among painters.

Lead Poisoning Can Be Prevented.

It is preventable partly by the proper ventilation of factories and shops. Hoods and other mechanical means to take away lead dust and fumes are necessary. Respirators for workers exposed to lead dust are very useful and should always be used.

But to a large extent lead poisoning may be prevented by the workmen themselves. *Lead is poison to the body.* Those who work with lead must themselves use the greatest care. Among white lead workers and others exposed to lead, the care which the workers take of themselves is of the first importance.

Carefully prepared information for the use of those who handle lead in any of its forms is printed on the back of this card. By following this advice most workers handling lead in any form may escape lead poisoning.

Read this advice carefully. Remember what you read. Follow the advice given.

A lead bill drafted in 1913 by the New York State branch of the American Association for Labor Legislation for presentation to the Legislature contains, among other provisions, the following for protection of workers in lead fumes, dust, salts or solutions:

Employers must provide reasonable and scientific devices for the protection of their workmen against lead poisoning. These include: Provision of overalls and respirators; the monthly (or oftener) examination of all employees by a physician and registration of their condition of health; the exclusion from work of those found to be poisoned or otherwise unfit; the reporting to the State authorities of all cases of lead poisoning; the provision of dressing rooms and lavatories fitted with hot and cold water for each 5 employees—smooth enamel wash basins or troughs, a nail brush, soap, and daily a clean towel for each employee, two sanitary lockers for each employee, in one of which to keep his street clothing, in the other his overalls when not in use; a time allowance at the employer's expense of not less than ten minutes before the lunch hour and after quitting work for the use of the lavatories and dressing rooms; a shower bath for each 5 employees exposed to poisonous lead fumes, dusts or solutions, provided with hot and cold water, movable floor gratings, and for each employee soap and two clean bath towels weekly; a

time allowance twice a week for the use of the baths, of which a record shall be kept; prohibition of taking any food or drink into the workroom; a suitable lunchroom in which meals may be eaten only; provision of accessible drinking fountains; provision for carrying off all toxic fumes and dusts; smooth, hard floors in the workrooms, to be kept clean, but not to be swept during working hours unless previously dampened; all ore, slag, dross and fume to be kept separate from the general working rooms; mixing, weighing and packing of lead products to be done in separate apartments; and, when possible, such products to be dampened before handling; polishing and finishing processes to be kept dampened when possible; all floors to be washed or scrubbed daily; flues to be cleaned under special precautions to prevent dust from escaping; all hoppers or chutes to be provided with adequate suction hoods and covered, as far as practicable; conveyances for transportation of lead products to be kept covered; no refuse to be allowed to accumulate where employees are working; printed notices of all special hazards to be posted conspicuously, with directions for avoiding them, printed in languages intelligible to all employees, who, if unable to read, shall be specially instructed as to their hazard. This proposed lead law to contain also provisions for factory inspection, enforcement of its provisions and penalties for violation thereof.

Dr. Edward E. Pratt made an exhaustive investigation of lead poisoning in New York City, in 1911-12, for the State Factory Investigating Commission. In a summary of his findings, published in the *American Labor Legislation Review*, vol. ii, no. 2, June, 1912, he mentions the following deplorable conditions: "Sixty-two of the 109 workers ate in the same room where they worked; 22 never washed before eating, and 45 washed only in cold water; 73, or almost three-fourths, were never given oral instructions of any kind as to the dangers of their work or as to methods of preventing lead poisoning; 76 men never saw any posted instructions where they worked." In discussing this paper Dr. M. Allen Starr stated that he had questioned 30 patients who had come to his clinic in the College of Physicians and Surgeons within the year, and not one had received instructions as to the hazard of his trade. Such facts

make clear the necessity of a widespread educational campaign to mitigate the evils of lead poisoning.

Substitutes for Lead Compounds.—In many industries in which poisonous lead salts formerly were used they are being replaced by less toxic lead salts or by entirely different substances. Thus anilin dyes are replacing lead chromate pigment in textiles, wall papers and artificial flowers; acids are replacing lead powder for finishing cut glass; in rubber manufacture lead sulphate is replacing the basic carbonate; and this salt as well as zinc salts are partially replacing white lead in the making of paints.

Guyton Morveau in the early part of the last century showed that zinc oxid might be used as a harmless substitute for lead carbonate in the preparation of paint, but its use, except in France, has not become popular, although it is to a limited extent employed in this country. In France a series of bills have been defeated by the Chamber of Deputies making the substitution compulsory. On July 20, 1909, the French Chamber of Deputies enacted a law introduced by M. J. L. Breton prohibiting the painting of buildings with white lead paint either inside or outside after July, 1914.

Austria, in 1909, forbade the use of white lead paint for building interiors. It is also prohibited in several cantons of Switzerland and in the government buildings of Belgium. In Germany and many other countries are increasing instances of the local prohibition of the use of lead paint. Unfortunately many substances—about 27—sold as fancy paints under misleading names contain lead, and the buyer is not correctly informed regarding them. In this country considerable zinc white paint is in the market, but there is, as yet, no compulsory prohibition of the use of lead paint. This attitude against the use of this paint has been brought about largely by the great number of damage suits and sick benefit claims instituted by the victims of lead poisoning. A pinch in the economic shoe is often a great stimulus to philanthropy!

Zinc oxid in glue water may be applied, and, after drying, zinc chlorid, also diluted in glue water, is used. The oxid and chlorid form a hard, smooth, shiny chemical combination, and this paint, for indoor work at least, is very durable and satisfactory. The dis-

coverer of zinc chlorid paint was paid 20,000 francs by the French Government, which had long sought a practical substitute for lead paint.

Another zinc paint is made with addition of soda and silicious material with glue. Zinc sulphid mixed with barium sulphate, called "lithopone," is also used as a substitute for lead paint, but it requires nearly twice as much oil, and the oil must be refined or it will turn the zinc yellow. This requires more time for drying, which is a disadvantage. On the other hand, sulphur does not blacken it, as it does lead, and the zinc paint does not crack or blister. Many experiments made at the Pasteur Institute in Paris demonstrated the feasibility of substituting zinc for lead paint, and thereby saving many lives and preventing much chronic invalidism. In the painting of castings with red paint much poisoning has occurred, but a filler and priming coat may be substituted, composed of silica, iron oxid and aluminum mixed with brown Japan drier. In works where this practice is followed there has been great reduction in plumbism. Lead which has been "fritted," i. e., heated with such materials as silica and boric acid, forms a brittle substance like glass which is less readily soluble in acids than most lead compounds, and may be used as a substitute for them in glazing.

Treatment.—In Acute Poisoning.—The acute cases are usually caused by inhalation of fumes, and hence evacuation of the stomach, which is usually recommended, or washing it with large draughts of water, is of little service. However, as some of the metal may be retained in the mouth and swallowed, there is no harm in pursuing that method. Alkaline carbonates of sodium or potassium and Epsom salts should be given, and castor oil is a suitable laxative. Milk should be drunk freely. Formerly, alum was much used. Cardiac stimulants may be needed, but artificial respiration is not required.

In Chronic Poisoning.—Hot baths to induce perspiration are very useful and the skin should be scrubbed with a stiff brush. They are often impregnated with some sulphur preparation which coats the skin with a black lead sulphid. For this purpose 4 or 5 ounces of potassium sulphid may be added to a large wooden bath-

tub full of warm water. Sulphur vapor baths are also much used for a similar purpose. In the rock caves of Glenwood Springs in Colorado, which are filled with natural warm sulphur vapor, the Leadville miners formerly used to sweat out the lead which they might have absorbed. The benefit, however, derived in both these methods is through inducing perspiration. The addition of sulphur is not very scientific, for it cannot penetrate the skin or draw out the lead. The heat and moisture make the patient perspire freely, but the sulphur merely unites with the lead which may have been excreted by the perspiration, thereby making it visible as a black deposit, which is no doubt impressive to the patient!

For the colic tincture of belladonna (℥ v) is useful, and the following combination often gives relief:

℞ Tincturæ cardamomi compositæ
Aquæ menthæ piperitæ
Spiritus ammoniæ aromatici, āā ℥ i
M. Sig. Give ʒ i every two hours in a wine-glassful of hot water.

In severe cases a hypodermatic injection of morphin may be required, but is to be avoided, if possible, on account of increasing the constipation. Chlorotone (gr. v) and chloroform water (℥ xx) are also useful remedies.

Hot poultices and stupes should be applied to the abdomen. Very hot normal salt solution may be used to irrigate the bowel, after previous evacuation with an enema of warm castor oil and soap suds. Oliver recommends the monosulphite of soda, gr. iii, t. i. d. Constipation may be treated in accordance with the general directions given on page 156, and the patient should be made to drink large quantities of water.

It is customary to prescribe potassium iodid with the belief that it tends to form a soluble lead iodid which is more readily eliminated than the carbonate. Caution is also given not to administer more than 5 or 10 grains daily, lest so much soluble lead be suddenly formed in the system as to give rise to acute plumbism, but this

danger is probably exaggerated. The iodid may be administered in milk.

Gargles and mouth washes of sulphur and potassium iodid may be used and the teeth should be cleansed and kept in order. Neuritis should be treated as detailed under Neuritis. Lead palsy should be treated by massage and electricity, and an attempt should be made to reëducate the muscles by special movements. Artificial supports and rubber bands may be fastened so as to aid the paralyzed extensors of the wrist. Strychnin should be given and iron and arsenic for the anemia. For the convulsions of lead encephalopathy the spinal canal should be tapped. Amyl nitrite and chloroform may be inhaled, and chloral hydrate and bromids may be given by mouth or rectum.

MANGANESE

This metal is used in the chlorin industry and to aid in liberating chlorin gas, in the liberation of oxygen, dyeing, coloring glass, charging galvanic cells, and in making lacquer, varnish and oil paints, enamel, linoleum, and marbling of soap.

When manganese dust has been breathed for a long time in ill-ventilated mills, paint factories, etc., serious and even fatal poisoning may occasionally occur, although it is rare.

Symptoms.—The victim feels weak and there is loss of appetite and weight. He becomes drowsy and complains of night sweats. Serious nervous symptoms next appear. Cramps in the legs, numbness in the feet and rheumatic pains in the legs occur. There may be edema of the ankles. Salivation, vertigo, intention tremor of the muscles of the face and head, and a feeble voice with scanning speech are observed. There may be a staggering gait or the symptoms may resemble locomotor ataxia.

L. Casamajor described in 1913 nine cases of manganese poisoning in workmen in an ore-separating mill. They exhibited intention tremor, festination, pains in the legs and asynergia. The urine and spinal fluid were negative, as also was the blood. In one fatal case there were enlarged perivascular spaces in the basal cerebral ganglia.

After chronic poisoning by manganese oxid hysterical symptoms have been observed, with sometimes more serious mental disorder. There are emotional disturbance with uncalled-for laughter or crying, and a tendency to walk backward (retropulsion). Incoördination in the movements of the hands, as in writing, etc., may sometimes be present. Finally the victim becomes unable to walk or to take ordinary care of himself without aid.

Treatment.—Treatment is preventive through adequate ventilation and cleanliness. (*See* pages 102, 91.) For the nervous and mental symptoms hydrotherapy, massage and promoting elimination through the bowels yield the best results. In many cases, if the symptoms are far advanced, amelioration is all that may be expected.

MERCURY

Mercury, both as a metal and in its manifold compounds, is one of the most poisonous of the metals used in manufacture, ranking in its evil effects with phosphorus and lead. Being volatile at low temperatures, it is readily vaporized, and, being capable of direct absorption through the skin and mucous membranes, it is liable to produce many cases of industrial poisoning in proportion to its use. The largest mercury mines are in the United States, Mexico, Spain, Austro-Hungary and Russia. In Almadén, Spain, convicts are sentenced to labor in the quicksilver mines. Formerly many of them were so soon overcome by the fumes from the smelters that they could work only one week in each month, but present conditions are much improved. The fact that mercury evaporates slowly at ordinary atmospheric temperature contributes to the ease with which it poisons by inhalation. The vapor condenses readily upon the workman's clothing, and Renk obtained 2.5 grains from the coat of a quicksilver miner.

In other quicksilver mines the workmen often become poisoned, and Kobert ("Lehrbuch der Intoxicationen") estimates that between one and two per cent. acquire chronic mercurialism. The mucous membrane of the mouth becomes inflamed, red and congested. Rarely that of the nose is also involved. There is stomatitis, with hyper-

secretion of thick mucus and salivation. As an early symptom, Sommerbrodt describes the appearance in the mucosa of localized white spots surrounded by pale blue or reddened areas which he calls localized pharyngeal hydrargyrosis. Wolf and Röpke have observed labyrinthine disease in quicksilver miners with Ménière's symptom-complex.

In quicksilver mining, where mercury is extracted by vaporization and condensation, fine droplets of the metal may find lodgment in the skin or on the hair or clothing of the workmen. These droplets on oxidation in the air may be inhaled or swallowed and give rise to mercurialism.

Mercury is much used to make amalgams in the extraction of gold, silver and other precious metals.

In the quicksilver mines of Austria, in 1893, fully 54 per cent. of the workmen became mercurialized during the year. The proportion is much less now, although many cases of mild mercurialism occur. Ludwig Teleky, in an investigation there in 1909, found 240 cases, six being severe enough to require hospital care. In 1908 Gigliolis reported 58 cases of mercurialism among 700 miners and smelters of mercurial ores in Monte Amiata, Tuscany.

Thirty years ago it was not uncommon for as many as 15 or 20 per cent. of mirror makers to be affected by mercurialism, but the process has largely been superseded by the use of silver nitrate. Nevertheless, mercurial poisoning is still sometimes acquired in mirror making. When silver nitrate is used it is precipitated on the glass by tartaric or other acid.

In a mirror silvering plant the Illinois State Commission on Occupational Diseases found that three deaths had taken place from mercurialism during a decade. The report states: "The men are unable to work at silvering for more than a few months before becoming completely disabled."

In the making of barometers, thermometers and other scientific instruments metallic mercury is employed. It is also used in some of the gilding and bronzing finishing of various metallic articles. The red oxid is used in "anti-fouling" paints to be applied to ships' bottoms.

Röpke has reported ("Krankheiten des Ohres," p. 28) a case of mercury poisoning in a man employed in gilding swords. He complained of muscle pains, severe nervous disturbances, and "acute labyrinthine affection with Ménière's symptom-complex." There were vertigo, tinnitus, deafness, vomiting and loss of equilibrium. He recovered on abandoning the work.

Dr. Teleky, in November, 1911, reported before the Gesellschaft der Aertze 14 cases of poisoning by mercury vapor among those employed in making special incandescent lamps. In the process a high gas pressure is employed which is obtained through use of mercury vapor, traces of which remain in the lamps. Proper precautions against poisoning had been observed, but, despite them, after a year of labor the workmen presented typical symptoms of mercurial stomatitis, anemia, general nervousness and tremor. As a subsequent precaution after these cases were reported the lamps, before being hermetically sealed, were manipulated in air-tight chambers into which the workmen's hands could be introduced.

The making of the large vacuum bulbs for X-ray apparatus presents the same hazard.

Mrs. Lindon W. Bates reports 3 cases of mercurialism derived from making electric light bulbs, the vacuum in which is produced by mercurial pumps.

Mercury is used in large quantities in a few manufactures, as in making fulminate powder for the caps used in setting off blasting powder. When impure the mercury may require redistillation, and I have notes of one case of mercury poisoning acquired in this latter process.

In a cartridge factory the foreman of the priming department was affected by mercury poisoning so frequently as to lose about half the year's work for a number of years, until a proper ventilation system was installed, after which he had no more trouble.

Mercury is used in the process of whitening cane for chairs and other articles, in coloring artificial flowers, making the toys known as "Pharaoh's serpents," in jewelry making and goldsmithing, polishing, stamping textiles with colors, making electric meters, making antiseptics (corrosive sublimate) and antiseptic dressings, rubber

manufacture, making hair dyes and cosmetics, bronzing, and sole stitching of shoes by the Blake machine.

In the electric meter industry in England, in one factory where Mrs. Lindon W. Bates examined 25 workmen, 22 had more or less mercurialism.

One man died in New York City, in 1910, from chronic mercurialism acquired while manufacturing rubber goods. In England, in a series of 94 cases occurring during a decade, 18 per cent. were due to thermometer making. The bulbs often break and scatter mercury over the floor.

Water gilding or fire gilding processes formerly gave rise to much mercurialism. In Paris, for example, in the decade ending in 1901, there were 15 cases of mercurialism from this cause treated in the hospitals. At the present time, however, galvanism has largely superseded other processes for gilding.

Mercury is used in the manufacture of felt hats, and C. T. Graham-Rogers found as much as 2.6 mg. of mercury per cubic meter of air in certain fur cutting rooms in hat factories. Dr. Frank E. Tylecote, of Manchester, England, at the Fifteenth International Congress on Hygiene and Demography in 1912, reported 20 cases of industrial mercurial poisoning, chiefly among hatters who presented tremor of the hands and arms and blackening of the teeth with gingivitis.

Felt hat making is one of the most complex of manufacturing processes in which mercury is employed, and the most thorough studies of the subject of poisoning in this process have been made by Mrs. Lindon W. Bates for the New York and New Jersey Section of the National Civic Federation (1912), and Dr. C. T. Graham-Rogers, 11th An. Rept. Com. Labor, Sept., 1911. These investigations covered a study of 122 cases. In Great Britain in 11 years 110 cases were reported. There are many subdivisions of the felt hat manufacture, and those chiefly exposed to mercurialism are the so-called "carotters," "makers," "hardeners," and "sizers" (Fig. 45), whereas the finishers are more liable to pulmonary disorders, particularly tuberculosis, from the felt dust which they inhale. The mercury poison itself also predisposes strongly to the acquisition of

tuberculosis, especially of the larynx. The Registrar-General's report for the past decade states that the tuberculosis mortality among hatters is 50 per cent. above the average. One reason for this is,

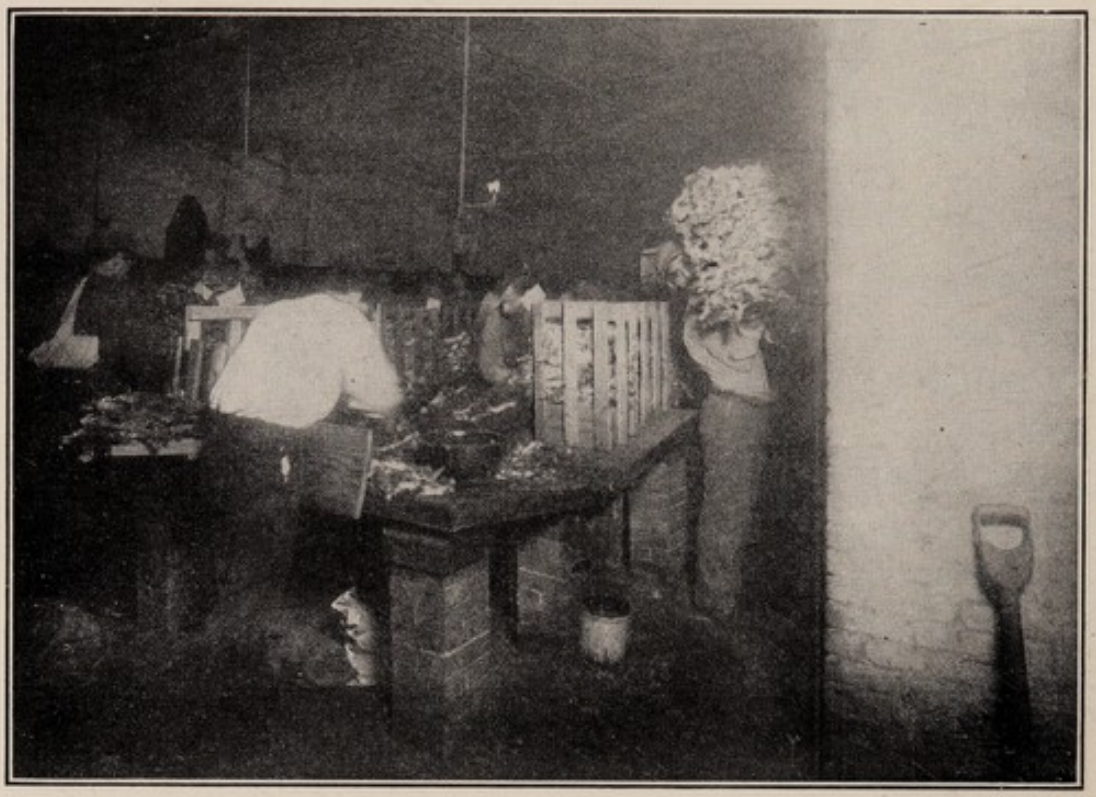


FIG. 45.—"CAROTTING ROOM" WHERE THE PELTS ARE BRUSHED WITH AN 11 PER CENT. NITRATE OF MERCURY SOLUTION. The men wear rubber gloves, work on marble slabs and stand on an asphalt floor. Once a week the room is washed down. The man on the right is carrying a pile of wet pelts held against his face. Note the dust and feeble illumination. Hazards: mercury and dust inhalation. (From a photograph contributed by courtesy of Dr. Price.)

according to Stickler, the laceration of lung tissue by sharp, fine hair dust.

In felt hat making the mercurial poisoning is mainly derived through the respiratory system, but the mercury may be conveyed to the mouth or absorbed through the skin. The vapor readily condenses on mucous membranes from which absorption promptly takes place. In addition to the hazards of felt dust and mercury inhalation, the workman is subjected in parts of the process to fumes of naphtha and from poorly burning gas heaters, the nauseous odors of grease, and the dust of emery and sandpaper-finishing machines.

The detail of hat making is briefly as follows: The bundles of dried furs, which are rabbit, beaver, musk-rat, nutria, Belgian hare, or other skins, are opened, sorted and clipped—a very dusty process. Forty thousand skins a day is the capacity of one plant in New York. They are then cleaned and the coarser hairs removed by hand or machine shearers. "Carotting," the next stage, is the sat-

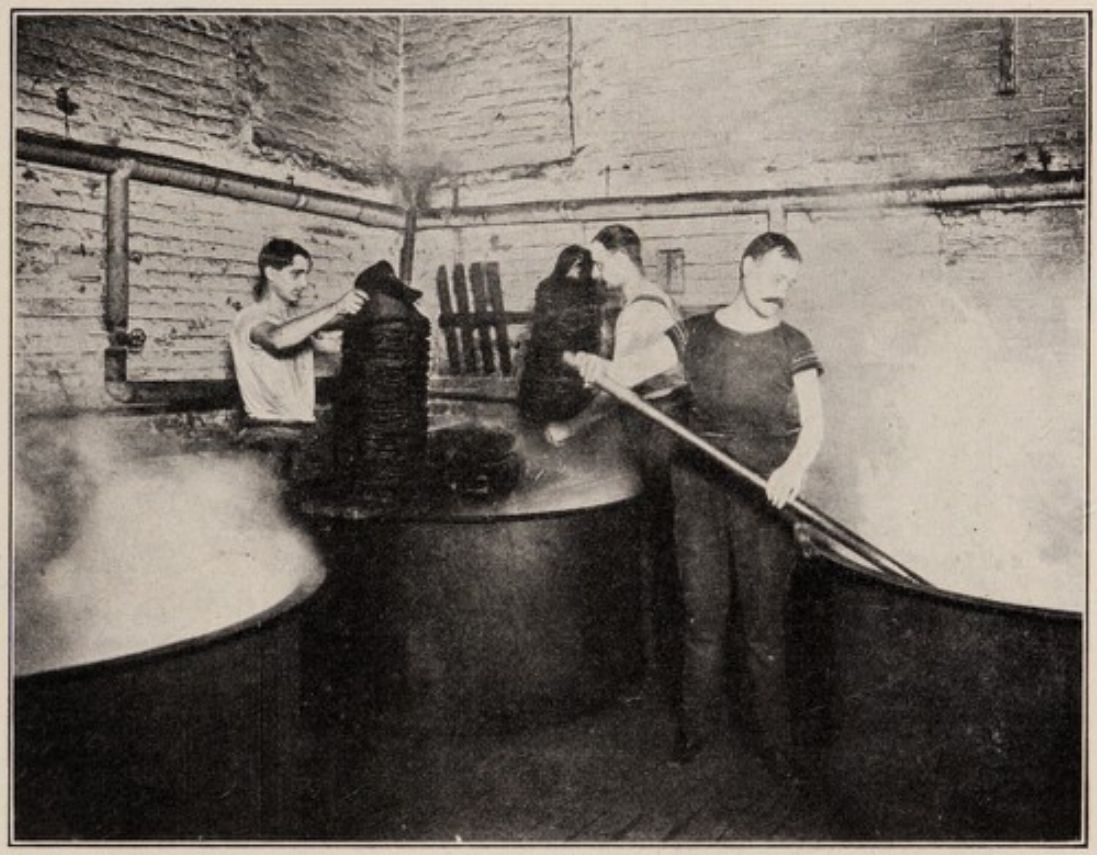


FIG. 46.—DIPPING FELT HATS INTO NITRATE OF MERCURY SOLUTION. Hazards: mercury, acid and steam inhalation.

uration of the fur with a solution of nitrate of mercury 11 to 20 parts in 100 parts of nitric acid at 36° C. (Fig. 46). The solution is scrubbed in with a brush, thereby twisting the hairs and roughening them so as to increase their adherent or felting properties, remove animal oil and make the hairs waterproof. The pelts are then set in ovens on trays to dry at a high temperature, further left a few days in a drying room, placed in bins and sprinkled with dilute acid. They are again dried and brushed, and cut by machines which rip off the skins, leaving the fur in masses. The fur is then placed in

a picking machine which teases or commingles the hairs, which are then separated by a blower, the hairs falling into different bins, according to their specific gravity. Some of the hair is picked and blown 24 times. The fur is then ready for the actual hat-forming process. Measured quantities of it are thrown over revolving hollow, perforated copper cones three feet in height, on which the preliminary

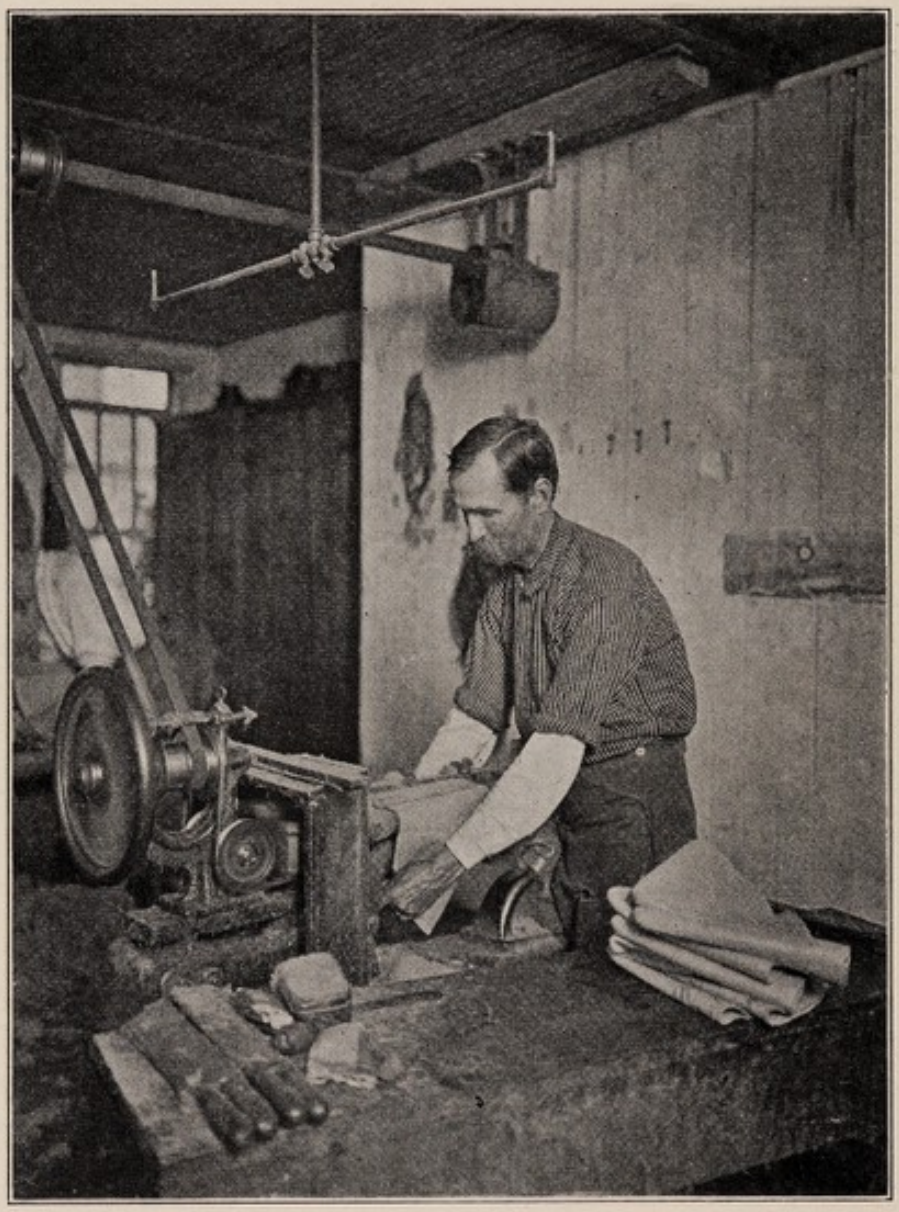


FIG. 47.—SHAVING FELT HATS.

shaping begins. The fur is then removed, after sprinkling with hot water, and rolled in burlap, or in a special machine. Another shaving removes any coarse hairs which still remain. Further

treatment with dilute sulphuric acid and other processes makes the fur compact, reduces the size of the hat, stiffens it and blocks it. Derby hats are coated with shellac under steam pressure to stiffen them. Many of these processes are wet and accompanied by much evolution of steam. The hat, after having been steamed, is stiffened, blocked and ironed, smoothed or "pounced" with sandpaper or emery wheels, and singed. The brim is cut, shaped, bound, lined and the inner band sewed on. Final smoothing is done with grease. It is impossible to use respirators in the more dusty processes, because they so soon clog with matted fur, and a system of strong exhaust fans is the only remedy for this hazard. The carotters should wear gloves, but the danger from mercurialism does not cease with the dipping process, for the dry fur dust which may later be inhaled is impregnated with mercury. Dr. Thorpe found in British hat factories as much as 1.34 per cent. of nitrate of mercury in dust taken from the cutting machines, often operated by women and girls. Jungfleisch recovered nearly 0.5 per cent. of metallic mercury from the cones (Rogers). In the shellacking process wood alcohol is used as a solvent for the shellac.

Symptoms.—Workmen who acquire chronic mercurialism complain of increasing headache, lassitude, weakness, insomnia and muscular pains. They become very anemic, lose weight, and are prone to resort to alcoholic stimulants to give temporary relief to their mental and physical depression and restlessness. They have strong, gross muscular tremors of the limbs and facial muscles which they call the "shakes." The tremors also affect the tongue and movements of the head, and the eyes roll from side to side (Teleky). There is albuminuria. The complexion is sallow and gray and the expression listless. Chronic pharyngitis, a metallic taste in the mouth, chronic gingivitis, fetid breath, vomiting and diarrhea are also observed. There are pains in the muscles and joints. A condition of advanced marasmus and asthenia finally supervenes. The mouth becomes dry and sore, the gums ulcerate, the teeth loosen, alveolar abscesses form, salivation is abundant. There may be muscular twitching as well as tremors. I have seen the latter so intense as to resemble superficially advanced paralysis agitans and the victim is

unable to convey the contents of a spoon or glass of water to the mouth without spilling, for the tremors are increased by volitional movements, unlike paralysis agitans. From these symptoms the patient may recover after a long interval of cessation of work, but too often he returns again and again, each time becoming worse, until he becomes a hopeless invalid, with trembling lips and tongue, hesitating, whispering speech, a peculiar drooping or drawn expression, a staggering, drunken gait and condition akin to senile dementia (Achille Monti, "Clinica delle malattie professionale," Milan, Ser. I, 1912).

Salivation is not invariably present—an important fact to remember—but usually the patient drools saliva to the extent often of several quarts a day. The salivary glands are swollen. The teeth are discolored and fall out. There may be caries of the jaw. The sputum raised in the morning is stained black with dust of fur. Asthma and emphysema may develop and chronic conjunctivitis and blepharitis are common. The paralysis usually first involves the hands and arms, and later may affect most of the body and legs. Mrs. Bates refers to a patient whose hands were so weak and tremulous that he had to hire a comrade to help him so that he should not tear fine hats in attempting to open them out. Such patients eventually become unable to feed or dress themselves. The tremors and paralysis are made worse by observation and criticism. In women who reach the stage of tremors and paralysis amenorrhea is common, or there may be miscarriage. If children are born they "are apt to be scrofulous, rachitic and mentally defective" (Bates). Convulsions may occur in childbirth.

The prematurely aged victims of chronic mercurialism sometimes become so despondent as to attempt suicide.

Mrs. Bates reports the poisoning of a boy of 14 years who had been employed in "sweeping the hat factory floor and feeding the machines with fur." He had partial paralysis of the arms and legs.

In chronic poisoning mercury, which circulates in the system as an albuminate, is very slowly eliminated, and traces of it may be derived from the saliva, urine and other secretions. In post-mortem examinations mercury may be found in the liver and brain, and

fatty degeneration involves the skeletal muscles, liver and kidneys.

Mercurial compounds, as handled by miners, smelters, photographers, felt hatmakers, etc., are sometimes so irritant to the skin as to give rise to a pustular type of eczema. Mrs. Bates found 20 cases of dermatitis among the felt hatmakers of New York City and New Jersey. I have seen several more.

Cases of dermatitis also have been described by Alderson (*Cal. State Med. Jour.*, April, 1910) as occurring in this country in the manufacture of blasting caps, using dry fulminate of mercury. In one case an erythemato-papular eruption involved the face, neck and forearms. There was severe conjunctivitis. In the beard the eruption became pustular. The eruption is naturally most intense where the skin is most sensitive, and is favored by perspiration. The disease lasts two or three weeks and is liable to recur, unless the skin is protected, for which purpose Alderson advises the following application:

℞ Sodii carbonatis..... gm. 30 } ℥ii
Aquæ destillatæ, q. s. sat. sol.....
Lanolini anhydrosi, q. s. ad.....c.c. 60 } ℥i

M. Sig.: Smear thoroughly over exposed parts before going into fulminate rooms.

Prognosis.—The lighter forms of mercurial tremor and such milder symptoms as usually affect quicksilver miners may be recovered from after a few weeks. The hatmakers, however, becoming expert in their work, are very apt to persevere in it after the first warnings of mercurialism appear, and, after reaching an advanced condition of marasmus, anemia and paralysis, become hopelessly invalided. They become an easy prey to some intercurrent disease or die from progressive inanition or in a hopeless condition of dementia or melancholia—a premature senility (Ludwig Teleky, "Die gewerbliche Quecksilbervergiftung," Berlin, 1912).

Prevention.—Mercury workers should hold the head turned away from escaping dust and fumes as much as possible and wear protective respirators. They should change their occupation frequently

from the more hazardous to less risky divisions of the work, and should be examined by a physician systematically at least once a fortnight. They should be clean-shaven and keep the hair close-cut. Women should either cut the hair short or wear tight-fitting oilskin caps.

Those employed in handling mercurial solutions, dust or metallic mercury should wash the hands frequently in sulphur water or in a dilute aluminum acetate or potassium permanganate solution. On leaving off work they should always wash thoroughly the hands, face and head. They should use individual soap, nail brushes and towels. It is most important to guard against looseness or decay of the teeth, and an alum or boric acid mouth wash should frequently be used. L. Carozzi ("Clinica della malatti professionale di Milano," Ser. I, 1912) cautions the workmen in mercury against the use of alcoholic drink, tobacco and fat foods (bacon, olive oil, butter, cream, suet, eggs, etc.) because fat promotes the emulsionizing and absorption of mercurial compounds. In foreign manufactories the workmen use a mouth wash of potassium chlorate before eating.

For the hazards of the felt hat industry Dr. C. T. Graham-Rogers suggests in the eleventh *Annual Report* of the New York State Commissioner of Labor, Sept., 1911, the following:

REGULATIONS FOR THE EMPLOYER

There should be an attending physician at each factory.

All employees should be examined physically every six months, and before returning to work after illness.

All cases of illness should be seen by a physician and the result, directly or indirectly, of the industry should be recorded in a book accessible to the Department.

A sufficient supply of wash basins (one to every five workers) with hot and cold water, soap and hand brushes should be provided.

Time should be allowed for washing before meals and before leaving the factory.

Overalls should be provided for males, and aprons and head coverings for females, the same to be discarded upon leaving the factory. Overalls, aprons and head coverings should be washed once a week.

Rubber gloves and aprons should be provided for workers engaged in the carotting process, the same to be kept in good repair.

No food should be brought to, prepared or eaten in a room where any of

the processes are carried on. A room for meals should be specially set apart for that purpose.

No person under eighteen (18) years of age should be employed in any process or room where dust or fumes are freely given off, or where shellac varnish is made or applied.

All workrooms should be ventilated by mechanical means so that an abundant supply of fresh air may be maintained.

Where dust is generated during the process of manufacture an exhaust system should be provided, consisting of hoods and piping connected to an exhaust fan of sufficient power to remove all such dust at the point of origin and in a direction away from the worker, the system to be operated during the time work is carried on.

In all carotting rooms artificial means for ventilation should be provided and maintained to remove fumes from the ovens.

All floors should be of such material as to be easily subjected to removal of dust by moist methods and should be cleansed daily.

The mixing of the carotting solution should be done in a special room provided for the purpose, or after working hours.

All rooms where wet processes are carried on should have an impervious floor and be properly drained.

Workers exposed to mercurialism should be alternately shifted to other work so as to lessen the danger.

Where illuminating gas is used to heat tools, apparatus or stoves, all fumes, gases or vapors generated during the processes of manufacture where such tools, apparatus or stoves are used should be removed from the point of origin by means of properly installed exhaust systems.

Notices regarding the danger of poisoning from materials used, the symptoms, remedy and preventive measures should be posted in each work room and dressing room, and in several languages.

Treatment.—The patient should be treated by means of hydrotherapy, electric light baths to induce perspiration, diuretics to promote renal elimination, and potassium iodid. The mouth should be rinsed frequently with an astringent and antiseptic wash, and the gums should be touched with argyrol. Excessive salivation may be controlled with atropin (gr. 1/100, bis die). Tremors may be relieved somewhat by massage, but more by improving general nutrition with an abundant diet of milk, cream, eggs and broths. As the mouth is often too sore to permit mastication, all food should be given in fluid or semi-solid form. Dilute hydrochloric acid, nux vomica and one of the simple bitters, such as compound tincture of cinchona or gentian, may be prescribed to aid digestion and appetite.

NICKEL

Nickel has no specific toxic action, but its ore is often impregnated with arsenic, and the process of nickel plating, galvanizing, etc., involves the same hazards as those described under "Gold," on page 189. A few cases are recorded of poisoning from nickel carbonyl.

PLATINUM

Platinum paper was formerly much used in photographic printing. Its manufacture and frequent use as well were sources of considerable irritation to the mucosa and skin, so much so that many photographers have resorted to substitutes for it. In 40 studios examined by the Illinois State Commission on Occupational Diseases (Jan., 1911) 8 cases of poisoning were found, the symptoms of which are described as follows:

"Pronounced irritation of the throat and nasal passages, causing violent sneezing and coughing; bronchial irritation, causing such respiratory difficulties as to preclude the use of the paper entirely for some individuals; and irritation, upon contact with the skin, causing cracking, bleeding and pain."

SILVER

This metal is obtained from its ores by amalgamation on fusing with mercury or lead. Vapors from the two latter metals may be evolved in the process, but poisoning is rarely experienced in this manner and pure silver is inert. Arsenic and antimony are often associated with silver in ores and may be volatilized in smelting processes.

Chronic silver poisoning, called, also, "argyria" and "argyrosis," is much less common at present than in former years. In fact, it is seldom met with except as a result of ignorance or gross carelessness. One of my cases was that of a man who had been given a silver nitrate spray to use for chronic pharyngitis, without warning as to its continued use. He used it several times daily for many

months and became of the typical bluish gray color all over the body which this salt produces. This, of course, was not an occupational disease. When argyrosis of occupational type occurs the pigmentation may be either universal or, more often, in localized plaques. The visible mucosa of the nose, mouth, pharynx and larynx is also stained of a bluish hue. The ear drums may be pigmented.

In 1896 Shubert reported several cases among Bohemian glass workers who used silver solutions to coat glass pearls, getting the stuff in some manner into the mouth.

Koelech (*Münch. med. Woch.,* Jan. and Feb., 1912) describes two industrial cases of general silver pigmentation of the skin in workmen who became affected either by dust inhalation or cutaneous absorption, or both. They cut silver leaf, laying it in booklets. One of them began work at 13 years of age and 5 years later first noticed the pigmentation, which grew steadily darker for 4 years, then remaining stationary until she was seen in her 27th year. The other woman began work at 14 years of age and 7 years later first noticed the pigmentation, which had lasted until she was seen in her 50th year. Both patients had suffered from anemia and digestive disturbances prior to the onset of the pigmentation, but when seen they appeared in ordinary health. In some cases a blue line appears, as in plumbism, at the margin of the gums.

The pigmentation of the skin in silver workers is due to the entrance of minute particles of silver dust beneath the skin, where they spread out to form bluish brown spots. Such pigmentation affects chiefly the exposed parts of the body, the face, hands and forearms. The more general argyrosis occurs only from absorption of silver salts which have been swallowed.

The medicinal use of silver nitrate for chronic diarrhea and other internal treatment has become obsolete, and for external use in the eye, nose and throat, etc., it has largely been replaced by colloidal preparations, argyrol, etc. It is still employed, however, in rectal irrigation in dysentery. Its trade use, beyond occasional discoloration of the skin, appears to do no harm, and the workmen in silver soldering, electroplating, etc., suffer from other metal poisons, acid fumes, etc., rather than from the silver itself. These haz-

ards are practically identical with those of gold workers, and are described under the heading of that metal on page 189.

TIN

Tin is not of itself to be ranked among the industrial metal poisons, but in making tin plate, sheet iron is dipped in baths of molten tin and sulphuric acid. In some factories where girls have been employed to carry the wet tin plates their clothing may be attacked by acid fumes, and cases have occurred in which there was a tendency to falling out of the hair and blackening of the teeth.

VANADIUM

Since its discovery by Sefström in 1830 vanadium has found increasing use in the arts. The pentoxid enters into developing solutions in photography, the trioxid and chlorid are used in calico and other cloth printing, and the most important use is that of the trioxid in steel manufacture to make a malleable ductile product. One of the important steel products in which it figures is in making the chassis of automobiles. The pentoxid has been given medicinally for a reputed effect upon metabolism, in anemia, lues, etc.

Symptoms.—Vanadium vapor, as well as the dust of its compounds, especially those of the trioxid, is poisonous. Wearing clothing which has been dyed by vanadium process has been known to cause toxic symptoms.

Dr. W. F. Dutton has lately described the symptoms as affecting the lungs, kidneys and alimentary canal with serious results (*Jour. Amer. Med. Assoc.*, 1911, 3.6). In a fatal case he found the lungs congested and the alveolar epithelium degenerated. The kidneys were hyperemic and in some other cases there has been acute hemorrhagic nephritis. Enteritis was also present. The red blood corpuscles are destroyed and a chlorotic anemia develops. There is an obstinate spasmodic cough with strong tendency to bronchial and pulmonary hemorrhage which may become fatal. The patient loses appetite, complains of nausea, fetid diarrhea, followed by constipation,

loss of weight and strength. The vapor irritates the eyes and nose, causing conjunctivitis, rhinitis and pharyngitis. The urine presents albumin, granular and blood casts and blood corpuscles. The blood pressure is raised. Headache, tremors and neuroretinitis are present, with amaurosis and mental disorders. T. Cruikshank has produced a similar group of symptoms experimentally in vanadiumized animals. The metal is eliminated in saliva, the feces and urine, in which its presence has been chemically detected.

ZINC

There has been much discussion as to the degree of toxicity of zinc. No doubt many of the toxic effects which have been attributed to it from time to time are due to the other metals associated with it in ores, which are principally lead, arsenic, antimony and cadmium. Sulphur dioxid is also present. In smelting as much as 2 or 3 per cent. of lead may be evolved. In addition various vapors and gases, such as sulphur, carbon monoxid and dioxid, are evolved during zinc smelting. Engraving on zinc plates is accomplished by means of chromic and phosphoric acids, and in one shop in which this process was conducted it was found that one-sixth of the workmen had been ill with symptoms which appeared referable to chromic acid (*See* page 171) rather than to any specific zinc poisoning.

Zinc white, or zinc oxid, is being increasingly used as a substitute for lead carbonate in the manufacture of paints (*See* page 214) on account of its apparent harmlessness, although the handling and sifting of the zinc powder are very dusty processes and should be conducted only under proper precautions against dust inhalation (*See* Dust Prevention).

Zinc smelters suffer more or less from chronic bronchitis and a moderate dyspnea which they term "asthma," and they are quite subject to tuberculosis. Of the 4,789 zinc smelters in Prussia, in 1905, 50 were reported as poisoned; probably, however, these cases were due to mixed fumes of various metals.

Lehmann and Lebord have given zinc white and various zinc salts to animals in large dosage without inducing toxic symptoms.

Zinc oxid is much used in the making of high-grade enamels for painting walls, hospital furniture, etc.

Symptoms.—Zinc fumes disorder digestion and irritate the stomach, causing gastralgia, nausea and vomiting. The skin acquires a grayish pallor. Workers in the production of sheet zinc, zinc white, battery plates, etc., sometimes suffer from chills, like brass-founder's ague, according to French writers, but they also are exposed to lead and arsenic.

The number of zinc foundrymen who at some period suffer from "founder's ague" is by some authorities stated to be as high as 70 per cent., yet I have heard owners of such foundries deny that their workmen suffered at all in this manner, and in E. R. Hayhurst's investigations in Illinois this ailment was found to be not very serious. A typical attack of zinc founder's ague is described as follows: Some hours after quitting work there are irritation and constriction of the throat. The patient feels chilly and the body shivers and shakes. There are muscular pains and cramps and more or less perspiration. There is a metallic taste in the mouth and there may be vomiting and palpitation. There is a slight fever, 100°-102° F., which lasts a few hours, and the duration of the entire attack is from 5 to 20 hours. Usually the patient is able to resume work the following morning, although the attack may be repeated several times. It is seldom that workmen are obliged to give up the work permanently on account of these attacks, for most of them acquire immunity. These ague attacks occur while smelting pure zinc when it reaches the temperature of volatilization. Workers in copper and iron never have such seizures. Zinc ague is worse in winter, when windows are kept closed and ventilation is poor. The attacks are said to be accentuated by excessive use of alcohol and tobacco. The workmen in the smelters in summer often have severe abdominal cramps due to an excessive consumption of ice water. Zinc poisoning may give rise to tetany with pain, cramps and spasticity of the muscles of the hands. It is most often met with in young persons.

An interesting non-occupational but nearly fatal case of zinc poisoning in early infancy was lately reported. The child's nurse diluted its milk with water drawn from the melted ice in a zinc-

lined refrigerator. The child acquired painful swollen joints, anemia and serious digestive disorders. How simple it would be to post a warning in all such receptacles against drinking or eating anything which has come into direct contact with the zinc!

Prevention.—Prevention is essentially that described for lead poisoning on page 271, and for metal poisons in general.

Treatment.—Treatment during the attack consists in drinking hot milk with bicarbonate of soda. The patient should go to bed, keep warm and subsequently take a cathartic. There is no specific treatment and zinc poisoning, unlike lead and arsenic, does not appear permanently to impair the health or cause destructive organic lesions.

II. TOXIC GASES, VAPORS AND FUMES

This subdivision is convenient, but is not an exclusive one, for the same substance may appear as a fume, a dust or solid, like phosphorus, under varying conditions. For example, fumes of white arsenic and certain other substances, on sudden liberation from a retort, may be precipitated as a dust, and sulphur dioxid or other fumes may be so attenuated as to constitute a gas.

The noxious gases, vapors and fumes which arise from various chemical substances not only affect the workman at his work, but, if he resides, as he often does, near to chemical manufactories where these substances are evolved in great quantity, the air which he breathes in his home may be contaminated as well. Professor Charles Baskerville, in the *American Labor Legislation Review,* vol. ii, 2, June, 1912, gives the following comprehensive summary of these poisons:

"The usual gases which give rise to complaint in manufacturing localities are the following: chlorin, which is emitted by pottery kilns and ceramic-products manufactories, and from plants for the electrolysis of halids; hydrogen chlorid, which is produced by the combustion of coal, and by pottery kilns, ceramic-products manufactories (partly from the coal and partly from the clay), nickel and cobalt smelting, platinum refining, glass manufactories, fertilizer manufactories, the chlorid of lime industry, and alkali manufac-

tories; sulphur dioxid and sulphuric acid, which result from the combustion of coal, coke, petroleum, and gas, copper smelting, bleaching operations, etc.; fluorids and hydrofluoric acid, which are emitted from acid phosphate and heavy chemical plants; hydrogen sulphid, from chemical works, especially those which produce ammonia; carbon monoxid, which is emitted from iron furnaces and from copper smelters; organic vapors, from, for example, glue refineries, bone burners, slaughter and packing houses; zinc fumes from zinc smelters and from brass foundries; arsenical fumes from copper smelters; phosphoric fumes from match manufactories; and carbon disulphid and sulphur chlorid from some rubber works."

Lehmann has compiled the following table to illustrate the degree to which these poisons are injurious to the workman, estimated per 1,000 parts of the air he may breathe:

Name of Gas	Rapid and Dangerous Injury	Bearable for 30 to 60 min. without Grave Effects	Trifling Symptoms after Action for Some Hours
Hydrochloric acid.....per 1,000	1.5—2	0.05	0.01
Sulphurous acid ..... " 1,000	0.4—5	0.05	———
Carbonic acid..... " 1,000	About 30	6 to 8	1 to 2
Ammonia..... " 1,000	2.5—4.5	0.3	0.1
Chlorin; Bromin..... " 1,000	0.04—0.06	0.004	0.001
Iodin..... " 1,000	———	0.003	0.005—0.001
Hydrogen sulphid..... " 1,000	0.5—0.7	0.2—0.3	0.1—0.15
Carbon disulphid ..... " 1,000	0.01	0.002	0.001
Carbon monoxid..... " 1,000	2 to 3	0.5—1.0	0.2

Professor Baskerville also furnishes the following summary: "Of the gases which affect the respiratory passages and eyes the most important are the following: illuminating gas, gases from coke and coal; carbon monoxid; carbon dioxid (in brewing, baking and the manufacture of aerated waters); chromic acid; chlorin; sulphuric, hydrochloric and nitric acids, and nitrogen oxids (in acid factories, heavy chemical works, engraving, etching, lithographing, etc.); mercury cyanid; heated lead; ammonia; naphtha and benzene (petroleum refineries and dry-cleaning establishments); arseniuretted hydrogen (copper refineries); sulphur, hydrogen sulphid, sulphur dioxid, and carbon disulphid; sulphur chlorid, nitrous gases, hydro-

cyanic acid; smoke (fire extinguishing); and the vapors of various organic compounds and substances (tar, creosote, carbolic acid, petroleum and its products, methyl alcohol, fusel oil, varnish solvents, dinitrobenzol, nitroglycerin, formaldehyd and formic acid, pyridin, etc.)."

The methods of reducing the risks from inhalation of toxic gases, vapors and fumes, smoke, etc., are thus classified by Dr. George M. Kober in the *Report* of the President's Homes Commission, 1908: "(1) Condensation; (2) absorption by water or chemicals; (3) destructive distillation by heat in a closed vessel; (4) combustion of gases that can be burned; (5) forced ventilation and the discharge of gases into the air at great height."

ACETALDEHYD OR ETHYL ALDEHYD

This substance is a very volatile liquid, without color and having a decidedly pungent odor. It is developed in connection with the making of vinegar, and is used in the modern method of making mirrors with silver. Being highly volatile, it is irritant to the respiratory mucosa, from which it is absorbed, and causes increase in the pulse rate, weakness and sweating. It gives rise to conjunctivitis and coryza, cough and bronchitis.

ACROLEIN

This substance is a colorless fluid of acrid taste and pungent, disagreeable odor. It is developed in connection with the various organic fat industries, as in fat and bone-rendering establishments, tallow making, soap and stearic-acid making, varnish boiling and the manufacture of oilcloth and linoleum.

Inhaled as a vapor, it irritates the mucous membranes, causing rhinitis, pharyngitis with constriction of the throat, and bronchitis, with itching in the throat, lacrimation and conjunctivitis.

AMMONIA

A number of trades are concerned with the handling of ammonia. The manufacture of the so-called "household ammonia," so largely

used for cleaning processes, the making of the chlorhydrate, sulphate and carbonate of ammonia, the tanning of leather, the making of ammonia for general chemical and drug purposes, and the extensive use of ammonia for producing artificial ice and refrigeration, all constitute common sources for liberation of free ammonia gas. It is also liberated in the Schlœsing process of making synthetic soda by mixture of sodium chlorid and ammonium bicarbonate. Ammonia may be inhaled by those who handle manure (especially horse dung), artificial fertilizers, and it is extensively used in cleansing various fabrics.

Pathology.—Experimentally ammonia produces in animals spasm of the glottis, and, according to Hirt, pulmonary congestion and emphysema. It favors the production of exudates. An atmosphere containing 10 per cent. of ammonia vapor may not be incompatible with life, but is irritating to the eyes and respiratory system.

Symptoms.—The conjunctivæ, when much irritated by ammonia vapor, may develop vesicular conjunctivitis, or a pseudomembranous croupous inflammation, with much pain, lacrimation and photophobia. The inhalation of ammonia vapor gives rise to instant spasm of the glottis and thus may prevent much of the vapor from entering the lungs, but the victim becomes asphyxiated, deeply cyanosed and dyspneic. Congestion of the buccal and pharyngeal mucosa takes place. There are sneezing and irritant dry cough, with subsequent bronchitis. There is an intolerable sensation of choking and burning in the throat. There may be violent vomiting and a rapid pulse. The perspiration acquires an ammoniacal odor. The poison usually is not fatal, but irritation of the pharynx, coryza and dyspnea may last for several days after exposure to the fumes. If large quantities are inhaled, however, the larynx and epiglottis may become acutely swollen, dyspnea is extreme and the victim may die in coma. It is irritating in less than one-thousandth part per volume of air.

Treatment.—Cold compresses and a saturated aqueous solution of boric acid should be applied frequently to the eyes, and demulcent drinks should be given to allay the irritation of the mouth and throat.

AMMONIUM CHLORID

Sal ammoniac is used in galvanizing zinc, being poured upon the molten metal. The fumes which are thereby given off in considerable volume are intensely irritating. It frequently happens that firemen are obliged to enter chemical works or other buildings where this substance is stored, and its liberation from bursting of the retorts is a serious menace to their lives. The fumes cause choking and intense dyspnea, cyanosis and a feeble pulse. Fatal edema of the lungs may ensue.

AMYL ACETATE

Amyl acetate is used as "zapone," a solution of celluloid in acetone and amylacetate. Zapone is employed to lacquer metal ware and jewelry. It is also used in preparation of metal wire for incandescent lamps and in oilcloth and patent-leather making. Inhaled as a vapor, it is absorbed, giving rise to nervous and circulatory phenomena such as fullness and pain in the head, vertigo, numbness and palpitation. There are also nausea and vomiting.

AMYL ALCOHOL

Amyl alcohol is the chief component of fusel oil, and is used in preparation of fruit essences, amyl nitrite and anilin dyes. When inhaled as a vapor it gives rise to vertigo and headache, tinnitus aurium, faintness, lowering of blood pressure, nausea and vomiting.

ANILIN

Anilin is a highly toxic volatile substance derived as a by-product in coal tar distillation, and indirectly from benzin. Its toxic action is mainly through the circulation after inhalation, but if it is swallowed it is also poisonous. It may also be absorbed through the unbroken skin. There is recorded the case of a workman who

died from anilin poisoning soon after spilling a solution of hot anilin over his body.

Anilin, anilin oil and various anilin compounds are extensively used for coloring in the liberal arts, and cases of "anilinism" may be found in almost every anilin works. Bachfeld observed 63 cases during 9 years in one manufactory in Germany, and in the district near Düsseldorf 24 cases were observed in 2 years. In a manufactory in Elberfeld employing 5,000 workmen more than 260 cases have been known to arise within a single year. Grandhomme collected 109 cases in France in a period of 10 years. Anilin is widely used in the textile industries for dyeing, and in some trades, such as the making of wall papers and artificial flowers, it has largely superseded the use of arsenic compounds and other poisonous pigments.

In cotton printing, for example, anilin is inhaled both as a vapor in the warm, moist dyeing rooms and as a dust in "napping" and finishing processes (*See* Cotton). Its toxic action is worst in the more highly heated rooms, as in drying rooms, where the temperature may reach 120° to 140° F. Its various combinations differ much in toxicity. Anilin blue is highly toxic, much more so than fuchsin. Wood alcohol is considerably employed as a solvent for the anilins.

The vapor of anilin is toxic in a strength of 0.1 volume per cent., according to Hirt.

Proust ("Traité d'hygiène") relates the case of a chemist who broke a flask containing a liter of anilin which spattered over his clothes. He promptly removed them, but notwithstanding became seriously ill for two days.

The case is reported in *Sozial Technik,* 1912, vol. iv, no. 2, of an Austrian employee in color works who acquired anilin poisoning from eating his luncheon without previously cleaning his hands.

Symptoms.—Anilin poisoning may be either acute or chronic. The acute cases are mild or severe ("massive").

Mild Acute Cases.—Anilin poisoning in mild acute cases, especially among new workers, is characterized by feelings of lassitude, weakness, vertigo, fullness in the head, and orbital pain.

The eyes are dull, speech is slow and hesitating, and the gait is shuffling and uncertain, so that the patient may appear drunken. There is pallor of the face, and the lips and finger tips are cyanotic. There is desire for frequent micturition and the urine is very dark. The patient usually recovers after some hours in fresh air. The symptoms are always more severe in hot weather. In exceptional cases the patient has no subjective symptoms, but shows pronounced cyanosis.

Severe Acute Cases.—When a large quantity has been inhaled or the workman's clothing has been saturated suddenly with anilin the symptoms become much more grave, and are: delirium or coma, epileptiform convulsions, general tremors, irregular, slow respiration and rapid, feeble action of the heart. There are hemolysis with vertigo, headache, nausea, vomiting and cough. The blood gives the spectroscopic band of methemoglobin, and the mucous membranes of the lips and mouth may appear almost black. The pupils are narrow, but react to light. The patient may stagger and fall to the ground. The exhaled breath has a strong odor of anilin. Sensibility is diminished. The pulse is small and feeble. Respiration is slow. In exceptional cases there may be strangury, with dark concentrated urine which contains anilin. The neck may become rigid; the pupils finally become dilated; the skin is cold, insensitive and bathed in perspiration; the face is pale and cyanotic, almost black; the temperature is subnormal. Such attacks may come with great suddenness. After some hours apparent recovery ensues, but in an hour or two the symptoms may all return. The workman may go home apparently well, and have an attack develop suddenly the next day. Final recovery is the rule, however, leaving the patient with severe headache and sensation of fatigue. It is important on coming out of an attack to keep the victim awake (as in opium poisoning), otherwise he is liable to a relapse. Proust refers to a workman in Paris who suddenly fell inert with cyanosis and shivering. He was given a bath of acetic acid and walked up and down in the fresh air by two comrades who kept him awake until he recovered. In still more serious cases the victim may suddenly fall to the ground; the mucous membranes are black, the skin is cold and

pale, the pulse is almost imperceptible, breathing is slow, and death may result in coma or convulsion.

Hausermann and Schmidt reported the case of a workman who spent half an hour at work in anilin preparation in a closed compartment. Symptoms came on several hours later with fatal issue. Fatty degeneration of the liver has been reported.

Chronic Anilin Poisoning.—Chronic anilin poisoning gives rise to anemia, bronchitis and predominating nervous symptoms. Graham-Rogers, referring to anilin calico dyeing, says, "with few exceptions all workers in this industry are pale." The chief symptoms are headache, tinnitus and disturbances of motility and sensation. The mind is dull. Vomiting and diarrhea may occur. Pustular eczema and ulcers may involve the hands, scrotum, and sometimes other parts of the body when the clothing has been saturated with the material. The cyanosis, which appears to be always accentuated in hot weather, is known by the workmen as "the blues."

Anilinism materially weakens the resistance against other diseases. Men employed in anilin works who handle anilin and other petroleum by-products are frequently subject to carcinoma of the bladder and testicles. In 1904, in 18 anilin works in Germany, 28 such cases developed. There are preceding hematuria and strangury.

In 1910 six more such cases were reported ("Gefahren der Arbeit in der chemischen Industrie. Verband der Fabrikarbeiter Deutschlands," Hanover, 1911). Linenberger believes that a primary chemical irritation of the mucous lining of the bladder induces the carcinoma which may form at the site of a polyp or some benign tumor. The carcinoma appears early, at between 30 and 40 years of age.

Prophylaxis comprises free ventilation by forced drafts of the workrooms, and the workmen should, when possible, be changed frequently to the least harmful departments of the work.

Treatment.—The victim should be taken into the open air and kept awake if possible. He should be sponged with acetic acid (or vinegar) and ammonium acetate, and strong black coffee should be freely given. In the mild cases saline laxatives should be given. Serious cases demand hypodermatic stimulation of the heart by

means of digitalis, strophanthin, ether or camphor. Strangury may be relieved by suppositories of hyoscyamus and opium. Strong coffee should be drunk and oxygen may be inhaled. Alcoholic stimulation should be avoided.

Warm saline solutions should be given by hypodermoclysis and by rectal injection. In extreme cases they should be given by venous infusion. Direct venous transfusion may be tried, preceded, if the pulse be not too feeble, by moderate venesection, of 10 or 12 ounces. The management of the case is virtually that of carbon-monoxid poisoning. (Page 326.)

ARSENIURETTED HYDROGEN

Arseniuretted hydrogen gas is developed in soldering and treating zinc and iron with mineral acids. It is liberated from ferro-silicon when the latter comes in contact with water.

It is extremely toxic to the blood and dissolves the red corpuscles apparently without previous methemoglobin formation. (*See* Ferro-silicon.) It causes chills, nausea, vomiting, hematemesis, vertigo, fainting, dyspnea, pains in the back, hematuria, jaundice, congestion of the liver and spleen, and sometimes fatal asthenia.

BENZENE (COMMERCIAL OR IMPURE)

The benzene of commerce is usually impure, and associated with it are methyl and phenyl carbylamins.

Benzene may be absorbed by the hands if immersed in it or the vapor may be inhaled. The inhalation in a confined atmosphere in processes such as "dry cleaning" and scouring of clothing, gloves, etc., dyeing, making of rubber shoes and other rubber articles gives rise to toxic symptoms. Benzene is also used in quick-drying paints and in extracting fats to clean bones for fertilizers.

Pathology.—Autopsies which have been performed in fatal cases have revealed fatty degeneration of the liver, kidneys, pelvic viscera, heart and endothelium of the arterioles. In a case examined by Lenoir and Claude widespread hemorrhagic lesions were found as

follows: hemorrhagic pleurisy, myocardial and subendocardial infarcts, ecchymoses in the gastric and intestinal mucosa, hemorrhages in the optic commissure and at the base of the brain. In such cases the benzene oxidizes in the blood to form phenol-glyceronic acid and hydroquinon, with a resulting widespread hemorrhagic purpura of the skin, mucous membranes and viscera. Blood pigment is deposited also in the lymph glands.

Symptoms.—Benzene poisoning presents three clinical forms, as classified by Proust ("Traité d'hygiène"): (a) mild acute cases, (b) serious acute cases, and (c) chronic cases.

(a) *Mild acute cases* arise from inhalation of cold benzene vapor. The symptoms are those of mild intoxication, namely: headache, vertigo, nausea, formication in the fingers and weakness in the legs. These symptoms usually pass off promptly on coming into fresh air.

(b) *Serious acute cases* arise from inhalation of hot benzene vapor. The symptoms are mainly nervous and vascular. The victim has profound sensory and cerebral symptoms such as anesthesia or hyperesthesia, aphasia, amblyopia, muscular cyanosis, weakness, narrow pupils, hallucinations, delirium and epileptic convulsions followed by usually fatal coma, with subnormal temperature and feeble, slow heart action. There may be salivation and ecchymoses.

(c) *Chronic cases* present varying degrees of toxicity. Glove cleaners and rubber goods makers may have polyneuritis. Various cases have been reported having such symptoms as facial paralysis, brachial monoplegia (a case of Guyot's), tremors and formication. There is some degree of loss of power in the arms, and especially of extensors of the fingers. The reflexes are diminished and there is incoördination with a "steppage" gait. Mental confusion and loss of memory are observed.

Absorption of benzene through the hands gives rise to localized congestion, tremors and ague. Benzene workers have occasionally developed hematuria and vesical carcinoma. Among 1,380 benzene workers examined by the Prussian Ministry of Commerce and Industry, 9 had general poisoning and 34 had acne.

A case of benzene poisoning in a linotypist was seen in the Milan

Clinic, in 1911 (L. Carozzi), and Meisser, in 1907, reported the cases of three workmen who became unconscious while using benzene in a carpet-cleaning plant. Saupesseu, of Stockholm, in 1897, collected 9 cases of chronic benzene poisoning. Lenoir and Claude reported a fatal case with purpura.

Prevention.—Workers in benzene should protect the hands by coating them with glycerin or other insoluble material, rubber gloves not being suitable. Free ventilation is the only real preventive of poisoning. Benzene should never be used in confined air spaces. There is no special treatment for the nerve symptoms other than abundant fresh air and rest. In the hemorrhagic acute cases calcium chlorid may be given and blood transfusion might be tried, although it promises little relief.

BENZOL OR PURE BENZENE (C_6H_6)

Benzol or pure benzene is used to make nitrobenzol, phenol, anilin, and, in pharmacy, to recrystallize many preparations after their solution. Although poisoning by benzol is rarely fatal, both acute and chronic cases are observed, chiefly among workmen employed in cleaning out the distillation apparatus in which the product is manufactured. Benzol was formerly much used for cleaning, and produced numbness and formication of the hands, but naphtha now largely replaces it. It is used to remove old paint and varnish and as a "primer" for hardwood.

Acute Poisoning.—Acute poisoning results from inspiring a large quantity of the vapor in a confined atmosphere. The symptoms are violent and alarming, consisting of vertigo, faintness, hallucinations, muscular prostration, nausea and vomiting, a quick, feeble and sometimes irregular pulse, cyanosis, cold perspiration, dilatation of the pupils, tingling of the fingers, and finally delirium, convulsions and paralysis. There is fragmentation of the red blood corpuscles and the hemoglobin is converted to methemoglobin. The poison is eliminated through the kidneys, being converted into sulphuric and glycuronic acids. Buchman has reported (*Berliner klin. Woch.*, May 22 and 29, 1911) a fulminating case in which the patient

died before many symptoms had time to develop, and an autopsy revealed only general visceral hyperemia. In such cases delirium and coma may precede death.

Chronic Poisoning.—Chronic poisoning gives rise to vertigo, headache, faintness, tinnitus aurium, loss of appetite and dyspepsia. In some cases an epileptiform condition has persisted. There are tremors of the hands and arms and dryness of the skin. In Baden, in 1908, two fatal cases occurred which suddenly developed hemorrhagic purpura with hemorrhages from the nose and mouth and into the skin. Beinhauer (*Münch. med. Woch.,* 1896, vol. 43, p. 915) reports a similar fatal case with parenchymatous degenerations. The pathological lesions of chronic benzol poisoning are mainly of the nature of fatty degenerations of such viscera as the kidneys and liver and of the bloodvessels. Ulceration of the gums and lips occurs. R. von Jaksch ("Die Vergiftungen," 1910) says that inhalation of benzol vapor may rapidly prove fatal.

Two fatal cases of chronic benzol poisoning were lately studied in the Johns Hopkins Hospital. The victims were girls employed in a canning factory, sealing cans with rubber dissolved in benzol. They developed anemia, purpura and hemorrhages from the nose, lungs and other mucous surfaces. The leukocyte count in one case dropped to 500. Experiments upon rabbits produced a similarly extraordinary leukopenia. (*See* Diseases of the Blood.)

This remarkable property of reducing the number of leukocytes in the blood, possessed by benzol, has lately led to its introduction in medicine as a remedy for myelogenous leukemia by Von Koranzi (*Berliner klin. Woch.,* 1912, xlix, 1857). He studied the results of benzol poisoning in girls using rubber dissolved in benzol to make a cement employed in the manufacture of tin cans. The substance appears to stimulate the activity of the bone marrow. From 3 to 5 grams are given daily in capsules, and may cause a fall to normal of the excessive leukocytes in leukemia. Overdoses cause vertigo, nausea, tracheobronchitis and gastric burning, with eructations and a taste of benzol in the mouth. Toxic erythema and pruritus have been observed. These symptoms may also appear when the vapor of benzol is inhaled in excess. Frank Billings and L. Selling de-

scribe several cases of leukemia which were much benefited by the treatment, but the former describes it as a "two-edged sword which, if used carelessly, may produce grave aplastic anemia and hypoplastic bone marrow." Wachtel has reported two cases of myeloid leukemia, in one of which benzol reduced the leukocytes from 102,000 to 8,000. The myelocytes, however, remain relatively numerous. Hemoglobin is increased, as is also the number of erythrocytes in moderate degree.

In a case of K. Jespersen (*Hospitalstidende,* Copenhagen, lvi, no. 7, p. 153) the leukocyte count under benzol administration fell in 10 days from 250,000 to 61,000, and subsequently to 5,000, but in a fatal relapse it rose again to 750,000. The dosage did not exceed 5 grams per diem. Unfortunately the remedy is not without danger, and tends to cause albuminuria and other unfavorable symptoms. A physician who took the remedy himself for leukemia told me that he was made seriously ill by it.

BROMIN

Bromin is of limited use in chemical manufactures, especially in the making of drugs (bromids, etc.).

Bromin vapor is somewhat less toxic than chlorin, and acts in a similar irritative manner upon the respiratory and digestive tracts.

Symptoms.—Acute bromin poisoning gives rise to conjunctivitis, coryza, salivation, nausea, brown discoloration of the mouth, choking sensation, hoarseness of the voice, vertigo, a dry cough, dyspnea, bronchitis, muscular weakness, and, in severe cases, convulsions and coma.

Schuler has reported three cases of poisoning, one of which was fatal, and in all of which there were muscular tremors and spasm, with subnormal temperature. In fatal cases suffocation results from spasm of the glottis, which is accompanied by anxiety amounting to terror.

In chronic cases there are dyspepsia, palpitation, dyspnea, coryza, cough and skin eruptions such as prurigo.

CARBON BISULPHID

This substance, which is a colorless, volatile, foul-smelling liquid, is highly inimical to life and may poison both those who make it and those who use it in any of the numerous industries in which it is employed. Its manufacture is conducted on a very large scale, many million pounds being produced annually in Europe. It is made by passing the vapor of sulphur over heated charcoal, condensing and distilling.

The most extensive use of this substance is in vulcanizing rubber and waterproofing materials. In this process the rubber is plunged into a solution of 100 parts of carbon bisulphid and 1 part of protochlorid of sulphur. The process has to be conducted in a hot room, at about 120° F., where there is much evaporation, and, furthermore, the substance is easily spattered on the hands and clothing. The substance is used to some extent in the extraction of fats and textile industries. Cases of poisoning by this substance are much less common at the present time than formerly.

Carbon bisulphid is absorbed through the skin and mucous membranes of the mouth and respiratory passages. A proportion of 0.5 to 1.0 of CS_2 to 1,000 of air is toxic. As soon as the vapor is absorbed it transforms the hemoglobin to hematin, and the latter pigment, being eliminated by the urine, imparts to it a brown-black color when Fehling's solution is added. Elimination of carbon bisulphid takes place also through the perspiration and lungs, but the process is very slow.

Symptoms.—Acute Poisoning.—Acute poisoning is rare. The patient complains of fullness in the head and ears, vertigo and disturbances of vision. He becomes as if intoxicated, is loquacious, and performs impulsive acts guided by hallucinations. He becomes pale and perspires easily. Dyspnea, palpitation, nausea and vomiting, with subnormal temperature and an odor of rotten eggs in the breath, are further symptoms. The pupils do not react to light and the extremities are relaxed. Anesthesia is present and reflexes are abolished. There may be slight elevation of temperature and deafness has been observed. There may be convulsions, but the poison is

rarely fatal, despite the severity of the symptoms, although a few fatal cases with profound coma are recorded (Wyle). The patient may recover with fair degree of promptness or a chronic condition of anaphylaxis may ensue in which the patient remains dull, depressed and has weak muscles. The urine, like the breath, may have a sulphurous odor.

Chronic Poisoning.—The symptoms of chronic poisoning are numerous and serious. In the milder cases they consist of headache, vertigo, confusion of vision, irregular pains in the extremities, dysesthesia, anorexia, nausea, vomiting, constipation, insomnia and mental depression. In severe cases there may be dyspnea, paralyses of the legs and bladder, with painful micturition and sometimes albuminuria. The urine has a sweetish odor. The sexual function is at first stimulated, later absent. There are eructations and a disagreeable taste in the mouth, which may become inflamed. Anemia is common, but disturbances of the circulation other than slight palpitation are not common. Conjunctivitis is present and there may be erythema and acne.

In chronic cases in which the poison has been absorbed slowly over a considerable period of time the symptoms are mainly motor, sensory and psychic. They may be divided conveniently into (a) a period of excitement and (b) a period of depression, and comprise many neurasthenic and hysterical phenomena, with more serious mental disorder.

(a) *Period of Excitement.*—The victim complains of headache and vertigo. There are exaggerated muscular excitability and contractures, cutaneous hyperesthesia and formication. The patient's manner becomes agitated. He is loquacious, restless, laughs without reason, has fits of violent anger, and shows mental alienation, so that the contact of his own hand feels like that of another person.

(b) *Period of Depression.*—The victim now becomes gloomy and morose. The muscles are weak and the gait is staggering. There are disturbances of vision and insomnia. Digestion is disordered, and there may be colic, with flatulency, diarrhea and attacks of vomiting. The symptoms constitute a pseudo-tabetic state. Tremor, so common in mercury poisoning, is rare, but there may be

paraplegia or hemiplegia and muscular contractures and atrophy, although the electrical reactions remain undisturbed. There may be slight facial spasm or tetany, which French writers term *pseudo-tétanique*. Sometimes there are severe muscular cramps. There are headache, vertigo, visual hallucinations and bad dreams, dullness, vertigo, sensations of fatigue or of shooting pains in the extremities, and disturbances of special sense.

Grave psychic disturbances are very common, occurring in more than three-fifths of the cases. The gait and speech are uncertain. Hemianesthesia is not uncommon and the nerves of special sense may be involved. Taste and smell may be diminished or absent. There is also often a variety of ocular symptoms such as conjunctivitis, epiphora, corneal anesthesia, amblyopia, paralysis of accommodation, opacity and a condition suggesting albuminuric retinitis, with an atrophic, pale disc and pupillary inflammation. Other symptoms which have been observed in some cases are: testicular atrophy, premature cessation of menstruation or dysmenorrhea, and, quite rarely, an irregular melanoderma such as one may see in chronic arsenic poisoning. The patient may complain of a sensation of cold or anesthesia on immersing the hands in warm water. The final mental state is one of simple chronic dementia which follows the intoxication hysteria.

Prognosis.—Although death from chronic carbon disulphid poisoning is rare, complete recovery may not take place, and psychic or other symptoms may persist.

Prevention.—Prevention is most important. Complete ventilation of the vulcanizing workrooms must be secured and the hours of labor should be restricted to not more than 4 hours a day, or more than one week without an interval of change of occupation. In England employees are not permitted to work with carbon bisulphid more than 2½ hours at a time, or for more than two such periods in a day. All workmen should frequently be subjected to a thorough physical examination.

Workers in carbon bisulphid should be selected carefully, and all alcoholic, neurasthenic or hysterical subjects should be excluded as being especially prone to this type of intoxication when exposed.

Every care should be exercised to secure proper forced ventilation with exhaust ducts (*See* page 109). Overalls should be worn while at work. They should never be worn away from the factory and should frequently be washed. The facilities and rules for washing described on page 91 should be provided. Workmen should protect the hands constantly by impermeable gloves. Poincaré claims that hydrated lime and sulphur may be used for vulcanizing to replace the noxious carbon bisulphid, and it is by some such substitution that the best hope is offered of relief from a very serious hazard which has already caused much deplorable chronic invalidism; for, although the results of this poison are not apt to be fatal, one can but feel that they might better be, rather than be allowed to produce permanent dementia.

Treatment.—Treatment is purely symptomatic, as no reliable antidote is known. The psychoses may require institutional care.

CARBON DIOXID

This gas exists both as a natural and artificial product. As the former it is found in volcanic caves; mines of all kinds, where, occurring with marsh gas, it is known as "choke damp"; at the bottom of deep wells; in sewers; peat bogs and marshes; deep cellars; tunnels and in cemeteries. Water may rise in deep pits and force the gas out.

Workmen employed in these various situations may be overcome by the gas, and others going down to rescue them may also lose their lives. In France five deaths have lately been reported in different places from this cause, and five more occurred in Bègles, among workmen in sewers.

As an artificial product or by-product in various industries carbonic acid gas is very often produced in dangerous quantity. This may take place in sugar refineries, starch factories, paper mills, lime kilns, print works, beer vats, in large wine presses and cider cellars, where the gas is a product of fermentation. Men who enter charcoal pits to clean them meet with both carbon dioxid and monoxid. In smelting works, roasting ovens, gas works, the bottling of mineral

waters, either natural or artificial, carbonic acid gas is evolved in excess. Seltzer water, for example, often contains 3 per cent. of CO_2.

Five per cent. of carbonic acid gas in the air may be breathed without inconvenience, but ten per cent. causes constriction of the larynx and dyspnea, and 20 or 25 per cent. gives rise to fatal asphyxia, for the gas itself is an intoxicant, besides replacing the oxygen of the air. These percentages are distinctly toxic, but the presence of 10 parts of CO_2 per 10,000 volumes of air, when present in a close room, is taken as a maximum beyond which the air, being vitiated with other products of exhalation, becomes unfit to breathe. (*See* Ventilation, page 100.)

It is customary to lower a lighted candle into deep holes in which CO_2 may have accumulated, but it should be emphasized that a candle may still burn feebly in an atmosphere which will not support animal life. A safer test, therefore, is to let one of the lower animals, such as a pigeon, down into the hole, to determine whether the air is also respirable by man.

Men employed in cleaning sewers, on submarine boats and in many other situations where CO_2 may be present in confined space may be overcome by this gas. In the historic prison, the Black Hole of Calcutta, in 1756, in a room about 6 yards square, 145 prisoners were confined, and in 12 hours 122 of them were dead from asphyxia from their own CO_2 exhalations.

A victim of carbon dioxid poisoning was reported in 1912 to the New York State Bureau of Labor. It is customary to "wash out" the carbon dioxid gas always remaining in the beer fermenting vats after the liquor has been drawn off, but the man entered a vat before this was done and lost his life in consequence.

Symptoms.—Symptoms of CO_2 poisoning may be acute or chronic. In acute cases, where the victim has been exposed suddenly to a large volume of the gas, he falls to the ground unconscious, with complete muscular relaxation, deep dyspneic breathing, deep cyanosis and a feeble, quick pulse. If not immediately rescued by artificial respiration he dies of asphyxia.

Experimentally the gas has been used to produce anesthesia, for

if oxygen be supplied with it its effects are not fatal, although they are too difficult to control to make this use of the gas satisfactory.

In chronic poisoning there are anemia, cyanosis, headache, drowsiness, vertigo, tinnitus and general "nervousness," with anorexia and a sensation of heat in the epigastrium. Sodium binoxid in cold water liberates oxygen by decomposition, and the sodium fixes the CO_2 present in the atmosphere, hence this substance may be used in submarines and similar confined spaces to render the air more respirable.

Treatment.—Treatment of carbon dioxid poisoning consists in performing artificial respiration, giving oxygen inhalation and stimulating the heart action hypodermatically with camphor, ether, or strophanthin.

CARBON MONOXID AND ILLUMINATING GAS

This gas is both a natural and an industrial product. In the latter state it is produced in large amount incidental to many manufacturing processes and is extremely toxic. It is formed in practically all slow-burning fires and hence is evolved in connection with lighting and extinguishing furnace or oven fires. The danger incurred through its presence is enhanced by the fact that it is both colorless and odorless. It is developed in all manner of subterranean work, and particularly in mines and tunnels, as a result of incomplete combustion of dynamite and powders of different grades. It is liberated in such cases in connection with CO_2 and nitrous fumes. It is liable to poison workmen in caves, deep trenches, and plumbers looking for gas leaks. It is very abundant in coke furnaces and foundries, where the men speak of being "gassed," and it may menace bakers, tailors' pressers and dressers of hats and cloth who use gas stoves. It is present in many establishments where small coke, charcoal or gas stoves are used, as by tinsmiths in melting solder, typefounders in melting lead, etc. It is developed in the Leblanc process of soda manufacture, in cement and brick works, and illuminating gas works. In iron and steel blast furnaces temporary disablement from carbon monoxid inhalation is quite common. The

waste products of imperfect gasolene combustion contain considerable carbon monoxid.

The gas stove which stands out in a room away from a chimney flue not only consumes much oxygen, but imparts very deleterious products of combustion to the air. I know of no more debilitating condition than the prolonged occupation of a small room containing a lighted gas stove which is not set within a chimney, and I have met with many serious results from this cause. In an analysis which I made, in 1904, of 90 cases of acute illuminating gas poisoning occurring in my hospital services in New York, 18.8 per cent. were fatal, and many were due to the careless use of gas stoves. In the fatal cases, if the patient survives for a few days, acute softening of the brain occurs.

Copra, or the dried cocoanut kernels from which cocoanut oil is made, and which is used also as an ingredient of curry, is stored in the holds of vessels plying between the Hawaiian and other Pacific islands and various ports. In cleaning out the holds of these vessels the natives are frequently overcome and sometimes fatally asphyxiated. Analysis of the gas which is evolved by this substance has shown it to be carbon monoxid.

Carbon monoxid is developed in considerable quantity in the atmosphere of stoke rooms and the turrets of warships from powder used in firing big guns, in blast furnace rooms and in the manufacture of phosphorus and calcium carbid.

Gas works are fertile sources of occupational diseases, especially of the digestive and respiratory organs, and rheumatism. According to Jehle, in Vienna 48 per cent. of all gashouse men become more or less ill during the year. In Berlin the percentage of illness per annum has reached 34, and in Berlin and Vienna per 1,000 workmen there are 1.5 deaths (W. Manauer, "Zeit. für Gewerbehyg.," 1911, s. 434). One of the chief hazards to which these men are submitted is constant temperature change. They become overheated, stoking hot furnaces, and then cool off in the outer air, constantly going back and forth. As a result, they acquire rheumatism, influenza, bronchitis, pneumonia and inflammations of the throat and middle ear.

They perspire freely and become thirsty in consequence. To alleviate thirst they drink large quantities of cold water and beer, etc., which gives rise to gastric catarrh and enteritis.

They inhale much coal dust, smoke, steam and a variety of toxic gases, in greater or less amount. Among the latter are acid fumes of sulphuric and traces of hydrocyanic acid, carbon dioxid and especially carbon monoxid.

Prof. W. T. Sedgwick has shown that in 50 years preceding the repeal of the Massachusetts law regulating the quantity of carbon monoxid in illuminating gas not a dozen cases of gas poisoning took place, whereas in the 20 years following its repeal there have been more than 1,200, or an average of 60 per year. This is a most striking demonstration of the harmlessness of the old-fashioned coal gas as compared with water gas. These figures comprise fatal cases alone, but there is always a large proportion of non-fatal cases, both acute and chronic, where the dangerous gas is freely used in manufactures, as by gas stoves, gas irons and otherwise.

Carbon monoxid is fatal to the lower animals if inhaled in quantity, and 1 part of CO in 250 of air kills a dog. For man 0.1 per cent. of this gas in the air causes unpleasant symptoms and 0.4 per cent. endangers life. One per cent. is almost surely fatal. The gas forms a relatively stable compound with the hemoglobin of the blood, thus interfering with the oxygen-bearing function of the red cells; but it also possesses a second more important direct toxic effect upon the central nervous system of the nature of a narcotic and depressant, for these effects are manifest even where there is still a large percentage of red cells carrying oxygen, and they often persist long after the CO has left the blood. One of my patients, on the sixth day after illuminating gas coma, had 5,440,000 red cells and 95 per cent. hemoglobin with normal lungs, yet he died two days later in coma.

Symptoms.—Symptoms of carbon monoxid poisoning may be acute or chronic.

Acute Poisoning.—The symptoms of acute illuminating gas poisoning are practically those of acute carbon monoxid poisoning, although they vary somewhat with duration of the inhalation and the

percentage of the monoxid present which is not always easily determinable. Water gas contains 20 to 30 per cent. of carbon monoxid. With acute intoxication there are violent frontal headache, vertigo, a sensation of oppression, dyspnea, weakness of the legs, and convulsions, or a tetanic state may supervene and prove fatal.

In my series of 90 cases above referred to a general blood count was made in 29, and in 18 of these there was a leukocytosis above 18,000. In an infant the count was 52,000, and in 3 non-fatal comatose cases among adults the counts were respectively 44,000, 32,000 and 31,000. Dr. Herbert S. Carter analyzed for me the chlorids and urea in 5 non-fatal cases, and found a considerable increase of these salts.

In nearly all the comatose cases there was elevation of body temperature, lasting from a day to a week or more. In some cases there was a preliminary fall to 96° or 97° F. The fever is remittent, and the maximum in any non-fatal case was 104.8° F. In one fatal case it rose to 107° F. A case is recorded of 110°F., with a pulse of 215. The pulse during coma is usually as high as 120, and may reach 140, and respiration is moderately accelerated. In one non-fatal case, however, it reached 62. Extreme dryness and redness of the mouth and pharynx are common, and vomiting sometimes occurs. In some cases there was excessive perspiration. The pupils are variable. Often normal, they may be contracted, dilated or unequal. In two cases I observed nystagmus. Other occasional symptoms were tremor, convulsions, muscular twitching, rigidity, opisthotonos, anesthesia, and increased reflexes. These nerve symptoms vary with the mode of poisoning. The color of the face is red, not dusty, owing to the line of methemoglobin, but as a late symptom the lips may be cyanosed. There are visual disturbances of various degrees. In the coma stage there is evacuation of urine and feces.

Recovery is slow, and for some days the patient may suffer from mental weakness and confusion, with loss of memory. Paresis or spasm of the extremities may persist for several days. Cases have been reported of sequelæ such as leptomeningitis serosa, acute mania, dementia, multiple sclerosis and several of multiple neuritis.

Bronchopneumonia and lobar pneumonia are common sequelæ. In the non-fatal cases of the series the maximum duration of coma was four days, but it usually cleared up in from 12 to 24 hours.

In 12 cases of the series autopsies were performed. The heart presented no lesions of importance. The brain showed congestion of the white matter, pia and arachnoid, in 6 cases out of 9 in which it was examined. The cerebral arteries are greatly distended and the typical lesion in cases in which the patient has survived long enough for it to occur is softening of the lenticular nucleus, which Schultze has pointed out is due to the peculiar curve of its nutrient vessels in which thrombosis frequently occurs.

Plumbers who work in cellars where they may have to disconnect gas pipes are exposed to its fumes, so that they may become dizzy, lose their sight, and become unconscious temporarily.

Surgeon-General Stokes has stated that carbon monoxid develops rapidly in gun firing in the turrets on battleships, with the result that men who begin firing with a pulse rate of 72 have in 10 minutes a rate of 120, and in the stoke rooms the so-called "heat prostrations" are often due, he believes, to accumulation of this and other gases.

Chronic Poisoning.—Chronic poisoning is characterized by a progressive, simple anemia, marked pallor, headache, vertigo, cephalalgia, gastro-intestinal disorder, a slow pulse, and a tendency to dyspnea on exertion and a subnormal temperature. There may be cutaneous irritation. The patient becomes mentally dull and listless, the gait is slow, memory fails, and insomnia, which resists narcotics, follows. There may be anesthesia or partial paralysis of the extremities. There may be further psychic symptoms such, for example, as visual and auditory hallucinations and delirium of persecution.

Karasek and Apfelbach, in a report on carbon monoxid poisoning for the Illinois Commission on Occupational Diseases, made in 1909-10, found in the industries of steel making and iron smelting that long-continued exposure to small quantities of this gas, liberated during smelting of iron ore with lime and coke, produces a polycythemia of between five and a half and nine and a half million

red cells. The 240 men examined were many of them in poor physical condition, with reduced muscular strength.

A case of multiple sclerosis from chronic illuminating gas poisoning in a laborer in a gas plant has been reported by Dr. Walter Stempel (*Zeitschrift für Versicherungsmedizin,* Jan., 1912).

A patient who came to my clinic was employed in fitting gas ranges, and was in the habit of blowing into gas pipes to clean them out. He had frequent attacks of nausea and vomiting, with severe epigastric pain. He stated that four or five men who were associated with him in this work had similar attacks.

Prevention.—Free ventilation and prevention of leaks of gas are essential. Employees should be warned by circular and personal instruction against the danger. No one addicted to the use of alcohol should be permitted to go where the gas is liable to be inhaled. "Such men occasionally sneak away to warm but dangerous places to sleep and there fall victims to CO poisoning," or, becoming slightly affected by it, fall into dangerous machinery. Of 22 men poisoned and rescued, three were burned and as many bruised. In another case the victim was burned to death.

Rescuers should wear oxygen helmets and oxygen tanks should be kept always ready for emergency use, for rescuers otherwise are certain to be overcome. (*See* page 145.)

Treatment.—In acute cases the clothing about the neck and chest should be loosened, bystanders should give way and admit abundant fresh air to the victim and artificial respiration should be maintained. (*See* page 145.) Oxygen inhalation may be given if the gas is obtainable. The body should be kept prone, with the head raised. The air should be fanned toward the patient. Ammonia vapor may be inhaled and flagellation of the chest with a cold wet towel may further stimulate respiration. If able to swallow, the patient should be given hot drinks such as hot whiskey and water and hot coffee. If the pulse becomes very feeble, hypodermatic stimulation is indicated.

In illuminating gas poisoning and all the more serious cases of carbon monoxid poisoning from any cause the patient should be bled 14 or 16 ozs., and transfused with a like amount of normal salt

solution or by direct transfusion of blood, if a donor can be obtained. Hypodermoclysis and rectal irrigation with hot normal salt solution should also be employed. Should coma continue more than 24 hours it is desirable to repeat the bleeding and transfusion. I have known one patient recover after a week of coma, hence the importance of continuing treatment.

CARBURETTED HYDROGEN

This gas, encountered in coal mines, is seldom unmixed with other gases such as marsh gas, carbon dioxid and monoxid. It contributes to the general toxic effects of these gases, and, when inhaled, gives rise to asphyxia, hemolysis and fatal syncope.

CHLORIN, CHLORID OF LIME, AND THE CHLORIDS OF SODIUM, POTASSIUM AND MAGNESIUM

Chlorin gas is evolved in making Javal water, glazing bricks, making chlorid of lime from sodium chlorid by electrolysis, and in its use as a disinfectant in sewers, privies, to cover dead animals, etc. In the manufacture of writing paper, wall paper, etc., the pulp is sprayed with an alkaline chlorid solution and sulphuric acid, thereby liberating much chlorin gas. I once tried the process of disinfection by chlorin of one of my wards in the New York Hospital, but the gas escaped into neighboring wards in such quantity as to cause considerable inconvenience to the patients from coryza and irritant cough, so I never repeated the experiment. To produce the gas, after sealing the room, a mixture of sodium chlorid and binoxid of manganese is made in a wooden trough, and a carboy of sulphuric acid is added, when free chlorin is evolved so rapidly as to make it difficult to run out of the ward in time to escape suffocation.

The gas for commercial use is sometimes compressed in cylinders called "bombs." Chlorin is one of the most irritant of all the irrespirable gases, and is highly injurious in any strength above $\frac{1}{5}$ part per 100,000 of the air inhaled (Lehmann).

According to Bernatzik, the vapor in contact with moist tissues of the body forms hydrochloric acid and other irritating products.

The chief industry in which chlorin is liberated is the manufacture of chlorid of lime. By this process chlorin gas is conducted to lime solution in closed chambers. The men who enter the chambers to clean them out and those who pack the finished product may inhale both chlorin vapor and chlorid of lime dust. Other workmen who grind and sift the lime are affected by its dust. In bleacheries much lime chlorid is used. It is employed also in making dyes, chloroform and oxygen, as well as for calico printing, tanning and tinning.

Various preparations of lime are much used as insecticides for the Gypsy, Brown Tail and Tussock moths, and in spreading dry lime about one should be very careful not to inhale the dust. The inhalation of chlorid of lime dust is exceedingly irritant to the lungs and liable to cause inflammation of them, with mucopurulent and bloody expectoration.

In an article in *Rauch und Staub* (June, 1912) it is reported that in a lime mill in Germany there were attacked by pneumonia, one after the other, the proprietor and six workmen, three of whom died. They had been employed in transporting the substance in sacks and in unloading it before milling from freight cars.

Physiology.—It was shown by Hirt in experimenting upon animals that traces of chlorin gas in the inspired air give rise to such irritation of the respiratory passages as to cause death in two or three days. The gas produces in them salivation, feeble respiration, purulent bronchitis and catarrhal pneumonia. In stronger dosage the gas gives rise to fibrinous pseudomembranous bronchitis, congestion and edema of the lungs. Chlorin poisoning may be either acute or chronic.

Symptoms.—Acute Chlorin Poisoning.—In acute chlorin poisoning the victim suffers from intense suffocation with cyanosis. The pulse is feeble, vomiting occurs and there is great prostration. Lewin has reported 7 deaths from this cause, and two distinguished chemists have thus lost their lives. In many cases of exposure to chlorin vapor, however, the victim is saved from death by the prompt, auto-

matic reflex closure of the glottis. In less serious acute cases the symptoms are coryza, sneezing, frontal headache, dry cough, conjunctivitis, choking sensation, vomiting, a feeble pulse and perspiration. The face is at first red, later pale. Rarely hemoptysis has been observed. The cases of this type, mild at the onset, have occasionally been known to terminate fatally, but recovery usually follows treatment in the open air.

Chronic Chlorin Poisoning.—In chronic chlorin intoxication the workmen become accustomed to the bronchial irritation and asthma which affects them at first, and suffer more from malnutrition, with anemia and emaciation. They are subject to attacks of gastralgia and may develop corneal ulceration. The teeth decay and the patient appears pale and sallow.

In addition to the symptoms of poisoning due to evolution of chlorin gas from chlorid of lime, the latter substance causes considerable irritation of the skin, such as pruritus, eczema and ulceration. Hyperidrosis is common, and the peculiar eruption known as "chloracne," caused by working in the chlorin salts, is described under Chloracne.

Treatment.—There are no specific means of treatment, which must be preventive, by means of ventilation, and symptomatic, as occasion arises. Workmen who are exposed to inhalation of chlorin gas or lime dust often wear respirators containing sponges moistened with alcohol. In serious acute poisoning artificial respiration should be maintained, preferably through the laryngeal tube, owing to the irritation of the glottis, which may otherwise be closed in spasm.

Chlorin Salts of Sodium, Potassium and Magnesium

In the preparation of sodium chlorid as a commercial product both from rocksalt and evaporation of salt water, the workmen who deal with the large evaporating beds or pans are subjected to a hot, moist, salt-impregnated atmosphere which tends to develop both acute and chronic catarrh. They also frequently have eczema of the nose and ears, which is due to irritation by salt dust. The chlorin

salts of sodium, potassium and magnesium are irritating to the nasal mucosa of those who dig in the salt beds or work in the mills in which the lumps of salt are ground. Müller (*Vierteljahr. für ger. Med. III,* Bd. X, S. 381) examined 165 salt workers, and among them found 45 cases of nasal catarrh, 9 of recent ulcers of the nasal septum, and 45 of perforation of the cartilaginous portion of the septum.

The manufacture of the chlorids of sodium, potassium and calcium by electrolysis is attended by evolution of vapors of irritant hypochlorites which may give rise to an erysipelatoid and acneform eruption of the skin of the face and thorax.

DIAZOMETHANE

This substance is a very volatile yellow gas used in methylizing processes. Entering the lungs, it causes extreme irritation with ulceration of the bronchial mucosa. Intense headache is complained of, with great muscular weakness. Other symptoms resemble those of dimethyl sulphate poisoning.

DIMETHYL SULPHATE

This substance, a colorless oily fluid, is used in the manufacture of perfumery and in making methyl preparations. As a fluid it irritates the skin, causing serious sloughs. As a gas it irritates the eyes and respiratory mucosa, causing lacrimation, photophobia, conjunctivitis, and corneal edema and opacity. When inhaled it gives rise to an ulcerative bronchitis with danger of aspiration pneumonia from sloughs. It causes pains in the neck and thorax, hoarseness, paralyses, convulsions and fatal coma.

ESSENCES AND EXTRACTS: VOLATILE ESSENTIAL OILS

Perfumery and flavoring essences and extracts containing volatile essential oils and similar substances, when inhaled in concentration, as in process of manufacture, may give rise to quite serious

symptoms. Such are the odorant essences of lavender, spikenard and rosemary. The latter is especially powerful. The peeling of great quantities of oranges for making essence liberates an irritant volatile oil. Experimentally in animals these substances give rise to tremors and stupor or convulsions. In man the toxic symptoms do not become so severe, but headache, vertigo, tinnitus, irritation of the eyes and skin, and dyspeptic symptoms have been observed.

Essence of vanilla resembles an aromatic aldehyd, and those who sort, clean and repack the vanilla beans in bottles in Bordeaux, where this industry is largely conducted, may complain of headache, vertigo, tinnitus, lassitude, insomnia, neuralgia, muscular pains and cramps, and sometimes of vesical irritation.

Vanilla extract, as used by confectioners and bakers, irritates the skin if it comes in contact with it, and its fumes may give rise to conjunctivitis and rhinitis. Makers of perfumery are subject to a papular eruption of the face and hands and a generalized pruritus, due in some cases to a mite or acarus. They may suffer also from coryza, conjunctivitis and epiphora. In some cases they are obliged to abandon the work permanently on account of such continued irritation to which they cannot become accustomed.

Prevention.—To prevent ill effects workers in volatile oils should protect the eyes with glasses or goggles and take pains to protect the hands as much as possible by wearing gloves, etc. Overalls should be worn and frequently cleaned, as they soon become saturated with the oil. In the distillation of coal tar products various hydrocarbons are separated in the form of both light and heavy oils which are largely used in the manufacture of colors for dyeing, etc. From heavy oils such as benzol an aromatic hydrocarbon series may be derived, as toluene, xylene bodies, etc., many of which are quite toxic. By reduction further products are obtained, namely, the amine derivatives, anilin, toluidin, xylidin, etc.

ETHER

Both ether and alcohol are used as solvents in a number of industries in which workmen are constantly exposed to the inhalation of

the vapors arising from these substances. Probably the ether is more toxic than alcohol. A form of smokeless powder used by the United States Government is manufactured with the use of these solvents combined, and a physician (Dr. Hudson) employed by one of the smokeless powder companies writes me that "the men employed in the rooms where the granulating process is carried on inevitably inhale small quantities of ether and alcohol vapors in spite of the best ventilation that can be provided. They become weak and pale without suffering from any well-defined disease, and after a few months have to be shifted to some other work until they have recovered."

ETHER, METHYLATED

In making incandescent mantles they are dipped in a mixture of 60 per cent. methyl ether, or industrial spirit, and 30 per cent. methylated spirit in which collodion and camphor are dissolved. C. T. Graham-Rogers, Medical Inspector of Factories of New York State, writes of this industry:

"The vapor arising from this mixture, if breathed to any extent by the workers, causes headache, sickness, anorexia, sleepiness and lassitude, symptoms which are experienced to a greater extent on first commencing employment. At one factory where the workers had to enter the hot stoves, heated to about 115° F., to carry in the mantles for drying and to remove the dried mantles, all seven workers complained of some of the symptoms described."

ETHYL NITRITE

This substance is evolved in the manufacture of fulminate of mercury, used for charging the caps for exploding blasting powders. Inhaled in concentration, it gives rise to very acute attacks of dyspnea and cyanosis. Although the symptoms are urgent and alarming, the victims usually quickly recover in the open air.

FORMALDEHYD

This substance is used as a gas for disinfection and in fluid dilutions as a preservative of anatomical and botanical specimens.

It is employed also in making dyestuffs, and by undertakers in embalming bodies.

When inhaled in concentration the gas causes disagreeable prickling in the eyelids and nose, lacrimation and increased nasal secretion, bronchitis and ulceration of the respiratory mucosa. The solutions of this substance cause diffuse skin lesions of maculo-pustular character.

GASOLINE AND NAPHTHA

Gasoline

Gasoline is used for fuel, cleaning purposes, as a solvent of celluloid, and in many other industries. The men who clean out large gasoline tanks may suffer from vertigo and asystole. Lately there have been brought to my notice a number of cases of chauffeurs who were overcome by gasoline fumes while cranking motor cars in small unventilated garages. They experienced vertigo, fainting and nausea, and one passed into coma, from which it was difficult to arouse him. The symptoms may not develop until the men go into open air.

Naphtha

Naphtha is obtained by treating with sulphuric acid the residue from certain products of fractional distillation of petroleum, such as gasoline, benzene and kerosene. The workmen employed in cleaning out the distilling apparatus may be acutely poisoned by inhaling the naphtha vapor and dust from the naphthalin products. Most workmen, however, become accustomed to the irritation which at first may cause bronchial catarrh. Diminution in the acuteness of the sense of smell is common among them.

Naphtha fumes are liberated in the preparation of waterproof cloth, the rubber industry, dyeing, trying out of fats and oils, and a variety of cleaning processes, although it is so very explosive on ignition that its use for the latter purpose has been supplemented to a considerable extent by other substances. In the making of rubber cloth, rubber shoes and patent-leather, in which the rubber is spread over a prepared surface, naphtha is extensively used as a solvent. It is employed also as a bath to disinfect clothing worn by those having infectious diseases, and as a solvent for metal polish.

Symptoms.—Acute Naphtha Poisoning.—The symptoms of acute naphtha poisoning resemble those of benzene poisoning. Headache, vertigo, dyspnea, palpitation, nausea and vomiting are chiefly complained of. There may be mental confusion and death may result from hemorrhage from the respiratory mucosa or paralysis of the heart. Sometimes there are acute hysterical attacks with insomnia. Autopsies in cases in which the patient dies after a few days, so that morbid changes have had time to take place, reveal acute fatty degenerations of the most important viscera, heart, kidneys and liver.

Chronic Naphtha Poisoning.—Chronic naphtha poisoning results in chronic bronchitis, tinnitus aurium, vertigo, headache and mental dullness. Both naphtha vapor and naphthalin dust are irritating to the skin, and Lewin found in American naphtha works disseminated acne of the hands, forearms and ears. Multiple papillomata have also been described on the hands and nose. The elevations become hard and wartlike.

A case of dermatitis and eczema of the hands caused by polishing metal bedsteads was reported to the New York State Bureau of Labor in 1912. The polish was dissolved in naphtha.

HYDROCYANIC ACID, POTASSIUM AND OTHER CYANIDS

Photographers may inhale hydrocyanic or prussic acid fumes derived from decomposition of cyanids. The fumes are developed in treating animal substances with strong alkalies, making red prussiate pigment, making coal gas, extracting the lees of manioc for indigo, making fulminate of mercury, potassium ferrocyanid and synthetic soda, and in making the so-called "Pharaoh's serpents," which, when ignited, form actively twisting coils. The acid is also evolved in electroplating.

Pathology.—The fumes of hydrocyanic acid, unlike most of the acid fumes, do not irritate the respiratory mucosa, but, being promptly absorbed, form a fixed compound with the hemoglobin of the blood.

Symptoms.—Acute Poisoning.—Large doses are instantly fatal. The discoverer of the acid died from its effects in his laboratory. In

non-fatal doses the poison produces marked pallor, vertigo, great prostration, a feeble pulse and voice, and cold sweats. The urine and the exhaled breath may possess an odor of bitter almonds. There is itching in the nose, with watery discharge and irritation of the throat.

Potassium and other cyanids were formerly a common source of poisoning among photo-engravers, who acquire it with great regularity after a few months' continuous work in the poison. Acute poisoning may be fatal within twenty-four hours. With present regulations in the industry and better understanding of the risks, comparatively few cases occur.

Chronic Poisoning.—With chronic poisoning there are headache, nausea, vomiting, muscular prostration, enfeeblement of the heart and reduced blood pressure.

Potassium cyanid caused the death of a lad in New York State in 1912 who, as a clockmaker's apprentice, had used it in hardening steel, and a blacksmith also died from using it in welding iron. In the *Bulletin* of the New York State Labor Bureau, 1912, are reported five cases of skin diseases of the hands and arms due to potassium cyanid used in plating typewriters. The cyanid solutions are used hot, sometimes to 110° F. Among 250 men employed in Illinois in plating of brass by cyanid processes, seven had ulcers of the hands from dipping them in the plating solutions.

The cyanids are further used in making oxalic acid, in dyeing and printing cloth, making phosphoric acid from bones, extracting gold, and making cyanogen.

Treatment.—Hypodermatic stimulation of the heart should be resorted to with ether or camphor in oil, and ¼ mg. of strophanthin should be given by deep intermuscular injection. The body should be protected with hot blankets and hot water bottles and hot alcoholic stimulants should be given by mouth.

IODIN

Iodin vapor is liberated in certain chemical processes, as in the manufacture of drugs, such as the tincture of iodin, and may affect

workmen so employed. It irritates the respiratory system but to much less degree than either chlorin or bromin, and does not cause death as these other gases may do.

Symptoms.—The so-called "iodin fever" consists of a sort of intoxication, with vertigo and headache. There may be coryza, bronchitis, rhinitis, and conjunctivitis. In chronic cases there are digestive disorders, with malnutrition, anemia, erythema, acne, blebs, and atrophy of the testicles.

LYDOL AND TRITON

These are high explosives of low-freezing property. Their toxic effects are practically identical and they act strongly as hemolytic agents.

Symptoms.—Lydol varies considerably in strength and consequently in the symptoms produced. Dr. W. G. Hudson, one of my former laboratory assistants, has furnished an interesting account of experiments with these substances in a manufactory of high explosives. He describes the symptoms produced in workmen by lydol as follows: they suffer from severe headache, pains in the back and great weakness of the extremities. The face becomes deeply cyanosed and there is a yellow pallor of the skin. The urine is colored dark red. The victims appear "half-strangled" and are often obliged to quit work for several weeks. Hudson proved by experiments on himself that the poison acts both through inhalation of vapors and by contact with the skin. The blood gives the spectrum of methemoglobin sometimes but not invariably. The erythrocytes are crenated, fragmented and vacuolated, and irritation types of leukocytes are observed in considerable number. These symptoms appeared to vary with the quality of the mixture. Workmen whose clothing becomes saturated with the fluid lydol or with triton dust develop these symptoms very promptly. A series of experiments upon the lower animals gave identical results, often proving fatal. In one case triton produced a temperature of 102° F.

A peculiarity of the effect of triton is the retardation of development of symptoms. Dr. Hudson, who was himself exposed for two

hours while experimenting, did not develop serious symptoms for two or three days. Convalescence is correspondingly slow.

Treatment.—The workman should take a hot bath and scrub the body thoroughly with pumice stone or a granular soap, to cleanse the skin of all possible impurities. He should discard his working clothes for clean ones and live in the open air. He should drink several quarts of warm milk a day, which is a good diuretic by virtue of its lactic acid. It is absolutely essential to avoid all alcoholic drinks. If the hemolysis threatens life, direct blood transfusion should be performed.

As a preventive of serious poisoning frequent blood examinations of the workmen should be made and, if vacuolated or otherwise deformed erythrocytes are present, work should be dropped temporarily.

Dr. Hudson recommends the introduction of an air shaft above the workman's head, arranged to direct a current of fresh air downward to an exhaust duct in the floor, covered by a grating upon which he stands.

METHYL ALCOHOL

Wood or methyl alcohol, called also "wood spirit," is used as a solvent for shellac and gums in a variety of varnishes, in a number of chemical industries, and to some extent in leather manufacture. It may be produced as an impurity of distillation of various empyreumatic hydrocarbons. It is used by workers in special industries, as by piano makers, felt and straw hat makers, workers in anilins and silk stuffs. When pure it is almost free from odor, taste or color. As a solvent for shellac it may be used in full strength, the shellac filling about 40 per cent. of the mixture, or it is added in 10 per cent. strength to grain or ethyl alcohol to make "denatured" alcohol, and then used as a solvent. Impure methyl achohol (and much of the commercial stuff is impure) contains acetone, ketone and aldehyd. Denatured alcohol also sometimes has 0.5 per cent. benzene or pyridin added to it. The wood alcohol varnishes, besides being cheaper, dry quicker than those made with ethyl alcohol, because wood alcohol is more volatile, having a lower boiling point.

Much of the varnish used, however, contains a compromise denatured alcohol made with only 5 per cent. wood alcohol. Owing to its volatility wood alcohol readily mixes with air at ordinary room temperature and such mixture is highly explosive.

This form of alcohol is very slowly eliminated from the system and its retention is associated with formation of formic acid and formaldehyd. (Pohl.) Nicloux and Placet have shown (*Jour. de physiol. et de pathol. gén.*, 1912, xiv, 916) that wood alcohol is soluble in such lipoid substances as are found in nerve tissues, and after death the brain retains a large percentage of this alcohol, a highly differentiated nerve substance like that of the optic nerve is therefore particularly liable to be affected by it.

Symptoms.—Acute Poisoning.—When wood alcohol is inhaled or swallowed, in toxic dose, it gives rise to abdominal cramps, nausea and vomiting, thirst, coryza, muscular prostration, chilliness, vertigo, headache, dilatation and immobility of the pupils with visual disorder and pronounced dyspnea, restlessness and insomnia. The blood serum is strongly toxic when injected into animals. These symptoms, it will be observed, closely resemble those caused by eating decomposed fish or animal foods. Prof. L. Pick, of Berlin, has found granular degeneration in the retinal ganglion cells, with swelling in the fibrils of the optic nerve. Apart from the ocular changes, no distinct pathological lesions are demonstrable. Wood alcohol, in distinction from grain alcohol, is more combustible in the body, being oxidized to formic acid. Ordinary alcohol, on the other hand, splits into the harmless products, water and carbon dioxid, unless it be taken in such excess as to prevent this change completely. Harnack believes that when methyl alcohol fails to poison, as in those who appear immune to its effects, it fails to be oxidized. The substance then acts more as ordinary alcohol, producing drunkenness without specific poison. He regards the action upon the optic nerve as due to some localized peculiarity of oxidation. The blindness usually develops within from 12 to 24 hours after exposure to the fumes of wood alcohol, and in fatal cases death occurs within one or two days from apnea and cardiac paralysis. There may be cold sweats and delirium or coma.

Although the symptoms of wood alcohol poisoning are often slow in developing, sometimes requiring 24 to 36 hours, they become rapidly cumulative after the onset.

The interiors of large brewery vats require varnishing. These vats are sometimes closed completely, except at a manhole at the bottom about 18 x 14 ins. in size, with a small opening for pipes in the top. Unskilled laborers are sometimes sent into the vats to apply the varnish, and, as the air at best is very confined, they are told to come out to breathe after 20 minutes of work. The varnish, moreover, is laid on with a broad whitewash brush, which, while it hastens the work, applies large quantities of varnish at a time. When this varnish is made with wood alcohol the fumes fill the vat in very concentrated form, and death may follow almost immediately. In a brewery in New York City three deaths have occurred in this manner, and in one case the diagnosis of the physician called to the victim was "epilepsy." In another brewery in Buffalo one death took place from wood alcohol inhalation and a fellow workman became permanently blind. The wood alcohol used is sometimes disguised by being named "spirits" under various qualifying patent titles. Two men employed as varnishers died, in 1911, in New York City from wood alcohol poisoning.

As small an internal dose as 10 drops has been known to cause serious visual disturbance. Dr. Hiram Woods, of Baltimore, reported, in June, 1913, a case of total permanent blindness of both eyes, due to inhalation of wood alcohol, with atrophy of the optic nerves and narrowing of the retinal vessels. The man was employed in a candy manufactory using a varnish for the candy, which proved to contain shellac dissolved in wood alcohol. Having acquired rheumatic pains, he also rubbed the "spirits" for some time over his painful joints and muscles.

A number of girls employed in a pencil factory suddenly suffered from visual disturbances and blindness caused by using a varnish made for the pencils which contained wood alcohol. A similar form of varnish known as Mingpoo, used in the Philippines for varnishing ships because it withstands the salt air, has been known to cause death in coma (Dr. Victor G. Heiser).

Dr. W. B. Marple has reported to me the case of a child who, having fever and lying in a small room, was ordered alcohol sponge baths. The mother used wood alcohol and the child became blind.

Although not an occupational example, as an illustration of the extreme toxicity of wood alcohol when swallowed may be cited the Berlin epidemic of poisoning which took place in the latter part of December, 1911, among occupants of a Municipal Night Lodging House to whom drink had been sold which was diluted with this cheap form of spirit. Eighty-nine died, among 163 who were made ill, and 5, who recovered, were made permanently blind. It was some time before the cause of the epidemic was discovered, the symptoms being unfamiliar to many physicians and at first mistaken for ptomain or fish poisoning.

Subsequently there were 7 more deaths from the same cause in another German town, Gelsenkirchen.

In Hungary, in 1909, a liquor dealer who diluted his beverages with wood alcohol thus caused the death of 59 victims. A number of poison cases were reported at a Hungarian wedding in 1912, among those who drank liquor diluted with methyl alcohol. Those who danced and thereby exercised and perspired most were least affected, and Foester (*Münch. med. Woch.,* April 16, 1912), in commenting on this observation, says that hard labor and free perspiration produce a relative immunity.

Grosz reported, in 1909, a number of cases of methyl alcohol blindness seen at the Budapest eye clinic, which occurred among workmen who had inhaled the vapor. In 1904, 20 persons were killed or made blind by wood alcohol in Dorpat, Russia.

When Ehrlich's salvarsan was used in Prague at first methyl alcohol was the solvent employed, but certain ill-effects led to its abandonment.

Cases of fatal poisoning from drinking wood alcohol are reported quite often in the public press, and much more stringent legislation restricting the sale of this product is required. In 1912 about 50 employees of a construction company in St. Lambert, Province of Quebec, indulged in a debauch in which they drank beverages diluted with this substance, as a result of which three of the men died.

In 1904 Drs. Frank Buller and Casey A. Wood reported from the literature to date 275 cases of death or blindness resulting from the internal or external use of wood alcohol, and Professor Charles Baskerville tells me that he has collected reports of upward of 1,000 cases to the present date (1914).

Chronic Poisoning.—Two cases of chronic methyl alcohol poisoning in varnishers have been reported by S. E. Jelliffe, of New York. The men applied shellac dissolved in the alcohol and worked in small, ill-ventilated rooms. They both had hyperesthesia of the arms, with paresthesia of the forearms and dorsal surface of the hands. There was pain on pressure over the nerve trunks, and paroxysmal pains of great severity also occurred in the arms. There was also motor weakness of both arms.

In chronic poisoning there may be conjunctivitis, epiphora, amblyopia and continued photophobia, so that the victim is unable to tolerate artificial light and must usually give up his work.

Prevention.—Preventive measures should consist in the abandonment of the practice of using wood alcohol as a solvent of shellac for varnishing in confined spaces, and all containers of wood alcohol should be labeled conspicuously with a statement as to the extremely poisonous nature of the substance. Wherever it is used for any purpose the freest possible ventilation should be maintained.

In New York City the Department of Health, in January, 1912, prohibited the use of wood alcohol in any article of food or drink or medicinal remedy, and its use by barbers in hair tonics or face lotions.

In Austria its use in all medicinal preparations, beverages and foods is now prohibited by law, and its sale and use in manufactures are also safeguarded.

Treatment of Acute Poisoning.—Artificial respiration should be maintained (*See* page 145) and cardiac stimulants should be given hypodermatically, such as strophanthin (0.25 mg.) or sodobenzoate of caffein. When possible transfusion may be employed after venesection. For this purpose direct blood transfusion may be used, or, failing that, normal salt solution. Unfortunately, when a victim has inhaled enough of the vapor to be rendered unconscious, its

toxic action is so prompt and powerful that even most energetic treatment usually fails to preserve the patient's life.

METHYL BROMID AND IODID

Methyl bromid is a colorless gas and the iodid a colorless fluid. Both are used in making anilin dyes. Inhaled in gaseous form, these substances give rise to headache, vertigo, diplopia and rigidity of the ocular muscles. There may be stupor. In more severe cases the skin is pale, the eyes have a fixed stare, the pulse is weak, there is obstinate constipation with restlessness, and unconsciousness or semi-consciousness may last for weeks.

NITROBENZOL AND DINITROBENZOL

Nitrobenzol

Nitrobenzol is derived through the action of a mixture of fuming nitric and sulphuric acids upon benzol, conducted by agitation in closed retorts. It is employed in the manufacture of high explosives such as roburite and in anilin production. It has an odor of bitter almonds and is used to a very limited extent in perfumery, soap, confectionery and cookery processes, in making dyes and in pharmaceutical laboratories.

The vapor of nitrobenzol, on entering the lungs by inhalation, is absorbed and forms droplets in the circulation which act as emboli. Nitrobenzol is most toxic when heated, but if cold it is also quite poisonous.

Symptoms.—Acute Type.—The substance is exceedingly poisonous and clings to the hands or gloves, so that persons who shake hands with a workman who has recently handled it may acquire poisoning in this manner, as it may be absorbed through the skin, in which it causes burning sensations. It is also readily inhaled, when it gives rise to throbbing fullness of the head, dizziness, tinnitus, constipation, nausea and vomiting, respiratory oppression, diminished blood pressure, and weakness. There is cyanosis of the face and lips and drowsiness, which may deepen into fatal coma. In

the acute cases symptoms may develop immediately or be delayed for an hour or two after exposure. In some cases, after improvement, a relapse takes place with fatal outcome.

Chronic Type.—In the chronic form, which may arise from saturation of the clothing with the vapor, there is marked cyanosis of the face, sometimes of the entire body, and a disagreeable prickling sensation in the tongue and pharynx. Anemia follows, with great lassitude. The blood shows deformed red cells and is brown and viscid. It gives the spectroscopic band of free hematin and a specific band, known as "Filehne's band," which lies between the red C and yellow D bands. The pulse is slow and tension is low, speech is hesitating, the gait is uncertain, the reflexes are intensified. Amblyopia and optic neuritis are present. The skin has an icteroid hue. The victim may have an attack of coma lasting an hour or two. Tonic and clonic convulsions have been observed. The pupils are dilated and there may be nystagmus. The breathing becomes irregular and the breath has the odor of bitter almonds. Nausea is common, with vomiting.

The course of the cases is variable. Workmen who have been employed with this substance for some time acquire a gradual toleration for it, but become anemic and are dyspneic on exertion. Others are so sensitive to its fumes that they are unable to continue in the occupation of making it.

Grandhomme has reported ("Die Fabriken") 60 cases of nitrobenzol poisoning, with 24 deaths. In only 5 of the cases, however, was the vapor inhaled. The other poisonings took place by mouth. R. Massini reported, in 1910, two cases, with recovery after serious symptoms, one having chronic poisoning and symptoms which lasted a month.

Prevention.—The workmen must be enjoined never to touch the compound with bare hands and to wash thoroughly and change the clothing before going home. Care must be taken to keep the shoes whole, as the substance may get upon the floor and be absorbed through the soles of the feet. It is important, also, not to use alcoholic drink while engaged in this employment.

Treatment.—There is no known antidote for nitrobenzol poison-

ing. Artificial respiration should be maintained and hypodermoclysis of normal salt solution should be given; also high rectal injections of hot solution of bicarbonate of sodium. Camphor, ether or other cardiac stimulants may be given hypodermatically.

Dinitrobenzol

Dinitrobenzol, which is used in making roburite, gives rise, when inhaled in powder or vapor, to amblyopia, scotoma, restriction of the visual field, venous hyperemia of the retinal vessels, and pallor of the papilla. The skin becomes brownish yellow and the sclera yellow. Appetite fails and diarrhea is common. The liver is enlarged and tender. Headache and vertigo are complained of. The mucous membranes of the tongue, mouth and pharynx are stained yellow. The urine is yellow and may contain unaltered dinitrobenzol. The breath has an odor of bitter almonds. In general the condition resembles a severe catarrhal icterus. Ten fatal cases have been reported by Schroeder and Strassmann.

PHOSGENE

Phosgene or carbon oxychlorid is a colorless, suffocating gas used in the production of various organic compounds. When inhaled it gives rise to acute poisoning, which first is noticeable only after several hours. The gas decomposes in the lungs with formation of hydrochloric acid, causing dyspnea, cyanosis and pulmonary edema, usually fatal in result.

PHOSPHORUS

Phosphorus is prepared or used in the extraction of phosphorus from bone and mineral phosphate of lime, making phosphorus bronze, tar dyes, various chemical compounds and matches. When inhaled or introduced in any form into the mouth it is promptly absorbed by the blood and acts as a general systemic poison.

White or yellow phosphorus was discovered by Brandt, of Hamburg, in 1609, and red phosphorus was discovered 236 years later

by Schröter, of Vienna. The former is volatile even at ordinary atmospheric temperature, and is highly inflammable and toxic. The latter is a crystalline powder which is not volatile and not very poisonous except in extremely large doses, whereas a single grain of white phosphorus may prove fatal if swallowed. The commercial phosphorus is made from bone ash with sulphuric acid.

The discovery of the lucifer match is claimed by several countries and appears to be of ancient date, but manufacture on a commercial scale was first employed in England by John Walker, in 1827; in Austria by Sauria in 1831; and in the United States in 1836. To France, however, belongs the credit of the invention, in 1898, of the non-poisonous sesquisulphid match. In that country the manufacture of matches is a government monopoly. Formerly the profits of the industry were wiped out by damage claims for sickness and death caused by the poisonous phosphorus, so a profitable method of substituting the non-toxic sesquisulphid was devised by two Government experts, Sevene and Cahen.

There are three types of matches in use: (1) one in which the match is non-poisonous but ignites only on a prepared surface; (2) one in which a poisonous paste is employed, and which ignites when struck anywhere; (3) one which also ignites when struck anywhere, but in which a non-poisonous paste is used.

In making matches both red or amorphous and white or yellow phosphorus can be used, but the "safety" match, striking only on a prepared surface, is made without either, non-poisonous red phosphorus being added only to the paste spread to make the striking surface on the side of the box. Antimony sulphid is another ingredient of this paste, and the match heads contain potassium chlorate as an oxidizing agent. Safety matches were first made in Bohemia in 1854.

The "strike anywhere," "Lucifer" or "parlor match" will ignite when applied to any rough surface with friction. It is made with a paste of poisonous white phosphorus, containing also glue, powdered glass, zinc oxid, potassium chlorate and some form of pigment. The proportion of phosphorus is 5 to 7 per cent.

Formerly another type of match was made with sulphur instead

of phosphorus, and sold in bunches of incompletely cut sticks, from which they could be torn off. The sulphur fumes were so disagreeable, however, that few of this cheap type of matches are made at present.

The third type of match possesses both qualities of igniting when struck "anywhere," i. e., on any rough surface, and of being non-poisonous. This is made with the sesquisulphid. Sir Thomas Oliver quotes the formula for this paste, now universally used, as follows:

	Parts
Sesquisulphid of phosphorus.....	6
Chlorate of potassium.....	24
Oxid of zinc	6
Red ocher	6
Powdered glass	6
Glue	18
Water	34

The method of making matches is described briefly as follows in the *Report* of the Illinois State Commission on Occupational Diseases, January, 1911: "The automatic match machines consist, essentially, of a series of wheels over which a continuous belt travels (Fig. 48). This belt is made of about 800 plates joined together. Each plate has 600 perforations—that is, twelve rows of 50 each. At one point in its transit each plate passes in front of a hopper, into which the trays of splints are emptied. An automatic punch strikes the splints, forcing them into the holes in the plate. This punch operates at the rate of 225 to 250 times per minute. As the belt moves, each plate, with its load of splints, passes over a vat of molten paraffin, into which the splints are dipped to a depth of about one-quarter of an inch.

"A little beyond the paraffin vat is the composition pot. This contains the material which forms the striking head of the match. The paraffined splints are coated at one end with this composition by means of slowly revolving rollers, which bring up an even amount of composition. For the ordinary parlor match one dipping is

sufficient. For the so-called double-tipped matches there is a second composition pot, with a different kind of material, into which the tip of the match is dipped."



FIG. 48.—POURING PHOSPHORUS COMPOSITION INTO THE TANKS IN WHICH THE MATCH STICKS DIP THEIR ENDS IN THEIR ONE HOUR'S TRAVEL AROUND THE MACHINE. Hazard: inhalation of phosphorus fumes.

The match heads each take up a little of the paste. The matches are then set aside to dry in an air current, when they are punched out of the traveling belt, grouped by machinery and boxed, labeled and wrapped (Fig. 49). Much of the latter work is done by women

and children. In all these processes, mixing, dipping, drying and packing, phosphorus fumes may be liberated in constant quantity, and the hands of the workpeople come into contact with the paste,

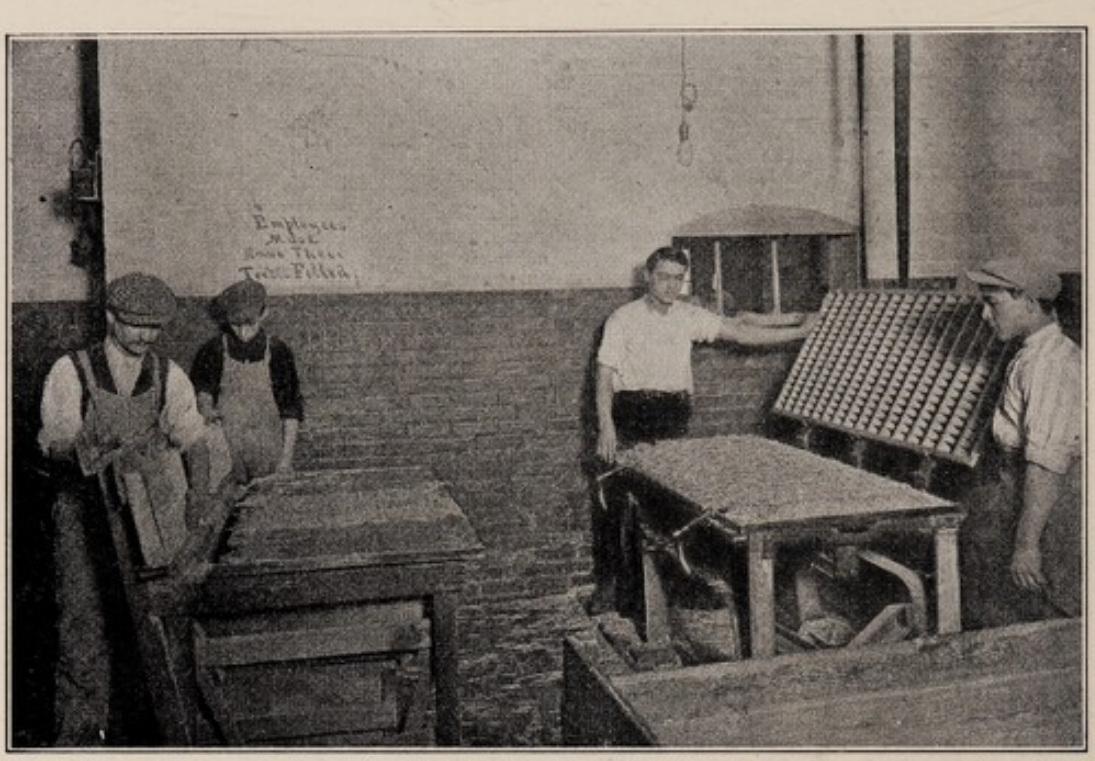


FIG. 49.—SORTING PHOSPHORUS MATCHES. Note the careless scattering of matches on the floor and the warning poster, "Employees Must Have Their Teeth Filled." Many young boys and girls work in this industry, inhaling phosphorus fumes.

either moist or dry, which is thus readily conveyed to the mouth by the fingers, on food or the rim of an unclean drinking glass.

The match sticks are made of white pine, poplar or basswood in this country, and the matches are packed in boxes made either of cardboard or a Russian aspen wood, which are constructed by machinery.

Oliver states: "On examining the hands of a boxer they are seen to be deeply stained by the dye given off by the heads of the matches, and they emit the characteristic garlicky odor. They glow in the dark. On analyzing the water in which 22 work people had washed their hands on leaving the factory, Thorpe found 37.3 milligrams of phosphorus, an amount equal to 4.2 milligrams of phosphorus per person for each ten hours' work."

In Great Britain are 22 match factories employing about 3,000 females and 1,000 males.

In the United States are 16 factories, and the 15 studied by Dr. John B. Andrews, in 1909, employ approximately 3,591 workers, of whom 65 per cent., or considerably more than half, were exposed to the fumes of white phosphorus. The worst feature of the matter



FIG. 50.—BOXING PHOSPHORUS MATCHES BY CHILD LABOR. The swivel-hung windows are of good type for ventilation, but the electric lights are poorly hung and unshaded. Hazards: handling and inhalation of phosphorus.

was the relatively great exposure of women and children under 15 years of age, of whom respectively 95 and 83 per cent. were endangered (Fig. 50). Many of them were permitted to work without the slightest effort at protection or warning against the grave risks to health and life under which they labored. In 1909 there were 121 boys and 193 girls, all under 16 years, employed in the match factories of the United States, considerably more than half of whom were under 14 years of age.

In Austria 126 victims of phosphorus poisoning were treated in hospitals in a period of 10 years.

Dr. Andrews found records of 82 serious cases of phosphorus poisoning in 3 factories, 40 of which were in a single factory. In one factory 21 cases were recorded, 6 of them in 1909. In another factory, during a period of several years, 15 employees lost either one or both jaws from operations necessitated by the poisoning. One of these patients, a girl 22 years of age, died in a few months after being poisoned. The total cases of Dr. Andrews' investigation made in 1909 revealed 102 cases of serious poisoning, with 19 deaths, a frightful mortality. He submitted data to the Congressional Committee investigating phosphorus poisoning of 14 deaths of children from 1 to 4 years of age, who, in playing about the floor or otherwise, had picked up and swallowed the heads of poisonous matches. One child, two years old, ate 60 such match heads and died in much agony. Death in such cases occurs usually within 24 to 48 hours. These matches have also been used for criminal and suicidal poisoning.

The first statutory prohibition of white phosphorus match manufacture and importation was brought about in Finland, in 1872, and in Denmark, in 1874, with the effect of eradicating phosphorus match poisoning from both countries permanently. Other foreign countries, after first attempting control of the industry, were finally led to prohibit it: France, in 1897; Switzerland, in 1898; and the Netherlands, in 1901. In 1905 the International Association for Labor Legislation advocated a treaty proscribing the making and selling of the dangerous matches, the signers of which, in 1906, were France, Germany, Denmark, Italy, Switzerland, the Netherlands and Luxemburg. In 1908 Great Britain and, in 1909, Austria became signatories, and Canada, since 1910, has prohibited the manufacture and importation of white phosphorus matches.

As usual in matters concerning protective legislation against occupational disease hazards, the United States was behind other civilized countries, and it was only through the persistent efforts of Dr. Andrews, acting for the American Association of Labor Legislation and the United States Bureau of Labor, that sufficient Congressmen were dissuaded from listening to the misstatements of self-interested and unhumanitarian manufacturers to follow the example of more

progressive countries. The Diamond Match Company possessed a patent which would enable the red phosphorus to be used almost as cheaply as the white, which it offered to give up to the other companies if they would agree to abandon the white phosphorus process. Thus legislation was again delayed for a year. But, as they declined the offer, and as public sentiment was meanwhile clamoring for definite action, it was at last secured. The Congressional bill which took effect July 1, 1912, taxes manufacturers of white phosphorus matches $1,000 per annum, but they may manufacture any other kind of match under a tax of only $50 per annum. Heavy penalties are attached for evasion of the tax, and, further, the white phosphorus matches, if made, are taxed one cent per hundred, which is economically prohibitive. The importation of white phosphorus matches is absolutely prohibited.

Andrews has computed that the cost to the average family by using the non-poisonous matches would mean an additional expenditure of only 5 cents per year.

The following abstract from the *Berliner klinische Wochenshrift* of May 16, 1910, was published in the *Medical Record* of June 18, 1910:

"Hemolytic Free Fatty Acids in the Liver of Acute Yellow Atrophy and Phosphorus Poisoning.—Joannovics and Pick have made a study of the extraction of hemolytic substances from the liver of a man who died of acute yellow atrophy, of a man who died of phosphorus poisoning, and of dogs and rabbits which were killed by phosphorus. They summarize their results as follows: (1) Hemolysins of exceptional activity may be obtained from the liver in acute yellow atrophy and phosphorus poisoning in both man and animals. (2) These hemolytic substances are soluble in ethyl and methyl alcohol, ether, and acetone, and are made up almost entirely of fatty acids; the lipoids insoluble in acetone are practically without hemolytic action. (3) In experimental phosphorus poisoning this hemolysin is present in the blood in large quantities. (4) The subcutaneous fat in phosphorus poisoning does not contain this hemolytic substance. (5) The presence of such an intensely active hemolysin in the liver is valuable for the demonstration of free fatty

acids. (6) The fatty acids which come in consideration in hemolysis in organic extractions appear from the manner of their hemolytic action to belong to the higher unsaturated fatty acids. (7) In acute yellow atrophy and phosphorus poisoning it would appear that these unsaturated fatty acids, which normally are combined in lecithin, are set free by the destruction of the latter."

Symptoms.—The victim of chronic phosphorus poisoning becomes very anemic, loses appetite, acquires diarrhea and bronchitis, and becomes of an ashen, pallid hue, with progressive emaciation. Albuminuria may be present. Stomatitis develops and becomes more and more serious. Ulcers form on the gums and buccal mucosa. The gums are swollen, spongy and easily bleed. The tongue is heavily coated and the breath is foul. The teeth are painful and discolored. They gradually loosen as the gums recede, and alveolar abscesses form. French authors refer to a condition of "phosphorisure," consisting of pronounced anemia, albuminuria, bronchitis, gastric disorder, and an odor as of garlic in the breath.

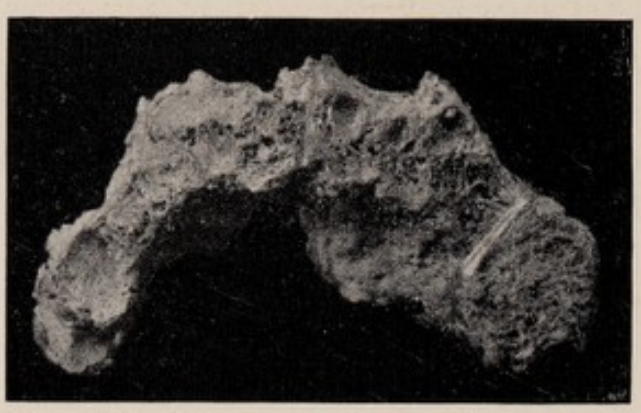


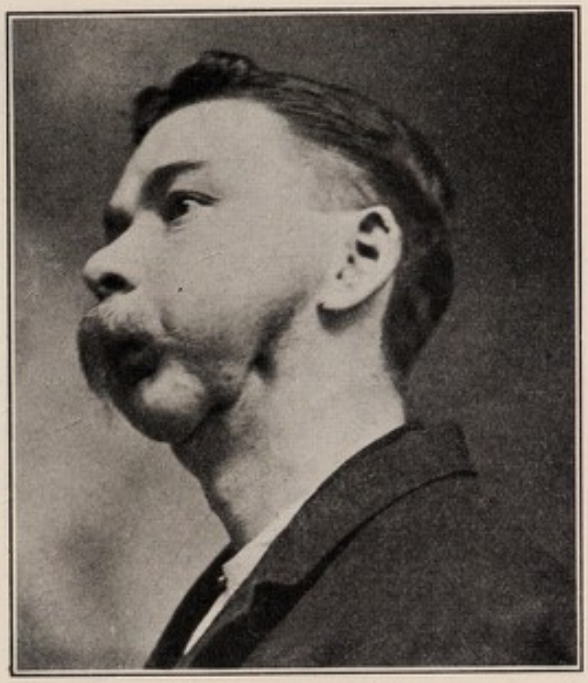
FIG. 51.—NECROSIS OF THE UPPER JAW FROM CHRONIC PHOSPHORUS POISONING. ("Gefahren der Arbeit in der chemischen Industrie," Verband der Fabrikarbeiter Deutschlands, Hanover, 1911.)

The specific action of phosphorus is finally manifested by a very painful subacute or chronic inflammation of the bones of the jaw, commencing usually at the roots of decayed teeth, and extending with periostitis and necrosis (Fig. 51) until a large-sized sequestrum is thrown off, with suppuration and sinuses which may open on the outer surface, forcing out stinking pus. The process may continue for months or several years unless treated. Meanwhile the constant secretion of pus gives rise to additional symptoms. It may be inhaled and cause bronchopneumonia, or, if swallowed, give rise to various digestive disorders. Necrosis of the upper jaw has been known to reach the base of the skull and induce a fatal septic menin-

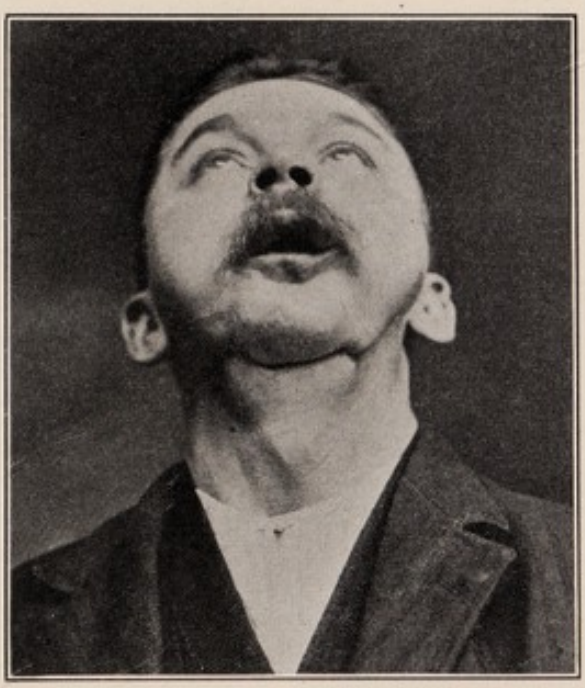
gitis. In exceptional cases the long bones become brittle and easily fractured by slight muscular contraction. In one of Kocher's patients five such fractures were observed, and Dearden, of Manchester, reported two more cases of fractured femur. The necrosis invariably begins at the site of a decayed tooth, and the lesion is probably due to the double irritation of the phosphorus dissolved in the saliva and bacterial infection of the decayed area, or, as Lewin suggests, there may be a primary septic gingivitis merely.

Andrews refers to the case of an old woman who had formerly lost her lower jaw from phosphorus necrosis twenty years previously, and who "masticated her food by pressing it against her upper jaw with her thumb."

The patient shown in Figures 52 and 53 is a German, 28 years of age, who worked in an Ohio match factory for 15 months in 1907-8. As a result of white phosphorus poisoning he lost his teeth, acquired necrosis of the lower jaw, and required two operations for its removal. He is



Side View Showing the Result of the Excision of the Entire Lower Jaw.



Figs. 52 and 53.—Necrosis of the Jaw Due to Chronic Phosphorus Poisoning. This patient worked in an Ohio match factory. At the age of 28 he lost the entire lower jaw through necrosis and prolonged suppuration. (Courtesy of Dr. John B. Andrews.)



FIG. 54.—PATIENT ROSE C., 31 YEARS OLD. Before working in a factory as boxer of phosphorus matches.



FIG. 55.—NECROSIS OF JAW DUE TO PHOSPHORUS POISONING. Patient Rose C. after 4 years' work. Upper jaw removed in Lakeside Hospital, Cleveland, O., 1911. Patient cannot articulate and can eat only fluid food. (Surgical records of the hospital; courtesy of Dr. John B. Andrews.)

unable to eat solid food. He sued the match company for damages, but under the then existing laws was unable to secure any. Figures 54 and 55 represent a similar case in a woman.

Children who have swallowed poisonous phosphorus matches present acute fatty degeneration of the liver and kidneys and symptoms resembling those of acute yellow atrophy of the liver, although they may die before there has been time for much jaundice to develop.

Prognosis.—The earlier symptoms of the disease yield readily to hygienic treatment on cessation of work, but after necrosis, with extensive suppuration, has taken place it becomes necessary to remove a considerable portion of the jaw, or sometimes take out most of both jaws, an operation critical in itself, besides the danger of fatal sepsis or inhalation pneumonia. Other patients may die from inanition. Not a few have committed suicide after realizing the hopelessness of their condition.

In France, since the exclu-

sive use of the non-toxic sesquisulphid of phosphorus in the match industry, not a single case of phosphorus poisoning has been recorded, nor have any fires occurred in the factories.

Prevention.—Prevention consists in the absolute prohibition under strict penalty of the use of white phosphorus in the match industry. In any match factory, however, good ventilation should be insisted upon and the teeth, particularly, and general condition of the employees should be subject to frequent periodic medical examination.

Two or three of the English match companies issue the following rules to employees:

THE PRESERVATION OF THE TEETH

Without good teeth there cannot be thorough mastication.

Without thorough mastication there cannot be perfect digestion, and poor health results.

Hence the paramount importance of sound teeth.

Clean teeth do not decay.

Food left on the teeth ferments and the acid formed produces decay.

Decay leads to pain and the total destruction of the tooth.

When decay occurs, it should be attended to, whether giving pain or not.

The immediate stopping of a small cavity is of the greatest service in preventing the necessity for extraction.

The following rules should therefore be closely observed:

1. The teeth should be cleansed at least once daily with toothbrush and powder.
2. The best time to clean the teeth is after the last meal.
3. A small toothbrush with stiff bristles should be used, brushing up and down and across, inside and outside, and in between the teeth.
4. A simple tooth powder, or a little soap and some precipitated chalk, taken up on the brush should be used. If the teeth are dirty or stained, a little fine pumice powder may be used, but only occasionally.
5. It is a good practice to rinse the mouth out after each meal.
6. All rough usage of the teeth, such as cracking nuts, biting thread, etc., should be avoided; but the proper use of the teeth in chewing is good for them.
7. All persons engaged in these works should rinse their mouths thoroughly before meals and before leaving the works.

Castile soap is cheap and makes a good suds, which should be squirted around in the mouth by moving the cheeks. Borax and

potassium permanganate solutions may also be used for rinsing the mouth. Foods, especially milk, butter and meat, readily absorb phosphorus fumes and should on no account be left in the workroom.

In Hungary cloths saturated with turpentine are hung in the workrooms where phosphorus is used to absorb its fumes, and turpentine (5 per cent.) is added to the phosphorus paste.

The treatment of the bone necrosis and abscess is purely surgical.

PHOSPHORETTED HYDROGEN AND FERROSILICON

Phosphoretted Hydrogen

This is a colorless, nauseous gas liberated in the process of phosphorus extraction and in making the sesquichlorid of phosphorus for match manufacture. It also is derived during the making of acetylene from calcium carbid and phosphate, and from ferrosilicon. When inhaled the gas causes oppression and burning pains in the thorax, with headache, vertigo, tinnitus aurium, weakness, and intense thirst. It disintegrates the blood, and may thus prove fatal.

Ferrosilicon

Ferrosilicon poisoning is one of the newest of occupational hazards, incident to modern chemical processes designed to improve products of the steel industry. The substance is composed of a mixture of products of both iron and silica, the latter being in proportion of 30 to 70 per cent. It is used in making electrodes and is added in iron and steel foundries to the molten metal to remove bubbles of gas. The high-percentage ferrosilicon is prepared by fusing a mixture of sand or quartz, which furnishes the silica, with iron or steel turnings and coal or coke in an electric furnace heated to 2,000° C. The impurities, calcium phosphate and arsenic, are not removed, but are fused with the carbon of the coke to calcium phosphid and arsenic. If water gains accidental access to these two latter substances, decomposition results, with evolution of phosphoretted and arseniuretted hydrogen gas. These gases are immediately fatal to animals if present in the atmosphere in only one-fourth of

one per cent. Spontaneous decomposition may also occur in the high per cent. grades of ferrosilicon, but percentages of 30 or less are comparatively safe to handle.

Symptoms.—Symptoms of the poisoning appear to be due to the inhalation of phosphoretted hydrogen mainly, as it exists in greater proportion than the arseniuretted hydrogen, although the effect of the two gases is similar. These symptoms are violent, as the gas is a powerful hemolytic, and death may take place within a few hours. They are chiefly gastric and circulatory and consist of nausea and vomiting, with violent abdominal cramps, followed by immediate collapse, the great weakness being followed by gradual onset of coma and death. The violence of the poison, with the nature of the symptoms and sudden collapse, has sometimes given rise to a suspicion of the presence of cholera, which, however, may easily be corrected by bacterial examination of the stools.

It is upon steamers in the holds of which ferrosilicon is carried that wholesale poisoning is liable to occur if bilge water gains access to the containers of the substance.

The first recorded case of poisoning was observed in 1904, and shortly after 50 steerage passengers of the steamer *Vaderland* were made violently ill by the gases, 11 of whom died. On another steamer, *Ashton,* making a short voyage of a day, 5 steerage passengers were fatally poisoned. A number of other fatal cases were brought to light by a British Parliamentary investigation, but in the United States no authentic cases of fatal poisoning have been reported, although the product is manufactured here in considerable quantity, especially at Niagara.

Prevention and Treatment.—To avoid the great hazard of ferrosilicon poisoning when the high-grade product is dealt with, it should be broken into bits and well aired before shipping, and should be protected from water when stored in the holds of vessels or elsewhere, and surrounded by open spaces. It should never be stored near apartments occupied by man or carried on passenger vessels. The poisonous gases act so quickly and violently when liberated that treatment must be energetic and prompt by means of hypodermatic heart stimulants, artificial respiration, and perhaps transfusion of blood.

SMOKE

This is an indefinite term usually referring to the products of imperfect combustion of wood or coal, but used also to describe unconsumed products of the burning of oil, kerosene and a great variety of chemicals. Ordinary wood or coal smoke contains soot and gases such as carbon dioxid and monoxid, sulphurous vapors, etc. It may be inhaled either hot or cold. It irritates the eyes, causing lacrimation and conjunctivitis. It gives rise to cough and rhinitis, laryngitis and bronchitis, according to its density and composition. Its effects are fully described under the headings of its several compounds, such as Carbon Monoxid and Dioxid. (*See,* also, Firemen and Air Impurities.)

SULPHUR AND SULPHUROUS ACID

Sulphur

The principal sulphur mines are found in Sicily among the volcanic products of the island. The miners are subjected to the inhalation of much irritant dust, and catarrh of the upper air passages is common among them. (Fig. 56.)

In the sulphur mines of Sicily about 40,000 workmen are employed. Sir Thomas Oliver (*Brit. Med. Jour.,* July 1, 1911) found that the men are sometimes asphyxiated by inhalation of sulphuretted hydrogen and carbon dioxid gases derived from bituminous clay in the mines and from the lights used in the mines. Sulphurous acid and sulphuretted hydrogen also give rise to conjunctivitis.

Workmen employed in the grinding of pure sulphur and in its distillation from pyrites are subject to sulphur poisoning. The latter substance usually also contains arsenic, which is a further source of possible poisoning. In sulphur-refining processes more or less vapor escapes from the retorts and condensation chambers, especially when they require to be opened or cleaned.

Sulphur, both in powdered form and as a paste, is much used on plants as an insecticide. Sulphur vapor is highly irritating and destructive of the lower forms of life. The vapor is liberated in

smelting and illuminating gas plants, match factories, the manufacture of sulphuric acid and in bleaching various products such as straw hats, cotton cloth, etc. It is also used in preparing hops and

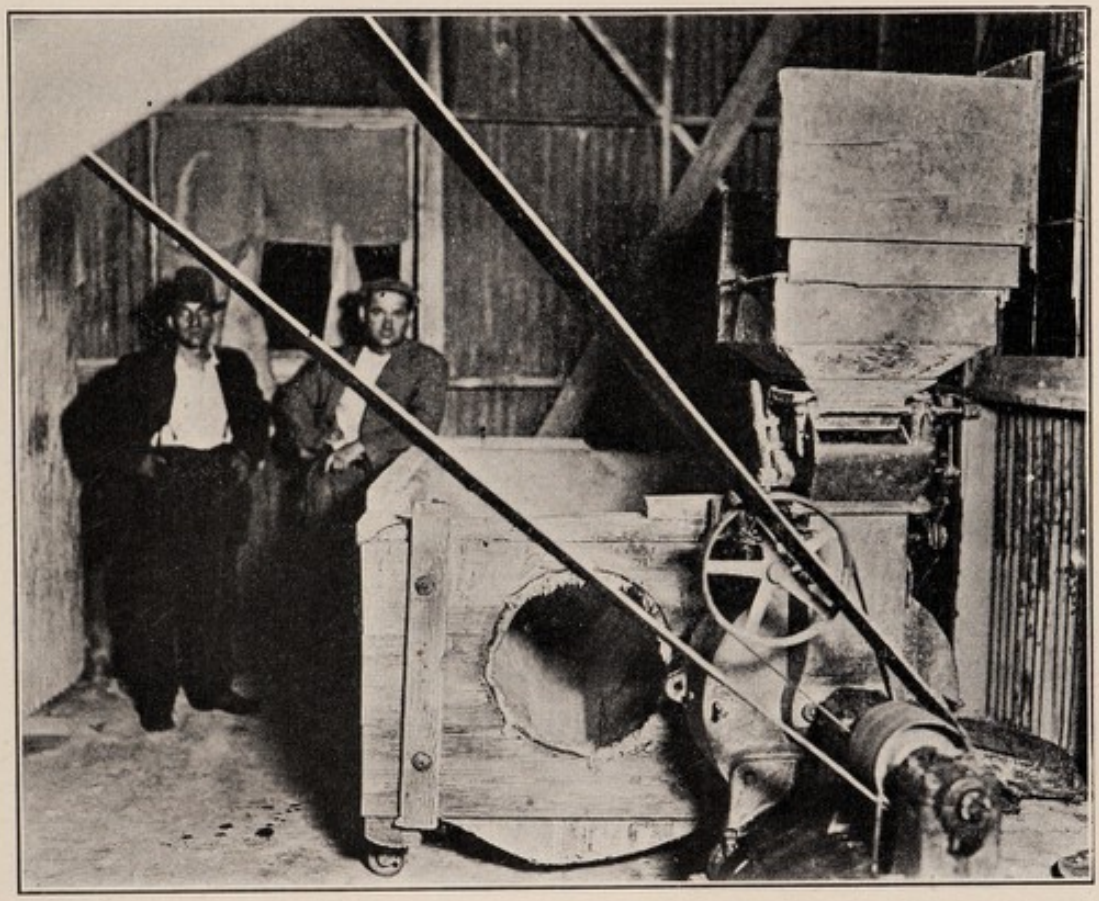


FIG. 56.—A SULPHUR PULVERIZER. A poor arrangement without adequate dust protection or magnets to collect scrap metal. Note the dangerously exposed belts. (From the *Bulletin* of the Illinois State Department of Factory Inspection, 1911.)

dried fruit, and it formerly was much in vogue in the form of "candles" for fumigation after infectious diseases, but is of doubtful efficacy. Lehmann found sulphur to be irritant in strength of 0.04 part per 1,000 of air.

SULPHUROUS ACID

This acid is evolved from the roasting of sulphur ores, and is used in making sulphuric acid, in candle, glue and brick works, as well as a bleaching agent. Among the numerous processes for which it is employed are the bleaching and disinfection of such animal tis-

sues as wool, hair, bristles, feathers, down, catgut, and gelatin, the refining of certain metals, vulcanizing of rubber, making ultramarine, flint glass and sodium sulphate.

Sulphurous acid may be inhaled up to a strength of 7 per cent. without serious effect, other than that of producing digestive disorders (Hirt), but if it be much stronger it irritates the pulmonary branches of the vagus, finally paralyzing the respiratory center. After death the lungs are found dry and contracted. According to Ogata, sulphurous acid may be transformed in the body into sulphuric acid, at the expense of the oxygen of the hemoglobin. When concentrated, the fumes are so irritating to the throat that the victim feels compelled immediately to seek the open air, hence cases of serious or fatal poisoning by inhalation of the fumes of the acid rarely occur. The conjunctivæ are inflamed, the tears are increased, there is a sensation of strangulation in the throat and intense dyspnea results, with violent coughing. In extreme cases death may result from respiratory spasm and asphyxia. Ordinarily, however, workmen who are exposed for some time to mild degrees of sulphur poisoning complain of headache, anorexia, spasmodic cough, sneezing, hemoptysis, bronchitis, constriction of the chest, gastro-intestinal disorders and conjunctivitis, with smarting of the eyes and lacrimation. Anemia, too, is common. There is more or less gastric disorder with pain. For these symptoms the workmen soon acquire toleration, but if they resume work and are again exposed to the fumes after a few weeks' interval, the symptoms recur. When inhaled in larger quantities the mucous membranes become ulcerated.

Treatment.—Preventive treatment comprises proper ventilation. Anodyne cough mixtures may be required, but a few days of rest and careful dieting will usually relieve the digestive symptoms. The eyes should be bathed with a saturated solution of boric acid in distilled water.

SULPHUR CHLORID

This is a thick, brownish, fuming nauseous fluid used mainly in the rubber industry and to dissolve fats and sulphur. When inhaled

as a vapor it gives rise to nausea and vomiting, and in contact with the water contained in mucus may form hydrochloric acid, giving rise to marked irritation of the respiratory passages.

SULPHURETTED HYDROGEN

Sources of the Poison.—This gas, like carbonic acid gas, exists both as a natural and artificial product and under very similar circumstances. As a natural product it is prevalent in subterranean passages such as deep mines, tunnels under rivers, in blocked sewers, and especially where there is decomposing organic material in privies, marsh mud, manure beds, etc. Many of the sulphurous mineral waters evolve it in considerable quantity, and it has more than once proved fatal to those employed in piping or bottling them. Men occupied in cleaning out cesspools may be overcome by the gas, and it has been known to accumulate in old casks on shipboard in which there were materials of decomposition. In the bronzing of metals a sulphid of arsenic is used, and sulphuretted hydrogen (H_2S) may be formed in the process, as it is in the manufacture of sulphuric acid (H_2SO_4). In soap factories and tanneries calcium sulphid and sulphuric acid are used, and by chemical reactions sulphuretted hydrogen may be formed. In its natural origin sulphuretted hydrogen is often associated with CO_2, carburetted hydrogen, carbon bisulphid, marsh gas (CH_4), ammonia and ammonium compounds, all of which are more or less toxic. In Paris about 1,000 men are employed in the large sewers, where they are exposed to these various gases and not infrequently are overcome by inhaling them. Plumbers and telephone or telegraph layers who are called upon to work in trenches may be exposed to sulphuretted hydrogen gas. The gas may be evolved in a decomposition reaction of Prussian blue or potassium ferrocyanid with sulphate of iron. It is given off in the refineries where certain animal products are made. In metallurgy it is formed by action of acids on pyrites. According to Brouardel and Loye, a percentage of 0.12 of the gas may prove fatal in the air breathed. It is present in gas liquor storage tanks, gas purifiers and sulphate stills.

Pathology.—The gas when inhaled is absorbed by the bloodvessels of the respiratory tract and promptly reduces the hemoglobin of the blood. It paralyzes respiration at the bulbar center, and produces death from asphyxia. The gas may enter in smaller quantity through the mouth and digestive tract, and it is a fairly constant product of intestinal decomposition and fermentation, especially after sulphur-containing foods have been eaten. It may be absorbed from the alimentary canal and given off by the lungs. Many years ago an ingenious but fallacious treatment for pulmonary tuberculosis was suggested. A small quantity of sulphuretted hydrogen gas was introduced through a tube into the rectum. The gas is inimical to the tuberculosis bacillus, and it was held that, on being absorbed by the hemorrhoidal veins, it would be borne in the circulation to the lungs and there destroy the bacilli. In experiments which I made I was able to detect a strong odor of sulphuretted hydrogen in the exhaled air of patients within 2 or 3 minutes after the gas was injected into the rectum. It is manifestly impossible to inject the gas in sufficient strength to affect tuberculosis bacilli without entirely decomposing the blood in the process!

Symptoms.—Acute or Fulminating Form.—In acute poisoning, which is uncommon, there is immediate general muscular paralysis, with loss of consciousness and convulsions. Respiration becomes feeble and irregular, there are deep cyanosis and a feeble, quick pulse, and the victim dies from apnea, or, if the dose be not fatal, he may be revived by artificial respiration after some hours of unconsciousness. In some cases the fatal symptoms do not develop immediately on inhaling the gas, but after an interval of perhaps half an hour. In such cases death from asphyxia may take place more slowly, with preceding dyspnea, irregular heart action, insensitive corneæ, dilated pupils, with absent pupillary reflexes, contractures of the extremities, a low blood pressure, cyanosis, sugar or albumin in the urine, and finally insensibility, which gradually deepens into profound coma.

Chronic Poisoning.—Chronic poisoning, or at least a slow type of poisoning, is met with in which the symptoms are: malaise, vomiting, fulness in the head and a sensation of weight in the stom-

ach. The latter symptoms the sewer men call "the lead." Anemia follows and the patient becomes weak and cachectic.

Sulphuretted hydrogen blackens silver with a deposit of lead sulphid, hence silver coins in the pockets of workmen exposed to this gas promptly become tarnished.

Prevention.—Before entering a sewer or trench where the gas may be present it is desirable for the workman to tie a rope to his waist so that he may be hauled out promptly if overcome. A lighted candle may be lowered first to test the quality of the air, or, as is done in Germany, a pigeon may be let down in a cage. When real danger is known to exist the workman should be provided with an oxygen helmet (*See* page 146).

Treatment.—Means of resuscitation should be always at hand, consisting of a can of oxygen gas for inhalation and hypodermatic stimulants (*See* page 144). Artificial respiration should be performed (*See* page 145) where any signs of failing respiration exist. As the action of the gas is hemolytic, as in illuminating gas poisoning, bleeding followed by saline infusion or direct blood transfusion should be resorted to.

TRINITROPHENOL

Trinitrophenol manufacture gives rise to much illness. According to Leymann's statistics for each 100 workmen, there are 128 cases of illness per annum in this industry. The symptoms are those of respiratory irritation, cardiac depression and gastric disorder.

TURPENTINE

Turpentine has many important uses. The vapor is evolved in the distillation of turpentine, in calico printing and wherever it is employed as a solvent or diluent, as in dissolving varnishing materials, diluting mineral paints, etc., and as a drier or oxidizer of paints and varnishes. Where the paint or varnish is spread over large surfaces in the confined air of workshops where carriages, wagons or automobiles are varnished, or in the closed rooms of freshly painted houses, the percentage of the vapor in the atmos-

phere becomes considerable. One of my patients had been a furniture polisher for many years, suffering very much from chronic bronchitis and chronic conjunctivitis.

Turpentine is especially used in painting on porcelain and on glass. It is also used by dyers of lace and of other fabrics, as a polish for furniture and wood flooring, and as a solvent in the manufacture of rubber articles. Cooking and other domestic utensils of iron ware are often shellacked and dried in ovens. In the process rosin and turpentine fumes are evolved and may prove quite irritating to the respiratory system. In Hamburg, to which port much turpentine is shipped, the navvies who unload it are sometimes poisoned by it.

Those who work in the industries above mentioned nearly always suffer sooner or later from the effect of the fumes. So do those who sleep in freshly painted rooms with poor ventilation. Many workmen acquire a considerable degree of tolerance for the fumes, but novices are promptly affected.

When derived from admixture with lead paint turpentine fumes alone do not explain the violent retching and vomiting, colic and other symptoms which sometimes ensue, for zinc paint with turpentine does not cause such disturbance, and painters may be made ill by using certain oils to mix with paint, whereas others do not affect them. Oliver believes that between a terebinthinated oil and white lead there is apparently some compound formed which in its nascent state is harmful to those who breathe it.

Turpentine vapor, when inhaled experimentally by animals, causes tremors, an uncertain spasmodic gait, paralysis of the hind legs, convulsions and a rapid, feeble pulse. Turpentine is a direct irritant to the skin and mucous membranes. As proof of the latter is its well-known effect in stimulating peristalsis when added to enemata, and in proof of the former are the superficial redness of the skin produced by turpentine stupes and the mild dermatitis which may be excited by turpentine ointments. When inhaled the vapor is absorbed by the blood, and the turpentine is subsequently eliminated in somewhat altered form by the kidneys, imparting an odor of violets to the urine.

Symptoms.—The symptoms of turpentine poisoning affect the eyes, skin, stomach and intestines, pulmonary, urinary, circulatory and nervous systems. Females are more susceptible than males to the nervous symptoms. Alcoholic subjects are easily affected by turpentine fumes.

Eyes.—Turpentine spattered into the eyes causes acute pain. The vapor also irritates the eyes severely. They present conjunctival congestion and acute or chronic inflammation, with redness and more or less swelling of the lids accompanied by visual disorder.

Skin.—The skin may present erythema, congestion and acute or chronic dermatitis. To the latter ailment painters are very subject. Much impure turpentine is applied by hand for polishing and cleaning painted woodwork, floors, furniture, etc. It irritates the unprotected hands, giving rise to hardening of the epidermis and chronic eczema of very intractable type. The thickened epidermis is liable to present deep fissures which bleed easily and cause considerable discomfort and pain.

Digestive System.—Nausea and vomiting are usual symptoms in acute poisoning, and diarrhea may result from increased peristalsis. In medicinal doses turpentine aids in expelling flatus and is mildly antiseptic, or rather antifermentative. It formerly had some reputation as an agent for controlling hemorrhage in typhoid fever, when given in capsules or emulsion in 5 or 10 minim doses.

Respiratory System.—The immediate result of inhaling strong fumes of turpentine is laryngeal spasm, followed by an irritant dry cough and hoarseness. Rhinitis may be present. As an after-result bronchitis occurs, which, if the irritation be long continued, may become chronic, with muco-purulent expectoration. In this connection it is interesting to note that turpentine medicinally inhaled, as with steam from a croup kettle, is an excellent deodorant in cases of fetid bronchitis, foul bronchiectatic cavities, and for abscess and gangrene of the lung. I know of none better. It also, like the balsams, acts favorably upon chronic bronchial catarrh. Turpentine thus affords another of the many illustrations of bene-

fit in medicinal doses to some of the very ailments which may be produced by toxic doses.

Urinary System.—Turpentine, being, as stated above, eliminated by the kidneys after poisonous doses of its fumes have been inhaled, irritates them severely, causing acute hyperemia and sometimes acute nephritis. Pains in the back are complained of, with frequent voiding of small quantities of urine and strangury. The urine is often bloody and may contain granular and blood casts, epithelial casts, and albumin. The urinary symptoms may appear a day or two after an initial attack characterized by vomiting, drowsiness and headache. In a study of 62 turpentine workers by Nicholl, Flinn and Hayhurst it was found that 14 had organic renal disease.

Circulatory System.—The circulatory system is affected by continued turpentine inhalations. The patient complains chiefly of headache, tinnitus aurium and vertigo (with sometimes loss of equilibrium), and a quickened pulse. Anemia is usually present.

Nervous System.—The patient becomes irritable and depressed, like many subjects of chronic alcoholism. In chronic turpentine poisoning, as seen among calico printers, there is emaciation with anemia and gastro-intestinal disorder.

Prevention.—Turpentine should be handled with care, transported only in metal containers to prevent the hazard of breakage, and they should be opened only under conditions of good ventilation. In painting or varnishing indoors good ventilation is of great importance, and one should not sleep in a freshly painted room until the paint is thoroughly dry and the room has been well aired for a day or two.

Treatment.—In mild acute cases the symptoms soon pass off in the fresh air, without treatment. In more severe cases the renal symptoms demand attention. The patient should be given a milk diet and drink abundantly of water. Cupping and poulticing over the lumbar region may be resorted to. The nausea may be relieved by bicarbonate of soda or lime water, and the cough is best treated by codein and a simple cough mixture such as ammonium chlorid in syrup of prunus Virginiana.

III. TOXIC FLUIDS: ACIDS AND MISCELLANEOUS FLUIDS

MINERAL AND OTHER ACID POISONING

General Symptoms.—Pulmonary Edema.—The effect of inhalation of mineral acid fumes by man varies naturally with the duration of the inhalation and density of the fumes. Concentrated fumes may cause immediate death from suffocation. Less concentrated fumes or inhalations of very brief duration cause irritant cough, a sensation of choking, increased bronchial secretion, turgescence of the veins, and lowering of the blood pressure. The coagulation time of the blood is somewhat lengthened. After a few hours pulmonary edema may develop. If the edema be slight, the patient may apparently recover, but in two or three days may develop lobar pneumonia, which is liable to prove fatal.

The acute edema of the lungs caused so constantly by the inhalation of strong fumes of mineral acids has been made the subject of an interesting experimental study by a former pupil of mine, Dr. W. G. Hudson, now connected with the largest manufactory of high explosives in the country. The experiments were conducted by subjecting rabbits and dogs to the acid fumes in order to determine whether the resulting edema was secondary to hemolytic changes or to a primary corrosive action upon the lung tissue. The blood was but slightly altered. There was, within a few hours after exposure to the fumes of three minutes' duration, a diminution in red cells of 200,000 or 300,000 and an increase in leukocytes of 2,000 to 4,000. Coagulation time was not appreciably altered in several cases, but in others it was slightly lengthened. The alkalinity of the blood was slightly reduced, probably from the acid absorbed. Further experiments were made in dogs by tracheotomizing them, tying off one lung during the inhalation of the fumes and then continuing artificial respiration until the animal died, both lungs being inflated. Autopsy showed that the lung into which the fumes had been prevented from entering remained normal, whereas the acidified lung was markedly edematous. Hence Hudson concludes:

"While some of the acid principles are absorbed into the blood in cases of acid fume poisoning, as shown by the various blood tests throughout these experiments, the serious secondary symptoms are due to the direct chemical action of the fumes upon the delicate tissues lining the air vesicles, and not to changes brought about by absorption into the blood.

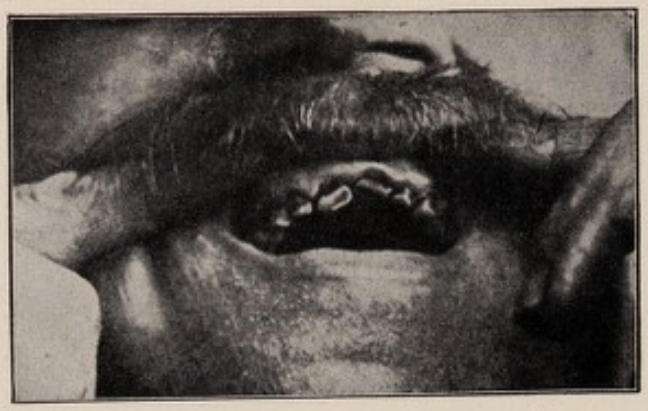


FIG. 57.—EROSION OF THE TEETH DUE TO TWO YEARS' WORK IN THE FUMES OF HYDROCHLORIC ACID. (From "Gefahren der Arbeit in der chemischen Industrie," Verband der Fabrikarbeiter Deutschlands, Hanover, 1911.)

"The usual secondary symptoms which have been so fatal are the result of a pulmonary edema which the acid fumes excite. This edema shows no pathological difference from that met with in general medical practice, although it occupies a rather unique position in being a simple, uncomplicated edema, while that met with in medical practice is always secondary to some other disease.

"But the experiments show in addition that when the exposure has not been sufficient to cause pulmonary edema it may easily be sufficient to be the exciting cause of a lobar pneumonia."

The experiments also showed marked diminution in blood pressure, and when large doses were administered the animals died in convulsions, frothing at the mouth. (*See* also Edema of the Lungs, page 154.)

The dipping of metals such as bronze, brass and copper into mineral acids to burnish their surface is a hazardous industry. For this purpose sulphuric, nitric and hydrochloric acids are used singly or in combination. These acids, especially nitric acid, through their fumes attack the respiratory passages and cause decay of the teeth. (Fig. 57.) The fumes are all heavier than air and should be removed by exhaust ducts placed immediately over their source, as well as near or under the flooring, which should be of asphalt with tile drainage.

The ill effects of acid fumes are by no means confined to the immediate surroundings of the workman. In the vicinity of chemical works, where large quantities of acid fumes are discharged into the surrounding atmosphere, vegetation is destroyed and animal life may suffer. The American Game Protective and Propagation Association has estimated that in Utah, in the vicinity of Salt Lake City, as many as 2,000,000 water fowl are annually destroyed by the acids discharged into marshes from manufacturing plants.

Treatment.—To prevent the local irritation of the mineral acid fumes the nostrils should be kept greased with vaselin. The best possible ventilation should be secured, for the wearing of respirators is of little value.

Conjunctivitis may be relieved by hot compresses and warm saturated boric acid solution. The bronchitis is best treated by rest in bed in a room in which the air may be kept constantly moist by means of a croup kettle in which plain water and lime water may be evaporated. If there is much constriction of the chest, a hot flaxseed poultice may be applied or a large weak mustard paste (1-8). Distressful cough may be relieved by codein or heroin, and laxatives should be given. If there is any tendency to edema of the glottis it may be relieved by a spray of adrenalin chlorid.

CARBOLIC ACID

Poisoning by fumes of this substance is uncommon. When it is observed there are frequent vomiting, salivation and difficulty in swallowing. Chronic nephritis may develop and the urine becomes of a smoky gray color. Emaciation ensues, known as "carbolic marasmus."

The symptoms in general resemble those of dinitrobenzol poisoning, described on page 344.

The eczema produced by handling carbolic acid is described under Eczema.

HYDROCHLORIC ACID

Occupations.—The vapor of this acid may be liberated during its manufacture, in the process of manufacturing chlorin or the alkaline

chlorids, galvanization of sheet iron, the bleaching of jute, hemp, flax and linen cloth, for which latter a bath of chlorid of lime and sulphuric acid is employed. The acid is also used in wire works and in the glazing of pottery, in enameling and soldering, and refining and bleaching tallow.

In general, hydrochloric acid fumes are less irritating to the respiratory passages than pure chlorin gas, and among workmen the ill effects are less severe than those of the other mineral acids, although brief exposure to an atmosphere containing 0.1 per cent. has been known to cause death. Lehmann (*Arch. für Hygiene,* v, 1) found that less than one-thousandth part of this gas per volume of air may give rise to serious symptoms.

Symptoms.—Hydrochloric acid fumes give rise to conjunctivitis, rhinitis and bronchitis. They produce irritant dry cough and sensations of burning and choking. Nosebleed may occur. If concentrated they may cause pneumonia, or prompt death from dyspnea, hemoptysis and stupor. When inhaled for long periods in dilute form they erode the teeth by solution of their lime salts and cause ulcers of the nasal cavities, tongue, mouth or pharynx, gastro-intestinal disorder, anemia and emaciation. Such chronic cases are most often found among makers of synthetic soda. In this occupation they are likewise exposed to fumes of sulphuric acid.

In chronic cases of hydrochloric acid poisoning Fornwood and Kobert have reported perforation of the nasal septum, as in chrome poisoning, and necrosis of the alæ nasi. Both anosmia and hyperosmia are observed.

HYDROFLUORIC ACID

This acid is derived from distillation of sulphuric acid and calcium fluorid. The fumes are exceedingly poisonous. They may affect workmen employed in etching upon glass (of which the acid is a solvent), in porcelain painting, and various bleaching processes, as in whitening cane and bleaching tallow. The acid is used also in cleaning glass, in making glass labels and signs, and by dentists to roughen the adherent surface of porcelain inlays. In making mineral phosphates or superphosphate for fertilizers the chlorin and

fluorin compounds associated with these phosphates, when treated with sulphuric acid, may be set free in the form of hydrochloric and hydrofluoric acids.

Two deaths among chemists are recorded from inhalation of this acid, and a number of cases of both acute and chronic poisoning by it have been observed, several of which were fatal.

In an autopsy reported by the Illinois State Commission on Occupational Diseases, made upon a victim of chronic hydrofluoric acid poisoning the lungs showed extensive cicatrization of old ulcers and fresh ulcers and abscesses at the bifurcation of the bronchi.

Symptoms.—Hydrofluoric acid fumes are especially irritating to the eyes, and may also irritate the respiratory system, causing, after long-continued inhalation in small quantity, deep ulceration of the nose with fibrous margins of the ulcers. Marked anemia is also present. The victims of inhalation of the fumes acquire coryza, conjunctivitis with greatly swollen eyelids, and sometimes ophthalmia with ulcerative keratitis. There are also rhinitis, pharyngitis, ulcers in the mouth, and bronchitis, with a choking sensation. Bronchopneumonia may develop, and pulmonary fibrosis occurs. The local reaction is so strong that periostitis may follow superficial application of the acid to the skin, and the cutaneous ulcers which form with blebs are deep, painful and extremely slow in healing, even when very limited in extent.

Dr. Laura H. Branson has reported the case of an instructor in chemistry in the Iowa State University who, while etching glass with the acid, injured his hand and got some of the acid into the cut surface of his fingers. Excruciating local pain was followed by edema, stiffening of the fingers, and constitutional reaction consisting of extreme nervousness and a rise of body temperature to 105° F. Local periostitis and synovitis followed, and resolution was not complete in less than eight weeks, although not more than 3 minims of the acid had originally been in contact with the skin.

A lad of 14 years came to my clinic who was employed cleaning stained glass with a mineral acid, the exact nature of which was not known to him, but it was probably hydrofluoric. In his work he inhaled acid fumes, and after two weeks of this employment he began

to vomit daily after meals. He had nausea, vertigo and diarrhea. He had previously been well, and on Sundays, when he did not work, he always felt better. The boy stated that a number of others who worked with him were similarly affected.

Prevention.—To protect the eyes, celluloid goggles should be worn and gloves to protect the hands. Respirators, too, should be worn and a good exhaust with blow-fan driving a strong current of air away from the workman is absolutely essential.

NITRIC AND NITROUS ACIDS, NITROUS GASES

Nitric acid is formed by subjecting Chile saltpeter to the action of sulphuric acid. Nitrous gases are formed by low degrees of nitrogen oxidation, such as NO, NO_2 N_2O_3, N_2O_4 and HNO_2. They are produced by the deoxidizing action of nitric acid on a variety of substances, like metals, wool, wood, paper, straw, and textile substances. They are formed in the preparation of nitric acid and its salts, in metal etching and electro-metallurgy, in the making of explosives, in celluloid works, in making anilins, picric acid, and hat making, dyeing and calico printing, and a great number of other common industries. Nitric acid on exposure to the air in the presence of metals as well as organic matter is decomposed and volatilized with formation of oxids, particularly the nascent peroxid, N_2O_4, known as nitrogen tetroxid or dinitryl, which is excessively poisonous when inhaled, giving rise to acute pneumonia, with much swelling of the bronchial mucosa and suffocation. The fumes of nitrous and nitric acids, nitro-hydrochloric acid and nitrogen binoxid arise from the processes of manufacture of a variety of products and are highly irritating to the respiratory system. Thus they may be developed in the making of arsenic acid, arsenate of sodium, the boiling of benzin in nitric acid to form nitrobenzin, and the preparation of sulphuric, oxalic and picric acids. Ammonium nitrate is developed in sugar refineries in the maceration of beets. False pearls are plunged into nitric acid to dissolve the central stem of copper on which they are held. In the making of cheap jewelry nitric acid is used to give to copper the appearance of gold. Nitric

acid is also used in assaying, as in testing coins, in the making of felt hats to form a nitrate of mercury (*See* page 291), and in certain metallic blackening and coloring processes in which sulphate of iron is mixed with nitric and hydrochloric acids. Nitric acid is sometimes used in textile printing, in the making of certain pigments, especially the chrome compounds, the making of potassium nitrate, fulminate and celluloid. In the latter process cellulose is dissolved in a mixture of nitric and sulphuric acids. Telegraph batteries may contain nitric acid. In all these processes the workmen are subject, from time to time, to toxic effects, and in many of them deaths have been reported. Motagné, in his Paris Thesis of 1901, reported 38 cases of poisoning by nitrous fumes, one-half of which terminated fatally. I saw recently, in a powder factory, a case of chronic atrophic rhinitis due to handling nitrate of soda in making black powder.

It has been shown by Hoppe-Seyler that nitrogen binoxid gas forms a stable compound with the blood, interfering with its normal oxidation, and in experiments with animals Eulenberg produced with nitrous acid fumes salivation, tremors, dyspnea, restlessness and fatal convulsions. Death ensued in less than 20 minutes, and at autopsy the meninges and brain were hyperemic, the lungs were congested and the right heart distended.

In an autopsy performed upon a workman who died from inhaling nitrous acid fumes, Tardieu and Roussin found the lungs were softened, emitted a strong nitrous odor and gave an acid reaction.

Nitrous acid is converted into nitric acid in the presence of the oxygen of the blood.

Symptoms.—Nitrous poisoning may be either acute or chronic.

Acute Type.—The acute form, owing to numerous accidents in connection with handling nitrous products, occurs more often and is far more dangerous than the chronic type. In mild acute cases the skin is reddened, the conjunctivæ are congested, and digestive disturbances such as dyspepsia and colic are observed. There are also dry cough and moderate dyspnea, with a feeling of constriction at the throat. In severe acute cases an intense bronchitis re-

sults within a few hours after the inhalation, which rapidly becomes capillary in type. It is accompanied by intense dyspnea, both subjective and objective. The victim becomes anxious and restless, there is severe cough, at first dry, later accompanied by a profuse watery, yellowish expectoration or bronchorrhea. Deep cyanosis is observed, with exophthalmos and coldness of the extremities. The patient vomits, and passes into a stage of delirium and final convulsions. A few years ago a number of workmen were unloading from a vessel at a dock in New York carboys of nitric acid, some of which becoming accidentally broken, their contents flowed over the wooden floor, producing dense clouds of acid vapor. The workmen were immediately overcome with suffocation and in a few hours intense capillary bronchitis developed, which was fatal in several instances. The action of nitrous compounds upon wood evolves large quantities of vapor very rapidly.

An unusual accident occurred in the Gunnison Tunnel in 1911. A blast was exploded, and 13 men inhaled the smoke at some distance. In less than 3 days 9 of these men died from acute inflammation of the lungs. It was found that nitrous fumes, consisting of nitrogen tetroxid or dinitryl (N_2O_4) had been developed from the powder smoke by the electric power current. (C. Johnson.)

A number of years ago a gallon jar of nitro-hydrochloric acid was upset on the wooden floor of my physiological laboratory, at once filling the room with irritant fumes. Despite protest, an assistant rushed into the room to open the windows, covering his mouth with a wet towel. He lingered less than two minutes, but acquired a severe bronchitis which lasted several days. The brown fumes which poured out of the window were so dense that someone passing in the street mistook them for smoke and turned in a fire alarm!

Chronic Type.—The chronic type of nitrous poisoning is characterized by cough, more or less mucous expectoration, moderate dyspnea, vertigo and anemia. There is marked redness and swelling of the respiratory mucosa, which bleeds readily when touched. Among 26 workmen in a nitric acid factory, Kobert found several with erosions of the nasal septum and one with a perforated septum.

Treatment.—The capillary bronchitis demands active measures

for relief. Heart stimulants should be given hypodermatically, mustard pastes should be applied to the chest, and, if there is an excess of watery secretion from the lungs, atropin (gr. 1/100) should be given hypodermatically. The burning of the throat may be relieved by inhalations of steam from a croup kettle, and codein may relieve the discomfort of the cough, but morphin is not a very safe remedy in these cases.

OSMIC ACID

This acid, when its fumes are inhaled, causes severe irritation of the Schneiderian membrane, with inflammation. Bronchitis also may be present.

PICRIC ACID

Picric acid is derived from the action of nitrous acid on phenol, and carelessness in construction of the retorts may liberate nitrous fumes. It is used in making certain explosives, such as melanite, and in photography and various chemical industries.

When volatilized it gives rise to anorexia, bronchitis, cough, and anemia. It is eliminated by the urine, from which it has been recovered. As a dust or in powder it causes, when inhaled, irritation in the nose, with sneezing and increased secretion. It also colors yellow any unprotected parts of the skin with which it comes in contact. Air which is dust-laden with powdered picric acid explodes very readily, so that the hearing of workmen employed in picric acid manufacture is frequently impaired. (F. Röpke.) Conjunctivitis is also common among them.

SULPHURIC ACID

This acid has many uses in the arts and manufactures, and those who are engaged in making or handling it may become poisoned by its fumes, and often sustain serious erosions of the skin, should the acid come into contact with it.

The acid is used in burnishing iron and steel, in sugar refineries and starch factories, hat and textile works, the making of powdered

fertilizers, refining linseed oil, petroleum distillation, patent wood floorings and many other industries.

Guano is treated with about 25 per cent. of sulphuric acid to neutralize the ammonium carbonate and make the calcium phosphate soluble.

Sulphuric acid is also used in the refining and bleaching of tallow and to disintegrate bones used for fertilizers. It is used in electric accumulator works, and is developed in making coal gas.

In the drawing of steel wire sulphuric acid is used, the fumes from which may prove very irritating, and sometimes lime is also used, the dust from which is injurious to the respiratory passages. The fumes of this acid produce symptoms similar to those of sulphurous acid, but they are considerably less severe. When inhaled they give rise to rhinitis and acute and chronic catarrh of the bronchi. The acid may cause bronchopneumonia. It provokes conjunctivitis and in time causes erosion of the teeth. Its use as a dilute lemonade for lead workers does little more than injure the teeth. (*See* page 368.) When spattered on the skin it causes severe pain and a brownish white eschar, with much local redness and edema. Absorption after widespread local acid burns has been known to cause duodenal ulceration, stupor and death.

One of my patients was a man 41 years of age who for 4 years had been employed for several hours daily testing milk fat and washing copper vessels, using sulphuric acid. When seen he was extremely weak and dyspneic and had an advanced secondary anemia, with hemoglobin 40 per cent. and red blood cells 3,800,000.

CHININ

Chinin is a petroleum by-product which gives rise to local cutaneous irritation, especially of the face and arms, but frequently of the entire body. The itching, which is intense, accompanies a scaly eczema.

CHINON

Dyers of yarn who are exposed to fumes from a hot mixture of anilin, hydrochloric acid and potassium chromate are affected by the

escape of chinon vapor which causes serious keratitis. The cornea becomes dark brown and the epithelium is undermined (Senn). The skin becomes bronzed. Recovery follows abandonment of the occupation.

METOL

Metol is used in conjunction with other chemicals in photography. Mrs. S. R. Karasek and Dr. M. Karasek found 31 cases of poisoning by this substance in 40 photographic studios visited in Chicago.

Metol gives rise to an erythematous rash of the skin which comes in contact with it, i. e., of the hands and arms, but it may involve the whole body. Like many toxic rashes, it may disappear after a short time, but in the more severe cases intractable ulcers develop which may last for months. Persons susceptible to this poison do not become immune, but have recurrent outbreaks of the local irritation. The use of rubber gloves affords complete protection.

NITROGLYCERIN

This is a colorless, odorless oily fluid which easily vaporizes. It is used in making dynamite, nitrocellulose and other high explosives. It is also used in medicine to reduce arterial tension, and the making of nitroglycerin tablet triturates sometimes causes mild toxic symptoms.

Nitroglycerin was originally used as an explosive in fluid form, but it was so uncertain in effect as to be very hazardous. Subsequent to the discovery by Nobel that it could be held by an absorbent in a condition of stability, various substances, such as earth containing fossil infusoria, wood pulp, etc., have been used for this purpose. Most dynamite, of which upward of 250,000,000 lbs. are manufactured annually in the United States, is composed of wood pulp, nitrate of soda, which supplies oxygen to enhance explosive force, and a varying per cent. of nitroglycerin, up to 75 per cent., which is within the limits of safety for transportation. Various strengths are used for different purposes, and a dynamite of 20 per cent. nitro-

glycerin is not necessarily poor in efficiency, though it may be in speed of explosion.

In Europe nitrate of ammonium is much used as an ingredient of the variety of dynamite employed in blasting. Another form of violent and hazardous explosive is the so-called "gelatin powder," made usually with 90 per cent. of nitroglycerin and 10 per cent. of guncotton.

Other explosive ingredients which have been used in combination are picric acid and potassium chlorate, but their great instability renders them unfit for most purposes. Dinitrotoluene and trinitrotoluene are also used, as well as several derivatives from them.

Nitroglycerin gains access to the circulation with greatest facility, being absorbed in all three ways, through the skin, alimentary canal and respiratory channels. So sensitive is the skin to this poison in some persons that by merely shaking hands with a workman who has just been handling giant powder they may acquire fullness and throbbing pain in the head—the "nitroglycerin head," as the workmen call it. Miners using blasting powder have been known to carry enough nitroglycerin home in their clothing, contaminated by fumes of ill-burned powder, to affect several members of the family.

There is the greatest possible variability in the susceptibility to nitroglycerin poison. Some persons can dip the whole arm into a pail of it without experiencing any subsequent headache or other discomfort, and others can barely touch a stick of dynamite with the finger without absorbing sufficient poison to make themselves most uncomfortable. Doubtless this diverse susceptibility is dependent upon differences in intravascular pressure, thickness of the walls of the arterioles, and of the integument, besides which there may be other individual idiosyncrasies. The same variability is noticed in the effect of the medicinal use of nitroglycerin in different patients, as it is with the nitrites of sodium and potassium, amyl nitrite and similar vasomotor drugs.

E. S. Evans, of Iowa, has reported a case of nitroglycerin poisoning in a farmer who used giant blasting powder to clear away tree stumps. He was thus employed for a fortnight and wore cotton-

flannel gloves in handling the powder. The wearing of the gloves for some time after repeatedly produced symptoms, and it was evident that they had retained nitroglycerin, which was absorbed by the man's hands. He suffered from violent headache, vertigo and vomiting. (*Jour. Amer. Med. Assoc.,* Feb. 24, 1912.)

Symptoms.—The symptoms of nitroglycerin poisoning are well known both to physicians and laymen. They may develop almost immediately or after half an hour, and are due largely to relaxation of the arterioles, with consequent fullness and congestion. The superficial capillaries in the skin of the face are congested so that the face is flushed and the conjunctivæ are injected. A pounding headache, vertigo, tinnitus and sometimes nausea are the cerebral symptoms. Frequent fainting attacks may occur. There may be temporary blindness. These symptoms are made much worse by stooping or lying down, so the poisoned miner sits with his head in his hands, or may be rendered almost maniacal by the pains, as C. E. Laws says, "running about, shouting, and striking his head against obstacles." The pain may be localized bilaterally in any part of the head or be general. Urination is frequent and the urine is pale and of low specific gravity. Aphrodisiac effects have been observed.

The heart action is at first accelerated, then retarded. Some years ago, by means of a camera which I devised for making investigations of cardiac stimulants by means of instantaneous photography applied in various ways to the beating heart in living animals, I found that nitroglycerin dropped upon the exposed heart of a frog or other animal gave rise to an extremely firm systole, and I have a number of photographs demonstrating its direct local primary stimulation of the heart action. If introduced more slowly into the general circulation by relaxing the vascular tension, like all the nitrites, it lessens the work of the heart and modifies its rate of beating accordingly.

As further symptoms, nausea, vomiting and colic occur. There may be paralyses in the muscles of the head, eyes and limbs. Respiration becomes slow and stertorous. Dyspnea and cyanosis are marked. In some cases, following explosions, there are tremors with coma, recovery of consciousness, an intermittent feeble pulse, motor

paralysis, subsequent return of syncope or coma, and death results.

Long-continued exposure to nitroglycerin fumes produces certain chronic symptoms, such as tremors, neuralgia and dyspepsia, although some degree of immunity from its disagreeable effects may be acquired in time. To quote from Laws, whose experience has been extensive with miners in the State of Washington (*Jour. Amer. Med. Assoc.*, March 5, 1910): "All who work in it are sooner or later troubled with dyspnea and tachycardia on exertion. Alcohol causes a flushing in some that very much resembles scarlet fever. Others are unable to touch it at all, and it is a well-known fact that 'powder men' become easily intoxicated." In order to maintain immunity the workmen, in periods of non-employment, sometimes "rub a small amount into the skin or keep some on the hat band, so that they may always be in condition."

Treatment.—Treatment of nitroglycerin poisoning is unsatisfactory. The patient should eat heartily, previously taking a hot bath. If sleep can be secured by an hypnotic such as codein or morphin, it is sometimes curative, but depressing hypnotics such as chloral and coal tar analgesics must be avoided. Subsequently strychnin may be given daily.

PARAFFIN

Paraffin is much used for waterproofing, as, for example, protecting the containers in which explosives are packed. Dynamite cartridges made of paper are placed in open wire baskets and treated with a spray of melted paraffin. Melted paraffin is poured into conduits for protection and insolation of electric systems.

Symptoms.—Melted paraffin evolves vapors which, when inhaled, give rise to headache, vertigo, anorexia, nausea, vomiting, gastralgia, enteralgia, diarrhea, thoracic oppression, cold sweats and lassitude.

Locally paraffin irritates the skin, especially the sebaceous glands, and a half-dozen cases of epithelioma have been traced to its use and reported by Bell, Wohlmann and others. It may give rise to pustular eczema of the hands, face and ears.

To protect the hands they should be cleansed frequently in alkaline solutions and rubber gloves should be worn when possible.

Paraphenylendiamin

Paraphenylendiamin, a petroleum by-product, is extremely likely to give rise after long-continued inhalation to severe vesical irritation, with passage of bloody urine, a condition which frequently has proved fatal.

PETROLEUM

Crude petroleum, or coal oil, as well as many of the products distilled from it at various temperatures, is a source of considerable cutaneous and other irritation, especially among workmen who are unhygienic in their habits. Thus Berthensen (who, in 1895, made a special study of the workmen employed in the petroleum wells of Tartary and Persia) found that, among 8,465 workmen, 1,216 had various skin eruptions and 1,475 suffered from respiratory diseases. In this country modern methods of distillation, refining and transportation of petroleum and its products, now largely carried out by mechanical means, have reduced the hazards to a minimum. Cleaning out petroleum tanks is one of the chief risks, and in general the lightest products of distillation evolved at the lowest temperatures are the most toxic and may decompose or liberate the hemoglobin from the red blood cells. Experimentally, in animals, inhalation of these products gives rise to congestion of the lungs and kidneys. Some of the petroleum oils are much more irritating than others, as they spring from the wells.

Symptoms.—Symptoms of petroleum poisoning may be acute or chronic.

Acute Type.—The acute form, known sometimes as "petroleum intoxication," may be very acute and promptly fatal. The victim is seized with sudden weakness of the legs and dyspnea. He may fall down in coma and die of asphyxia on entering a non-ventilated, partially emptied reservoir. Korjenewsky reported the case of a man who worked for a day at a petroleum well, when he was seized with hemoptysis, hematemesis, melena and delirium, and died the following day.

The comatose cases are not always fatal and a patient may remain

in coma for a week and yet recover. In very mild cases some of the workmen complain of vertigo, headache, nausea, bronchitis and mental depression, but others have a feeling of elation and rather like the intoxication.

Chronic Type.—Chronic poisoning causes vertigo, fullness and throbbing of the head, cough and dyspnea, anemia, general nervousness, hallucinations, and loss of memory. There may be attacks of syncope and loss of consciousness. The effects vary with different persons, some being excited and others calmed, as if they were under the influence of opiates. Suppurating ulcers of the skin may form and refiners may develop a special type of papilloma.

Prevention.—Special care should be exercised at all pumps, reservoirs, tanks, conduits, etc., to prevent leakage and accumulation of dense vapors where they might be inhaled. Workmen should take frequent hot-water baths, using soap freely, and should have their overalls washed often. As a rule, in American refineries the workmen are well protected, so that serious poisoning is uncommon.

PHENYLHYDRAZIN

This is a pungent, brownish-yellow, oily fluid derived as a by-product in making antipyrin from anilin, and used in connection with various organic compounds. Its action is local upon the skin, causing itching and burning with a vesicular eruption. When absorbed it causes granular degeneration of the erythrocytes and digestive disturbances with diarrhea.

PYRIDIN

This substance is a pungent, colorless fluid derived during manufacture of coal tar, and sometimes added in denaturing alcohol, to the toxic effects of which it contributes, as used in hat making, gilding, furniture and wood polishing in general. As a vapor when inhaled it causes choking, hoarseness and laryngitis, with headache, vertigo, tremors and weakness of the extremities. Dyspnea is marked and there may be clonic convulsions. Such poisoning is rare and a few

cases only are recorded. As a fluid, in contact with the hands, it gives rise to eczema.

TAR AND PITCH

Tar and pitch or bitumen, when melted, produce irritant fumes, and contact with the skin develops serious local lesions. Various light oils are distilled from tar at temperatures of 100° to 200° C. Rectification is accomplished with sulphuric acid and soda.

Symptoms.—Inhalation of tar fumes may cause headache, vertigo, tinnitus, anemia, nausea, dyspepsia and diarrhea. Bronchial asthma, bronchitis, angina and coryza may develop. In serious cases of poisoning there may be mental and nervous symptoms, such as alternating depression and exaltation, paresis, muscular cramps, hyperesthesia or other sensory disturbances. Suppurative otitis may occur and the urine is dark in color.

Local Symptoms.—"Tar itch" is the name given by the workmen to the pruritus which affects the hands or various parts of the body from clothing saturated with tar fumes in processes of distillation, boiling, etc. The skin may be bronzed and an eruption resembling psoriasis or ichthyosis may appear. Conjunctivitis and ulcers of the nasal cavities and mouth may be observed. Handling wood which has been treated with tar as well as creosote as a preservative may give rise to considerable irritation of the skin, usually of the type of simple or pustular eczema or a scaly dermatitis. In the *Bulletin* of the New York State Bureau of Labor for 1912 it is stated that there were reported, "Two cases of poisoning by creosote of section-hands on two different railroads due to handling of ties treated with a preservative containing creosote. In one case the poisoning was reported as on hands and arms, in the other on the face."

There are many other fluid substances produced in the chemical industries which are highly toxic and which, from time to time, have furnished illustrations of poisoning. They are so infrequent, however, as not to merit detailed descriptions. Examples of such substances are thorium nitrate, carbon tetrachlorid, ammonium sulphate, nickel carbonyl, carburetted hydrogen (beet sugar industry), etc.

IV. IRRITANT DUSTS AND FIBERS

Dusts in General.—The varieties of dusts generated in connection with industrial labor are well-nigh innumerable, but for convenience of study they may be classed by their origin briefly as follows: (1) mineral dusts, (2) metallic dusts, (3) vegetable dusts, (4) animal dusts, (5) dusts of mixtures of two or more of the preceding groups. The particles of dust vary in degrees of dryness, hardness, sharpness and coarseness. Dusts are not only irritating to the eyes, skin, hair and respiratory passages, but give rise to untidiness and discomfort. As J. S. Haldane says, in a lecture on "Dust Removal in Factories," delivered at Oxford in 1908, "It inevitably tends to lower the social status and self-respect of work people if they have to go back to their homes in the same untidy condition." The coal miner who walks through the streets to his home in dirty clothes, with face so begrimed that he is almost unrecognizable, carries much dirt into his rooms, and taxes his wife with effort to keep them habitable and presentable.

Frederick L. Hoffman, writing of injurious dusts, says, "The morbidity and mortality of wage-earners are high or low in almost exact proportion as the air conditions are those of relative purity or impurity, of wholesomeness or pollution."

Dusts may be merely irritant, like flint dust, which is the most harmful of all the hard, sharp dusts, or poisonous, like lead dust, which is absorbed into the system, or, like flour dust, they may choke the respiratory passages without serious irritant or toxic properties. Moderately irritant dust, however, often gives rise to acute symptoms among new workmen unaccustomed to its irritation, such as coughing, sneezing, fever, lassitude and pains in the eyes and head. Illustrations of similar conditions are found among the workers in horsehair, furs, feathers, tobacco, leather, skins, paper, and workmen in cotton and woolen mills, grain elevators, flour mills and saw mills.

Attempts have been made to show in definite figures the relative harmfulness of the different types of dust of metallic, mineral, vegetable or animal origin, especially as gauged by favoring tuberculosis, but the figures given by various authors are so divergent as to be

scarcely worth quoting. For example, Hirt gives the incidence of tuberculosis among 100 cases in workmen, assigning 25 per cent. as due to working in mineral dust and 13 per cent. in vegetable dust. Perlen, on the other hand, in reporting 1,425 tuberculosis cases at the Munich Polyclinic, assigns only 18 per cent. to mineral dust and 26 per cent. to vegetable dust.

There are two reasons for such discrepancies. In the first place, if a clinic happens to be located near a large stone-cutting or millstone plant, cases due to mineral dust will naturally predominate, whereas, if textile fabrics are made on a large scale near by, vegetable dust will figure largely in the statistics. Secondly, tuberculosis is much more often due to lack of home hygiene and conditions arising from poor food, drink, etc., than to manufacturing conditions, which makes it extremely difficult to place the influence of the latter on a convincing statistical basis. In general, it may fairly be stated that the sharper, hard metallic and mineral dust particles do more mechanical injury to the bronchial mucosa than the softer dusts of vegetable or animal origin, and the latter are more liable to convey germs of various sorts into the respiratory passages.

Of 68 patients among workers in textile industries treated in the Milan Clinic in 1910-1911, 19 presented blood disorders, 28 respiratory affections; 4 dry pleurisy, 12 tuberculosis, 20 nephroptosis, 5 nervous diseases, 15 digestive disorders, 6 circulatory diseases, and 3 diseases of the muscles.

Dust Explosion.—The explosion of finely subdivided and widely disseminated dusts is a subject which concerns industrial accidents rather than diseases, and hence does not properly come within the scope of this book. Such explosions are liable to occur from time to time in sugar refineries where powdered sugar is made; in linoleum works, where pulverized cork is used, etc. In a recent explosion from sugar dust ignition in an Austrian refinery the roof of the establishment was blown completely off, and in an explosion from dust in a grain elevator in Buffalo a large number of lives were lost.

Quantity of Dust in the Atmosphere.—The quantity of dust particles which pollute the general atmosphere around certain chemical works, factories, smelting works, rolling mills, etc., is almost in-

credible. It exercises a very deleterious influence not only on the general health of the workman, for it is the air nearest the factory which adds outside dust to the already polluted air of the workroom, but also of his family if they live in the immediate vicinity. It becomes difficult to keep home and clothing clean, and vegetation is so stunted or destroyed as to deprive the neighborhood of all growth of grass or trees which might render it more attractive. Time and again has been demonstrated the depressing effect upon the general health of a community, particularly of the children, of the deleterious influence of smoke and chemical fumes. It is difficult to put the matter in the form of numerical statistics, for the evil influences are subtle and operate over long periods of time, but everyone conversant with such environments knows how baneful they are. In Pittsburgh, in this country, in Leeds, in England, and in many towns in Germany and elsewhere special commissions are at present at work upon the scientific investigation of the evils of the smoke, fumes and gases arising from varied industries, and in many cases progress is being made to abate them.

The University of Pittsburgh has constructed a smoke house 18 x 30 feet square, where, under the direction of Dr. R. C. Brenner, experimental studies are made of dusts and fumes, such as those of ashes, tar, various gases, etc., particularly with reference to the workman's health.

Dust Estimation.—Various methods exist for determining the density of atmospheric dust, some of which are based upon collecting by filtration or settling, and then weighing the dust from measured quantities of air; another, like that of John Aitken, is based upon the principle that aqueous vapor, when cooled in a confined space filled with dusty air, condenses about each particle of dust, thus making a visible cloud of greater or less density. The apparatus consists essentially of a small closed chamber of definite size filled with dust-free air saturated with aqueous vapor. By means of an air pump a measured quantity of the dusty air to be tested is forced into the chamber. This dust-laden air forms a cloud of varying density, and comparison of this density with the quantity of air required to produce it may be made. The dust is then permitted

to settle upon a ruled glass plate at the bottom of the chamber, when it may be illuminated with a mirror and its particles counted with a lens, as blood corpuscles are estimated. The measuring of dust by weight is less instructive than by count, for a heavy metallic dust will have far fewer particles than a much lighter coal dust, per pound.

Dr. Walther Friese, of Dresden, furnishes a table derived from different observers with the Aitken apparatus (*Rauch und Staub*, March, 1912), which shows variations in the number of particles of dust per cubic millimeter of air, as follows:

Mountain air with a sea breeze	72
Fresh country air	500
London air	300,000 to 500,000
Paris air	400,000 to 500,000
In the garden of the Meteorological Institute only	160,000
Salon of an ocean steamer with open port holes	775
With closed port holes	22,060
In the engine room of the steamer	985,000
In an audience chamber before a meeting	175,000
After the meeting	400,000
Average of 32 daily observations on a voyage from Hamburg to South America	1,130

Such measurements naturally are subject to great and instantaneous fluctuations, depending upon wind, temperature, general cloudiness of the air, etc., but in the main they serve to emphasize the enormous preponderance of dust in the air of large manufacturing and soft coal-consuming cities like London and Paris over ordinary country air. Such air often contains acids. (Fig. 58.)

To collect dust for analysis from dusty workrooms and in dusty trades, several other forms of apparatus have been devised. A simple type, described by Dr. Norman E. Ditman, is figured herewith. (Fig. 59, p. 389.) A measured quantity of the air to be examined is drawn by an aspirating hand pump through a filter bottle packed with cotton wool. The cotton withholds all dust par-

ticles, which subsequently may be carried to the laboratory for weighing and analysis.

In London the annual precipitation of soot a few years ago was

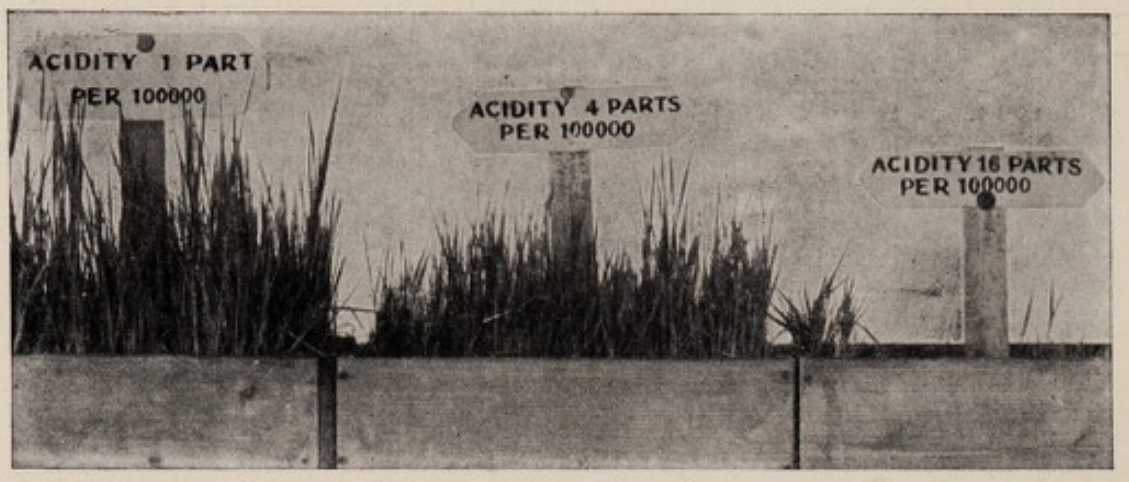


FIG. 58.—THE EFFECT UPON THE GROWTH OF GRASS OF ACID IN THE ATMOSPHERE OF DIFFERENT PARTS OF THE MANUFACTURING CITY OF LEEDS, ENGLAND. (Arthur C. Ruston of the University of Leeds. Reproduced from *Rauch und Staub*.)

estimated at 76,000 tons, but during the past decade so much has been accomplished by the "anti-smoke and dust crusade" that the number of hours of bright sunshine has increased from an average of 70 per month to 93.5. In Chicago, since the establishment of



FIG. 58a.—SHOWING THE CHOKING WITH SOOT OF A BREATHING PORE OF A LEAF OF A SILVER FIR TREE IN LEEDS, ENGLAND. (Arthur C. Ruston, University of Leeds.) This is quite analogous to the choking of alveoli of the human lung with coal dust.

the Anti-Smoke Commission, in 1907, it is estimated by T. E. Donnelly that the smoke nuisance has been abated 75 per cent.

The most dangerous size of dust particles is a diameter of 0.005 to 0.01 mm., for they are liable to be most deeply inhaled.

Some idea of the quantity of dust capable of suspension under

ordinary conditions in factory workrooms may be gathered from the following estimates by Dr. C. T. Graham-Rogers, who has made a large number of air analyses with reference to dust content in different industries, which are given in the *Report* of the New York

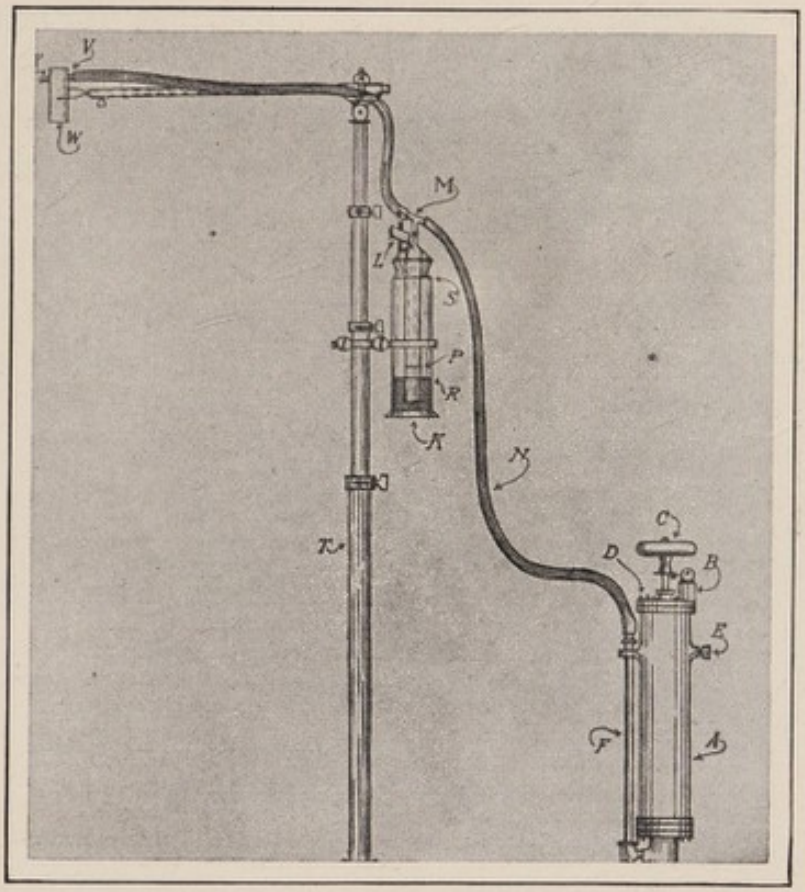


FIG. 59.—DUST ESTIMATION APPARATUS IN USE BY THE BRITISH FACTORIES AND WORKSHOPS INSPECTION DEPARTMENT. (From the *Journal of Industrial Safety*, vol. 2, no. 3, March, 1912.)

State Commissioner of Labor for 1911. In a skirt factory he found 70 grains of dust per million liters of air, as much as he found in pearl button factories. In a brass foundry were 75.2 grains, of which 55.4 grains were silica from the sand moulds. In the finishing room of a felt hat factory there was .01 gram of silica in the dust. In a room occupied by cutters in the garment industry there were 59 grams of dust per million liters of air.

In his study of the air in the New York Subway, Dr. G. A. Soper found its dust to contain iron, silica, cement, stone, cotton,

wool, wood, molds and refuse of various sorts, 22 per cent. of the whole being organic. He found 61 milligrams of dust per 1,000 cubic feet of air, and estimated that the average passenger inhaled ½ milligram of this dust in half an hour's ride, which would be at the rate of 2.4 centigrams for the 24 hours. Of course anyone walking along a dusty street on a windy day inhales more than this, and the only reason the lungs do not completely choke up is the activity of the leukocytes in gathering up the dust and its entanglement in mucus and expectoration. (Figs. 58a, 60.)



FIG. 60.—CROSS-SECTION OF A FIR TREE 30 YEARS OLD GROWN IN THE MANUFACTURING TOWN OF LEEDS, ENGLAND. The narrowing of the rings as the tree grows older shows the stunted growth due to the sooty atmosphere. (Arthur C. Ruston of the University of Leeds. Reproduced from *Rauch und Staub*.)

Prof. Hartly, of Dublin, experimented upon the metallic dust contents of atmospheric air by means of photo-spectroscopic apparatus. He found traces of copper very constantly present, also of calcium, particularly where coal combustion products were abundant, as copper is a common ingredient of coal in minute quantities. In a shoe factory a very high percentage of copper oxid was found in the leather dust derived from the use of brass machinery for polishing the soles. He also found the dust of piano manufactories to contain considerable copper. Numerous particles of iron and felt were present in this dust.

Although dust of every kind is a menace to health, it is in its relationship to tuberculosis that dust in general produces the greatest harm. This it may do (1) by irritating the lungs and maintaining constant catarrhal processes, (2) by conveying tuberculosis germs,

(3) by making preëxisting tuberculosis much worse through incessant irritation of the lungs and catarrh. (*See* Tuberculosis, page 53.)

Prevention of Dust.—The question of dealing with dusty trades may be subdivided into (1) checking the formation of dust, (2) checking the escape of dust, (3) dust removal, (4) prevention of distribution of dust.

(1) Checking the Formation of Dust.—Dust formation may be checked by sprays or jets of water, steam or oils in many



Fig. 61.—Overhead Rock Drilling, Showing Method of Dust Protection by Squirting Water into the Drill Hole with a Syringe.

industries, like rock drilling (Fig. 61), pottery cleaning, brick making, metal grinding, etc., where the nature of the substances dealt with permits the application of moisture without injury to the product. In fact, in many forms of drilling and grinding the moisture lessens friction and is an advantage to the process. Its application is usually easy and inexpensive and should be made wherever practicable.

(2) Checking the Escape of Dust.—This may be accomplished in such industries as stone crushing, the mixing of lead pigments, dusting pottery and china when removed from the kiln, clay grinding, etc., by enclosing the entire machinery used in a protecting case, which is opened only after the dust has settled after the completion of the process. Glass screens may sometimes be employed to shield the workman's eyes and face from flying particles of dust, but flint and steel soon make the glass opaque, and it cannot, therefore, be of much service for protection against the dust of grinding. In some industries, like that of knocking the loose flint from pottery, for example, or sand-blast scouring of pottery and china, the dusty work may be conducted inside a cabinet into which the workman inserts his hands through a small cloth-covered opening. (Fig. 62.)



Fig. 62.—China Scouring by Sand Blast, in a Cabinet. (Royal Worcester Porcelain Works, England.) The workman inserts the china article through a canvas opening, holding it against a scouring wheel within the cabinet from which dust is removed by a strong exhaust air current. The dust contains lead glaze and emery. (From Shaw Lecture by William Burton, F.C.S., on "Hygiene of the Pottery Trade," Royal Society of Arts, London, Feb. 7, 1908.)

Another protective method consists in letting heavy dust particles drop into a trough of water.

(3) Dust Removal.—The removal of dust may be accomplished when neither of the foregoing methods is practicable by the use of exhaust fans in connection with hoods or collecting tubes, which should always be placed as close as possible to the source of

the dust. (Fig. 63.) By so doing the dust is collected before there is opportunity for its dissemination in the workroom, and less power is required to operate the exhaust fans. To attempt to eliminate dust from the entire atmosphere of a workroom by any system of



FIG. 63.—DUST REMOVAL BY EXHAUST DUCT PLACED CLOSE TO EMERY POLISHING WHEEL. Diamond polishing.

forced ventilation necessitates changing a large volume of air and creating strong intake drafts to replace it. Moreover, in winter this requires increased expenditure for heating.

The fans in common use are either of the propeller or centrifugal type, but the latter are preferable as working better against outdoor wind, requiring smaller ducts and having little tendency to permit backward currents. It is impossible with some dust-producing ma-

chinery to place the exhaust tube very near, or the motion of the machinery itself may produce counter-currents. In such cases it is sometimes possible to employ an additional motor fan in the open workroom, so placed as to direct an air current away from the workman and toward the entrance to the exhaust duct. Large looms,

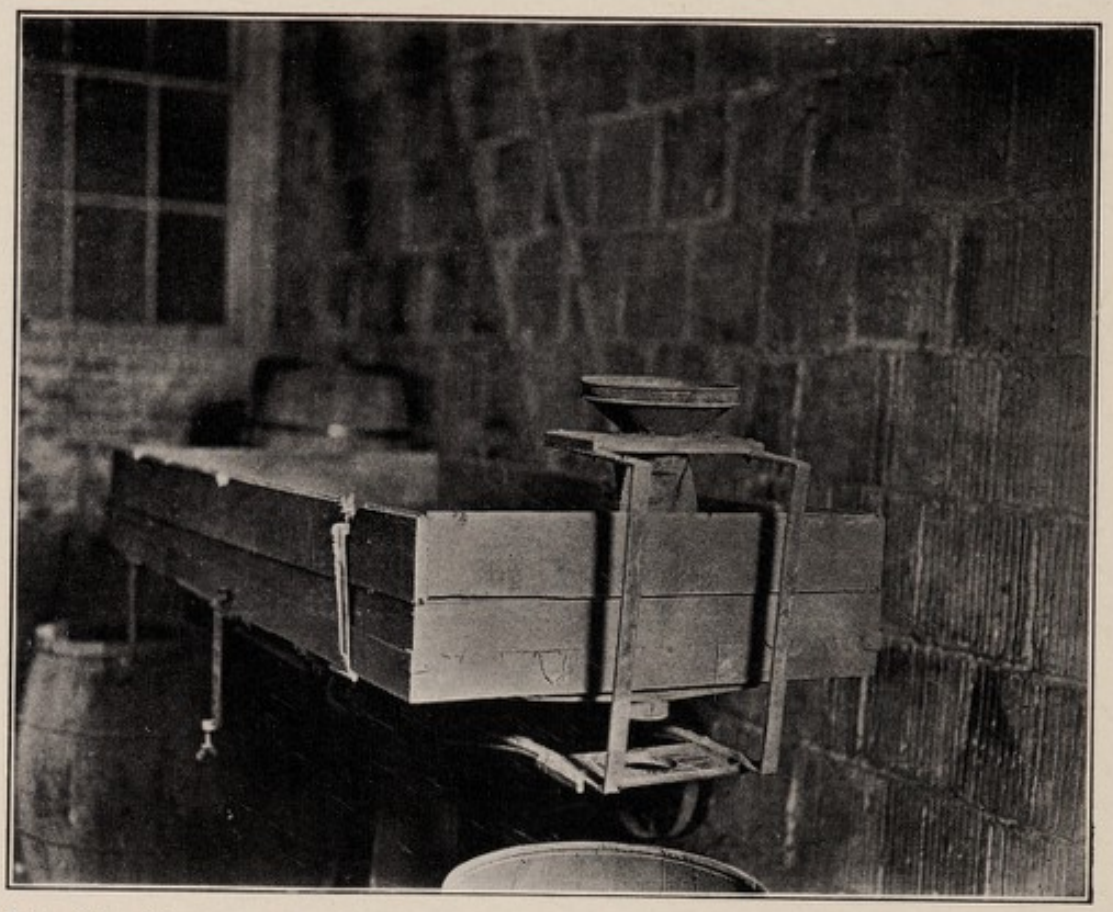


FIG. 64.—SIFTER FOR CHEMICAL PRODUCTS. Note entire lack of dust protection. (From the *Bulletin* of the Illinois State Department of Factory Inspection, 1911.)

carding, hackling and rag-tearing machines cannot be boxed in, and in such cases it is best as far as possible to direct the currents of dust-laden air downward and remove it by ducts near or under the floor. (*See* Fig. 19, page 110.)

One of the commonest errors in forced ventilation instalments in factories is the admission of air at the lowest part of the room, so that an upward current of dust is borne toward the workman's face. Wherever the trade is a dusty one the intake should be a few

feet above the operator's head, and the outlet just at the level of the baseboard of the floor, so that dust, which naturally tends to fall, is drawn downward and outward.

An ingenious method has been devised to protect wool-sorters from dust. The wool is sorted upon a fine-meshed wire screen which fits over the entrance to an exhaust duct, so that all dust is drawn downward away from the workman and does not fly about the room at all. This is practically the same as the method shown in Figure 82, page 436.

Emery grinding wheels and buffing wheels are now almost universally protected with close-fitting exhaust hoods, leaving only a portion of the wheel exposed, but so little appreciation do many workmen have of the danger to their lungs that they often deliberately remove the hoods which annoy them. As both emery and metal dust are heavy and the velocity of the grinding wheels is great, this type of dust is projected in a fairly circumscribed stream, so that it is easily directed into a hood.

In any system of exhaust ducts it is necessary to provide free entrance of an equal volume of air in the room to that removed or the exhaust will lose in power.

The whole question of the size and shape of exhaust ducts and the proper adjustment of the fans, etc., has been made the subject of an admirable study by Dr. J. S. Haldane, of Oxford University, in a lecture before the Royal Society of Arts on February 28, 1908. Supplementary factors in dust removal concern (a) the construction of workrooms and (8) the cleaning of workrooms.

(a) Workrooms in which dusty trades are conducted should be constructed with as little surface on which dust may lodge as possible. Exposed girders, shelves, etc., should be avoided as far as possible. Walls should be smooth and without unnecessary angles, and corners should be rounded. Machinery should not be so crowded as to form inaccessible places in which dust may accumulate.

(b) The workroom should be swept daily after work hours, so that any dust raised may settle before morning, and the floors, tables and benches should be mopped frequently. Sprinkling should precede sweeping whenever the nature of the industry permits. Floors,

when possible, should be of hard material and not unnecessarily encumbered.

The question of dust and the workman's body is discussed under Personal Hygiene of the Workman on page 113.

(4) Prevention of Distribution of Toxic Gases and Fumes, Irritant Dusts, etc.—To prevent the poisoning of the atmospheric air in the vicinity of smelting works and chemical works of various sorts, or its pollution with soot, various methods are in vogue. Some of them have the economic advantage not only of protecting the health of the worker and nearby residents, but of saving considerable metal or other material which might otherwise be wasted.

(a) One of these methods is to provide large *settling chambers* in which suspended particles may settle in time by gravitation. Such are used by the Tennessee Copper Company to collect deposit from the gases of their smelting ovens.

(b) Another method, applicable only to large particles, is to cause them to aggregate by application of *centrifugal force in revolving drums,* etc.

(c) A third method is to force the dust or vapor through *mechanical filters* such as wire mesh or cloths. In the Mammoth Copper Company's works in California is the largest plant of this sort, which consists of 3,000 woolen sheets through which 300,000 cubic feet of air may be forced per minute.

(d) A method in very general use is to treat the dust, gas or vapor with a jet of *water or steam.* In the Rowntree Cacao Works, for example, a saving of 10 per cent. of the fuel consumed is recovered in this manner.

(e) Various substances are sometimes added to *neutralize toxic fumes.*

(f) *Superheating* and *recombustion* is a method which further reduces many deleterious fumes and gases.

(g) To a limited extent *electro-magnets* have been employed to collect iron or steel dust, but this method is not practicable upon a large scale.

(h) *Dust and Smoke Precipitation by Electricity.*—Particles of soot, coal and other dust suspended in gases of combustion may be

precipitated by passing through an electrical zone. A special research in this subject was conducted, in 1911, by R. C. Benner at the University of Pittsburgh. It has been known for some time that such dusts as licopodium, sulphur precipitate, etc., would arrange themselves in peculiar rings and figures under the influence of a strong electric "breeze," and this principle has been practically applied, so that soot particles, for instance, on passing through a long duct or chimney, on reaching an electrified zone, have their velocity of motion so slowed that they fall in precipitation, being attracted by the electrodes. If the dust particles are metallic, they may show distinct polarization. In some cases the ions tend to aggregation with each other, forming balls. To accomplish the electric separation and retardation of moving smoke particles of coal combustion, for example, a current of 20,000 or 40,000 volts is passed through a rotating commutator and projected from a brush as a "breeze" or in the form of a circular "corona" through which the smoke or dust is made to pass. The electric field may be as much as 30 feet in length, and as much as 30 pounds of dust an hour may be precipitated, depending, of course, upon the nature of the material treated. In the Portland Cement Works of Riverside, California, from 95 to 98 per cent. of the cement dust has been extracted by this method from escaping gases. (*See* page 402.)



FIG. 65. — RESPIRATOR MADE BY CLOETTA AND MÜLLER OF STUTTGART. The nosepiece is of hollow soft rubber, fitting closely over the face. The two lateral cylinders serve, one for entrance, the other for exit of air, being closed by valves which operate in alternation. Their perforated caps may be removed to insert wool, cotton or sponge. (From *Rauch und Staub*, iii, 9, June, 1913.)

(i) *Respirators* or inhalers are constructed with the object of

filtering smoke, dust, gases and fumes out of the air. To this end they are constructed with simple screens, of cloth, wire, etc., or with loose, removable filter material, such as wool, cotton or sponge, contained within the appliance, which may be moistened with glycerin or other adhesive substance. They should be adapted to fit closely over both nose and mouth. (Fig. 65.) For temporary purposes they are very essential and serviceable, as, for example, to be worn on entering the "blue beds" in lead works to remove the lead carbonate (*See* page 212), or whenever metallic or acid fumes are liberated suddenly, as on opening ovens, boiling kettles, vats, etc. For permanent use, also, they are absolutely necessary in some industries, as in the sandblasting of metal castings, etc., but in many industries, such as glass cutting, emery grinding, pottery scouring, etc., while they theoretically should be worn constantly, such use is practically beset with so many difficulties that workmen often will not tolerate them, especially if their hours of work are long. Some, especially women, object to their looks. It is difficult to speak plainly through them. They interfere with chewing tobacco, expectorating, blowing the nose, etc., and are often uncomfortably hot, and become heavy when clogged with dust. The latter difficulty is most serious, for with permanent use the filtering material becomes so clogged that it is difficult to secure sufficient air circulation, and the wearer rebreathes his own exhalations.

Workmen frequently prefer to make use of improvised respirators. For example, men employed in barreling chrome pigments, white lead, lime, and similar irritants tie a wet towel or bit of cheesecloth over the nose and mouth. A simple respirator may be fashioned with a cambric bag tied over a wire bent to fit over nose and mouth. In general such a simple device is more apt to be used by the workman than a more elaborate manufactured respirator, which he often will pull down and hang around his neck while at work in a cloud of dust!

When valve respirators are used the valves frequently become rusty from the exhaled moisture of the breath, or otherwise out of order, so that complete closure of the respirator fails. If, as in the case of the glass-making industry, there may be a dust containing

90 per cent. of alkaline material, it unites with the sweat of the face and causes irritation of the skin at the points of contact of the respirator. If wet cloths be bound over the nose and mouth, and if the dust contains lead or arsenic, the repeated removal and replacing of the cloths in order to wet them may seriously irritate the lips.



FIG. 66.—PROTECTIVE MASK WITH CELLULOID EYE-SHIELD FOR SANDBLASTING, CLEANING STONE BUILDINGS, ETC.

Another objection to the use of respirators is that many of the cheaper grades sold are worse than useless, for they become clogged with dirt and afford a false security which leads to neglect of measures of thorough ventilation. Schablowski (*Zeitschrift für Hygien. und Infections-krankheiten,* 1911, lxviii, 169) reports the results of tests of 37 different kinds of respirators and masks. Twenty-six of these admitted fully 30 per cent. of dust, some of them admitting 89 per cent. An absolutely dust-proof mask requires so much force to aspirate sufficient air through it that it can only be used for emergencies, as in entering a room filled with dust and gas after an

explosion, or on opening a dusty oven, as in the pottery trade, or while barreling chrome or lead pigment, etc.

Naturally much depends upon the kind of dust dealt with, and protecting masks may keep out much irritant sharp, hard dust, as in sandblasting of castings, emery grinding of steel, glass, etc., whereas they may not keep out finer coal or cement dust.

Some dusts are heavy and soon fall to the ground. If directed in a stream toward the workman's face they may be dodged by using a respirator and occasionally turning the head. Lighter dusts, on the other hand, become universally diffused in the workroom and soon clog the respirator, whether it be made of wire mesh, linen, cotton or batiste. In sandblasting a head mask and hood may be worn, protected in front by a mica or celluloid window, and having the air admitted at the back. (Fig. 66.)

A. INSOLUBLE INORGANIC DUSTS

Asphalt

Workers in asphalt who stand over the melting pots are exposed to the irritating greenish-yellow fumes which arise. They acquire catarrhal conjunctivitis and bronchitis. A uniform eruption may appear over the entire body, which becomes of a yellowish color. (Weyl.) Four cases of asphalt poisoning were reported by Kemp in the *Zeitschrift für med. Beamte,* 1903, s. 271.

Cement

Portland cement is composed of a mixture of limestone and clay which is roasted in rotating drums and then ground to the fineness of meal. It contains much silicic acid and is highly hygroscopic. Some cements contain feldspar and calcium carbonate. The roasting or drying of the cement is conducted in ovens sometimes 100 feet long, which are heated by oil fuel to a temperature as high as 450° C. W. A. Schmidt, describing such an oven, 7 feet in diameter, states that it may develop 50,000 cubic feet of gas per minute, from which 4 or 5 tons of dust may settle in 24 hours. Cement, both in manufac-

ture, transportation and use, gives rise to much irritant dry dust which, on being inhaled, or becoming moistened with the secretion of the bronchial mucosa, is highly irritating.

In the crushing and drying rooms where the limestone is first treated, and in barreling or bagging, the workmen are exposed to risk of bronchial and pulmonary irritation, as well as to irritation of the skin and conjunctivæ. In the better class of mills the crushing and grinding machinery is enclosed and connected with aspirating ducts or hoods through which the dust is drawn to settling rooms, where it is filtered or precipitated with water. The packing in sacks for transportation is sometimes also done by machinery. The workmen frequently further protect themselves by binding thin cloths over the nose and mouth or by wearing respirators. They often complete the filling of the sacks by adding a few handfuls of cement to make up the full weight, thereby scattering much dust and irritating the hands. Cleaning out the clinkers from the ovens in which the raw material has been roasted subjects the workmen to dry heat as well as coarse dust.

Upon the whole, in proportion to the quantity of dust inhaled, cement dust, like coal dust, produces less damage to the respiratory system than might be supposed—less than the harder, sharper flint or glass dust, although chronic bronchitis, asthma and pneumonoconiosis may result from it. It causes considerable itching in the nose, to relieve which the workmen put their dusty fingers into the nose and scratch the septum. This only increases the trouble, and in some cases ulceration with perforation of the septum occurs, as in chromic acid poisoning. Workmen with sensitive skins sometimes scratch the dusty skin so that ulcers form which are so slow in healing that they may be compelled to change their work. The cement dust mixes with the perspiration of the skin and gives rise to a general pruritus which the workmen call "cement itch."

The residents of a town in Maryland recently appealed to the State Board of Health for relief on the ground that dust from neighboring cement works was seriously affecting their health.

In Los Angeles successful use has been made in the large cement works of the electric process devised by Dr. F. G. Cottrell for alter-

ing the electric resistance of the gases of combustion developed during the process of cement roasting. In passing through a large electrified chamber the ions electrify the dust and gas particles, which subsequently are arrested in their escape by precipitation upon the electrodes. The electrodes, placed in 20 rows, 5-15 cm. apart, are shaken free of the dust by an electric motor as it accumulates on them. By such means the air in the vicinity of sensitive orange and lemon groves may be kept reasonably pure and prevented from destroying the trees.

Diamonds and Other Precious Stones

The cutting and polishing of diamonds and other hard precious stones involves several hazards. The dust of these stones is exceedingly fine and hard, but is rarely inhaled in sufficient quantity to be injurious of itself. The stones, however, are ground and polished with emery and sand, and the dust of these materials is highly irritating. (*See* pages 395, 403.) The stones, moreover, are imbedded in a leaden matrix, or a matrix of lead and zinc, to facilitate handling such small objects, and may be held by copper wires. In the setting of precious stones in jewelry, etc., solder is often used, and both the imbedding in the matrix and soldering must be conducted over a gas jet which is directed to a fine point by a blowpipe. In this manner some of the metal is volatilized, and, as the work requires close vision, the fumes arising, as well as incompletely combusted gas, may be drawn into the lungs. Formerly charcoal was used to heat the metal, and the danger of carbon-monoxid poisoning was added. Cases of lead poisoning have thus occasionally been produced in jewelry manufacture, and some of them have also been traced to the habit of moistening the lead matrix with the finger to clean away dust.

Prevention.—The work of jewelry soldering should always be conducted under a hood with a good exhaust, and the emery wheels used for grinding, cutting and polishing precious stones should be protected, whenever possible, by shields. (Figs. 29, page 190, and 11, page 93.)

Emery

Emery is a very sharp, irritant form of dust to which the makers of emery wheels and emery polishing paper are exposed. A greater hazard, however, consists in the use of emery grinding wheels, especially for smoothing castings, sharpening cutlery, cutting glass and polishing diamonds and other precious stones. In many industries in which moist grinding or polishing is employed there is little risk from the wheels, but much dust lies on the floor and rests upon various surfaces in the workshop, where it becomes very dry and is borne in the air. In industries in which water cannot be used to moisten the wheels the emery flies from the wheel in a constant stream. Emery paper also must usually be used dry. These hazards are illustrated under the various headings of the substances in the manufacture of which emery is employed. (*See* Figs. 27, 63, 68, on pages 172, 393, 406.)

Emery Grindstones.—The emery is ground and pulverized in mills. The dust is then glued to paper to make emery paper for polishing, or mixed with some cement-like substance, moulded under pressure in the form of grinding wheels, and burned like pottery. All these processes stir up a great deal of injurious dust which acts by mechanically irritating the respiratory passages. The artificial emery stones must be ground into perfectly symmetrical form before they are ready for use. Among 23 persons employed in emery milling, Röpke found practically all had chronic nasopharyngeal catarrh, and 15 had dry atrophic mucous membranes of the upper air passages, 7 had otitis media and one a perforating ulcer of the nasal septum. The patients complained much of dryness of the nose and throat.

Emery Grinding and Polishing.—In grinding and polishing the operator sits at his work, unless the article to be sharpened be very long, like a scythe or sword. He bends over the wheel, resting his elbows on his knees to give purchase for firm pressure. In this position there is naturally some impairment of lung expansion.

In Germany it is customary for the grinding wheel to rotate

toward the operator, the sparks and dust flying downward toward the floor (Fig. 31 on page 194), but in England the custom is for the wheel to revolve away from the operator, with the dust flying upward, which is a less desirable method. The operator sits more nearly over the wheel and presses downward with outstretched arms. The quantity of dust from the wheel may be imagined from the fact that a wheel 30 inches in diameter and 4 inches broad in a month's constant use may be reduced to half its original diameter, and the objects which are ground or sharpened often lose 20 to 30 per cent. of their weight in the process. Polishing with Vienna chalk upon a wheel adds another type of dust, and when revolving metal or hair brushes are used fine dust particles of brass or hair are given off in considerable quantity.

Both the wet and dry grinding processes are productive of catarrh of the nose, middle ear and bronchi, the former, because, despite every precaution, the workman is frequently wet, the latter because of the fine sharp emery stone or steel dust particles which he inhales. But the most serious hazard of the emery wheel grinder is found in the predisposition to tuberculosis which may follow chronic bronchial catarrh or pulmonary fibrosis. The mortality from tuberculosis among grinders is as high as in almost any other class of skilled workmen, amounting sometimes to 60 to 70 per cent. of all causes of death. According to Moritz and Röpke, there is scarcely a metal grinder to be found who, if long at work, does not present lesions of the nose, such as small erosions and ulcers over the cartilaginous septum, redness and swelling of the Schneiderian membrane, a tendency to epistaxis, and more or less occlusion of the nasal passages. In a later stage the mucosa becomes atrophic and there is impairment of the sense of smell. Often, too, there is hyperesthesia of the bronchial mucosa, due to the irritation of dust and giving rise to a vexing dry cough. Middle ear disease is a further outcome of the chronic nasal catarrh, which is often accompanied by tinnitus and deafness. The eyes are more or less endangered from trauma in all emery steel grinding, from particles of dust which often fly off the wheel with such force as to be deeply imbedded in the cornea. The steel dust may be removed with the electromagnet.

Prevention.—There are two ways of protecting the grinder—by shields and by strong exhaust currents of air. The wheel should be encased in metal, all except the comparatively small surface actually

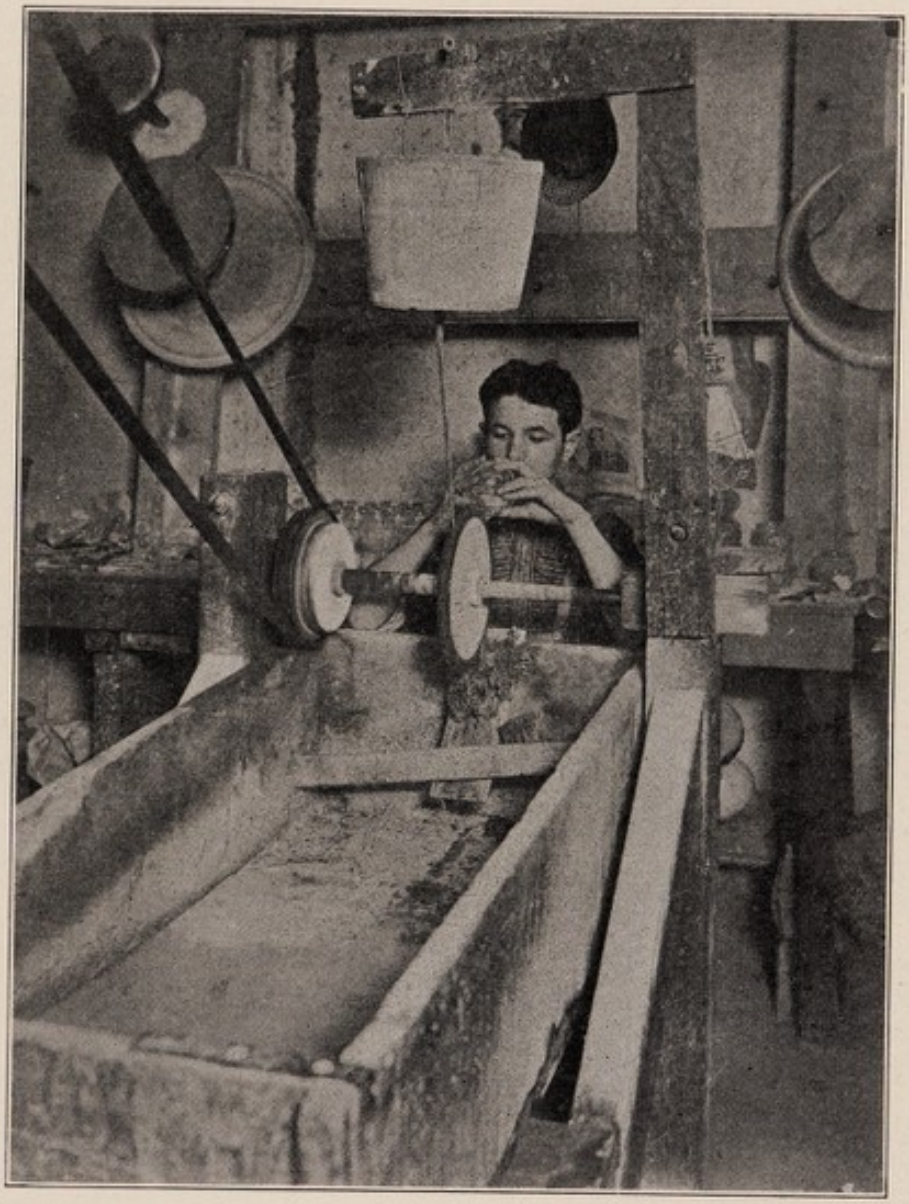


FIG. 67.—CUTTING PATTERNS ON GLASS BY MOIST GRINDING WITH AN EMERY WHEEL. A stream of water drips from the overhead pail, but the room is dusty and dirty, and the glass object is held too near the face.

needed for grinding. (Fig. 11, page 93.) Glass shields are useless, for they soon become opaque, but sometimes metal shields may be so adjusted between the operator and wheel as to direct a part, at least, of the dust away from his face without restricting freedom of

vision. The wheel should always be made to rotate away from the operator and he should learn to keep his face as far from it as possible. Whenever practicable wet grinding under a stream of water should be used (Fig. 67), but unfortunately with many types of work this is not feasible. In all cases in grinding shops where many

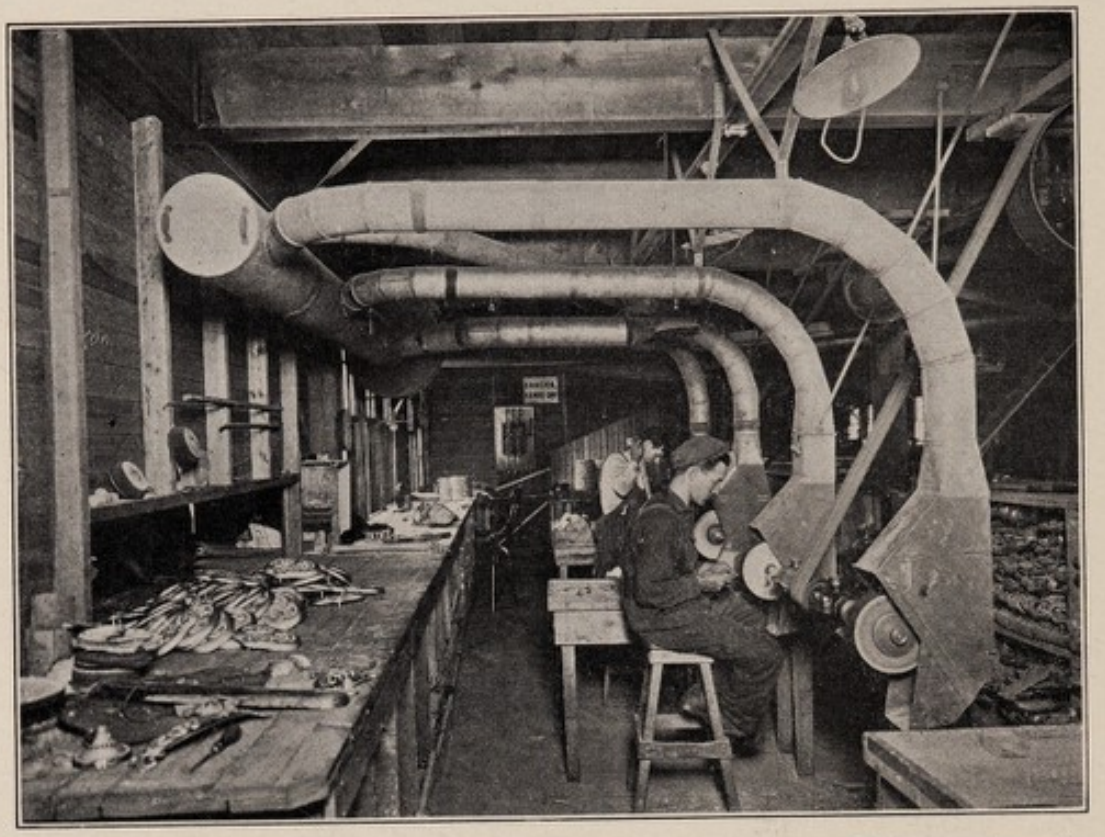


FIG. 68.—DRY GRINDING ON EMERY WHEELS. Effective exhaust system for the removal of dust, each wheel being partially enveloped by a hood connected with central dust exhaust system. (Reproduced by permission of Dr. William C. Hanson, Massachusetts State Board of Health, Aug., 1910.)

wheels are employed there should be a strong exhaust fan operating through individual ducts which form part of the shield of the wheel. (Fig. 68.) Where large articles are being ground the operator should stand over a grating and the exhaust current may be made to operate beneath the floor through the grating.

GLASS

Glass workers are subject to four principal forms of occupation hazard, namely, (1) exposure to great heat; (2) mechanical and

chemical dust irritation; (3) poisoning by certain metals such as lead oxid, zinc oxid or arsenic, used for coloring, etc.; (4) irritation of the eyes from excessive heat and light.

The raw materials, such as flint, sand, quartz, powdered marble, limestone, soda, Glauber's salt and potash, are finely ground and mixed, usually in open vessels, which is extremely dusty work.

In the industry the men who attend the melting furnaces, known as "shearers," are subjected to great heat and intermittent glare of light. The heat of the workrooms may reach 140° F. and the workmen in winter are thus subjected to great changes of temperature in passing in and out. For glass blowing an iron tube four or five feet long is dipped into a molten mass of glass and rotated by hand until a sufficient mass adheres to the end. Into this mass the workman then blows expired air, and, if the mass be large, several workmen may have to blow in turn, passing the tube quickly from mouth to mouth.

In the making of glass bottles the men work in groups of three, two of whom gather and blow the glass while the third smooths the neck and finishes the work. Such a group often turns out 250 to 300 dozen finished bottles a day, according to size. Recently machines are coming into use for blowing bottles by compressed air, and the glass may also be gathered and moulded by machinery.

For the making of glass-stoppered bottles accurate grinding of the necks becomes necessary, an occupation which is quite hazardous from the dissemination of glass and emery dust. Moreover, the bottles sometimes break and lacerate the face or hands or destroy an eye.

The blowing of large glass carboys used to hold acids, etc., requires great expenditure of strength and skill.

Small vials are made from glass tubing by means of gas jets and blowpipes. The men thus employed, from their use of gas jets, are known as "lamp-workers." Bottle making (Fig. 69) is one of the industries in which the employment of boy labor is essential for such purposes as shutting the moulds in which some bottles are cast, carrying finished bottles and other products, etc.

Iron workers are also employed in the glass bottle industry to

make the iron moulds and cut the lettering upon them, which is impressed upon certain types of bottles, but they are not subject to special hazard.

Single glass vessels may, when cooled, have to be cut off by a

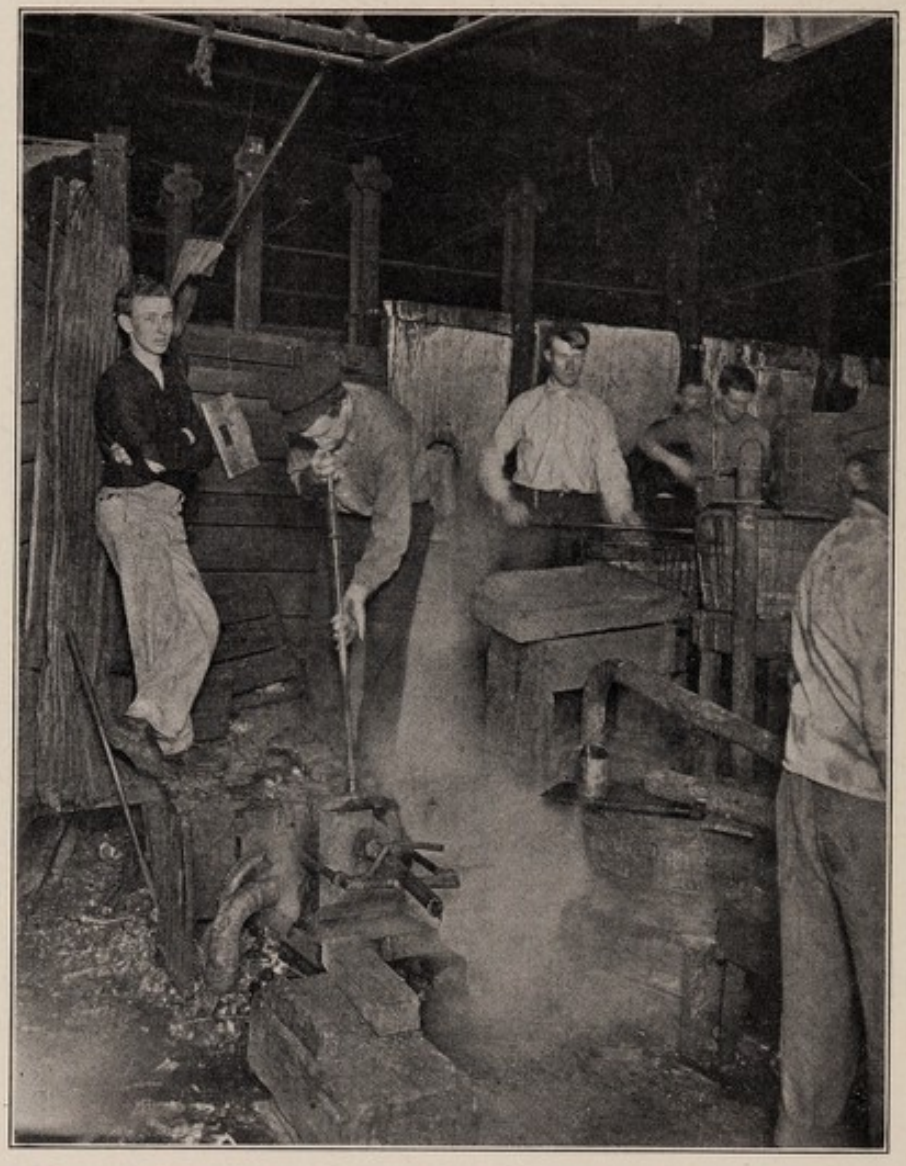


FIG. 69.—GLASS BLOWING OF BOTTLE IN A MOULD. Hazards: excessive heat, light and moisture. Note the primitive colored-glass eye-shield in a wooden frame suspended in front of the boy.

diamond, and the rough edges are filed—also a dusty occupation—and fine glass splinters fly off. Or the cut surfaces may be smoothed on wet emery wheels while sand is added. Polishing is accomplished with rotating brushes which are kept as moist as possible, but

the heat of friction soon dries them and dust is scattered. Statistics of glass makers show a rather large percentage of illnesses, about one-third of which are classed as respiratory diseases. There are also

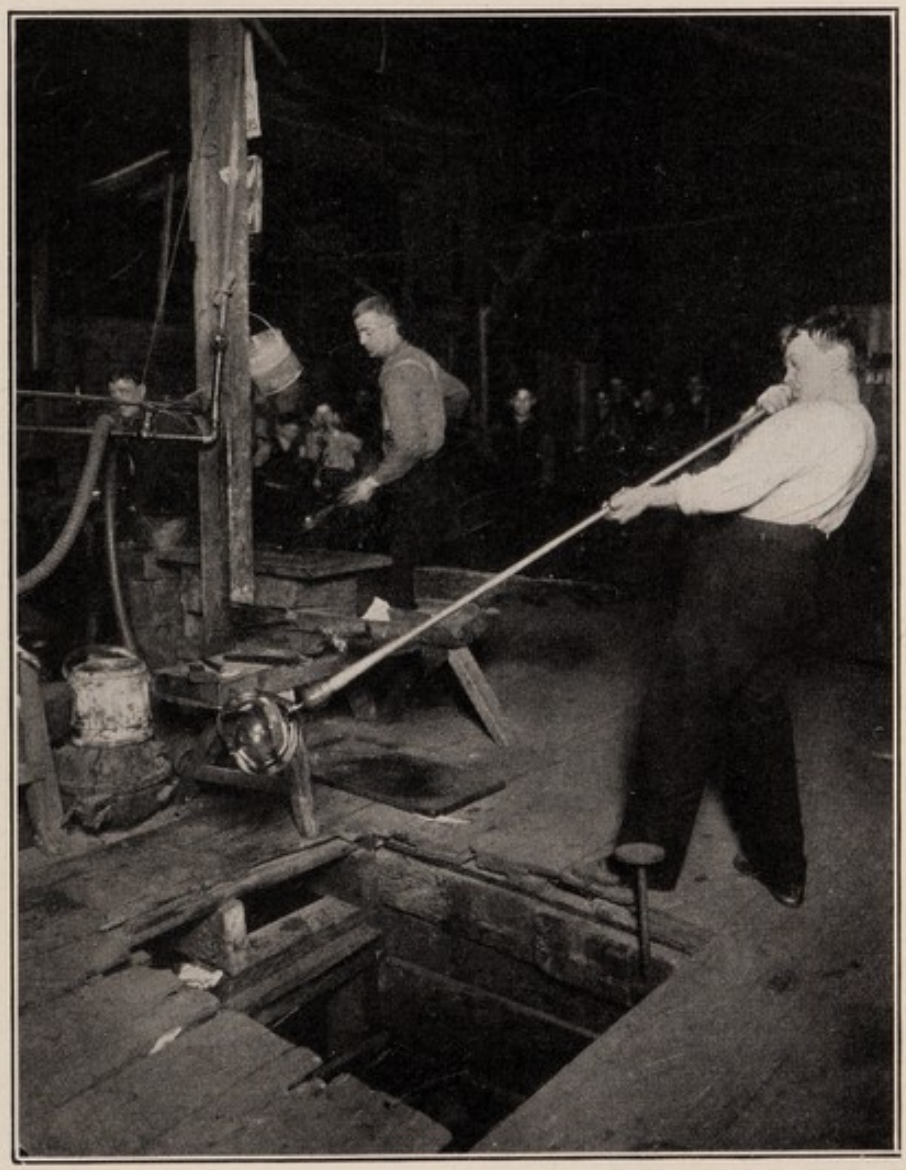


FIG. 70.—GLASS BLOWING. Hazards: excessive heat and light; possibility of overinflation of muscles of the cheeks and of Steno's ducts; irritation of skin of hands.

many cases of digestive disorder (about 16 per cent.), rheumatism, eczema and other skin diseases, conjunctivitis and a few of lead poisoning. Cutaneous wounds are common and may become infected.

Makers of plate glass lift very heavy masses at the ends of their

blowpipes, which are held with the left arm outstretched (Fig. 70), so that often the left arm muscles are more developed than those of the right arm (C. F. Schmidt), and from the rotation of the pipes the skin of the palms becomes extraordinarily hypertrophied, more so than in almost any other occupation. This is due to the heat of friction, pressure and a mixture of charcoal and wax or rosin sometimes used to afford a better grip on the smooth iron blowpipes. Uneven, horny protuberances of the skin of the fingers may become quite painful, like corns.

Syphilis may be transmitted by mouth infection by means of the blowpipes, and Eysell reported the occurrence of syphilitic mouth infection among 12 workmen, derived from one of their associates. In workmen who have been employed for a long time as glassblowers, white plaques may be seen in the mouth and on the lips, due to irritation of the rotated blowpipes and formed by thickening of the epithelial layers. The front teeth may become worn down from the same cause. The cheeks are distended by the constant blowing and there may be some degree of atrophy of their musculature (Schmidt). Air may be forced into the salivary ducts, causing widening of them, with painful swelling and deforming of the parotid glands. Schiele described this condition as "pneumatocele," or "emphysema of the ducts of Steno." Food may accumulate in the ducts and irritate them, and de la Faille reported a case of rupture of a duct following acute parotiditis, with emphysema of the subcutaneous tissues of the neck. Several other interesting cases of this form of pneumatocele have been reported by Liniger and Warat. (*Deutsche Zeitschrift für Chirurgie,* Oct., 1912, cxix, pp. 201 and 368.)

The result of inhalation of so many kinds of dust, from the raw materials used, the particles of ground glass, and the grinding materials, such as emery, etc., may give rise to pulmonary fibrosis and chronic bronchitis, which predispose to tuberculosis, but emphysema is not produced by glassblowing, as formerly supposed, despite the deep inspiration and prolonged expiration employed in the process. Emphysema is due to connective tissue changes in the lungs, and this disease is no more frequent among glassblowers than among any simi-

lar group of workmen, when due regard is had for age, alcoholism, chronic pulmonary disease and other predisposing factors.

Prettin and Leibkind (*Münch. med. Woch.,* 1904) examined 230 glassblowers who had been employed for 10 or more years, and found no cases of emphysema in those who were under 40 years of age, and only 5 cases, all told, in those who were older. Similar results were found by the late Dr. J. West Roosevelt, of New York, who some years ago examined a number of members of orchestras who played upon wind instruments and who showed no special predisposition for acquiring emphysema.

The excessive heat to which glassblowers are exposed leads them to sweat excessively and they, therefore, drink copiously of water—perhaps 8 or 10 quarts a day—with the result of producing gastric catarrh.

Cut glass is finished either by strong hydrofluoric or sulphuric acid, or by polishing on a wheel with putty powder, which is three-fourths lead oxid and one-fourth tin. (*See* Fig. 67, page 405.) As the powder, moistened to a paste, spatters about it dries, and the dust constitutes a serious menace from lead poisoning. It is among this class of workmen especially that tuberculosis prevails, and they usually appear pale and thin. According to Hirt, the average duration of life among glass grinders, cutters and polishers is only 42.5 years.

The eye diseases of glass workers, due to heat and trauma, are described under The Eyes. Glass etching by means of the sandblast is described on page 417.

Mineral Wool.—Mineral wool is much used for packing around boilers and steam pipes and for deadening in building construction. It is made of very minute threads of glass and resembles, as its name indicates, sheep's wool. It is made by injecting steam under pressure into liquid blast furnace slag. The slag is thus blown into shreds which are collected in wire receptacles. In the process much irritant dust flies into the hair and faces of the workmen, and collects in the clothing and works into folds of the perspiring skin, causing itching and eczema. When inhaled the dust gives rise to irritant dry cough, and may cause pulmonary fibrosis.

Prevention.—The raw material of glass, when being mixed, should be kept in covered receptacles as much as possible. The introduction of mechanical apparatus for glassblowing is doing much to mitigate the evils of this occupation when performed by mouth. Workmen should be examined by a physician and all who are actively syphilitic excluded. The excessive heat from the furnaces may be guarded against by the use of asbestos screens and forcible introduction of a stream of cool air by means of a blow-fan and duct. The eyes should be protected from the light and heat of the ovens by blue and gray goggles, and face masks may be worn to protect the skin of the face from blistering. All grinding rooms should be thoroughly cleaned daily and dust removed from the wheels, tables and benches. The wheels should be encased as much as possible and a strong exhaust duct should be operated in connection with them. Women and children should be excluded from the more hazardous departments of work. When handling sharp-edged glass vessels, or working with lamp chimneys or thin bottles which are liable to explode, the hands should be protected from injury by stout leather gloves.

The grinding or cutting of quartz, crystal and jet, jade and similar substances presents the same hazards to the respiratory system as those of glass grinding.

Mica.—In the manufacture of mica goods considerable mica dust is found in the atmosphere. It is slightly irritating to the respiratory system, like dust containing any solid sharp particles, but does not appear to be particularly injurious.

Meerschaum

Meerschaum, or sepiolite, is related to talc and soapstone in qualities. When being ground much fine dust is evolved which is very irritating to the lungs. It tends to produce fibroid phthisis and to maintain chronic bronchitis. (Fig. 71.)

Metal Filings

A very large proportion of the serious diseases of the lungs and bronchi are due to inhalation of filings of a great variety of metals,

but particularly of iron, steel and copper. These diseases are principally pneumonoconiosis, asthma and chronic bronchitis, with the frequent sequel of tuberculosis. The conditions under which such dusts are formed are fully described under the separate metals caus-



FIG. 71.—MAKING MEERSCHAUM PIPES. The fine sharp dust is irritating to the lungs.

ing them. The number of industries, too, in which metals are filed or ground and polished is very great.

STONES AND EARTHS. CARBON

The manufacture of grinding and polishing materials such as emery powder, corundum, glasspaper and sandpaper is productive of much fine, injurious dust. The fine dust from bricks, tiles, terra-cotta, marble, limestone, flint, granite, silica, etc., is developed in very many industries. All these dusts, if inhaled for long periods of time, tend to produce the same type of pulmonary lesion, namely, fibroid phthisis (described on page 33). They also cause conjunctivitis and traumatic injuries of the eyes (*See* Eyes). Among the workmen chiefly exposed to such hazards are stonecutters, rock

drillers, and particularly those who use the sandblast for cleaning metal castings and making ground glass. (Fig. 72.)

Stonecutters and quarrymen have been found in Germany to have a death rate of which 86 per cent. is due to pulmonary diseases. In Massachusetts, in statistics covering 16 years, it was shown that the



FIG. 72.—THE STONE INDUSTRY. "The workman is using a surfacing machine which is operated with compressed air. The strong blast of air keeps the granite clean, but gives rise to a great amount of dust, as shown in the picture. Of the mineral dusts granite is generally considered the most irritating." (Reproduced with permission of Dr. William C. Hanson, the Massachusetts State Board of Health, Aug., 1910.)

deaths among stonecutters were due to tuberculosis in the ratio of 41 per cent., and 12 per cent. were caused by other forms of pulmonary disease.

Statistics of the Massachusetts State Board of Health, published in 1907, show that the mortality among stonecutters in Quincy, Massachusetts, from tuberculosis is 41 per cent., and that of all forms of pulmonary disease is 53 per cent. In general the tuberculosis

mortality among stone and marble cutters and carvers is 5 times greater than among farmers or lumbermen.

The drilling of rocks and coal or mineral veins for blasting is almost universally accomplished by machine drill-hammers, operated by compressed air or steam, which have replaced the slow method with the crowbar and hand-wielded sledge hammer. (*See* Fig. 61, page 391.) When this process is conducted by machines in mines, tunnel boring, or any kind of hard dry stone without the use of a water spray to moisten the dust, it is one of the most dangerous of all the trades which produce chronic disease. When the drilling is done overhead, so that the dust falls back toward the face of the machine operator the hazard is at its worst.

J. S. Haldane, investigating the rock drillers of the Cornwall mines, found their average age at death was only 37 years, and that of those who died 94 per cent. had pulmonary diseases. Their death rate exceeded that of coal miners by more than 10 to 1.

The machine drills operate with such rapidity that the fine dust of the boring would choke the hole, and it is either removed by making the drill in screw form, like an augur for wood boring, or by blowing it out by compressed air, which is forced out at the tip of the drill. In the latter case, particularly, much irritant dust is distributed in the surrounding air. It is not feasible always to pour water into the drill hole, for in mines especially the drills are set at all angles, and water interferes with the use of compressed air to remove the dust. Generally speaking, the harder the rock, the greater the damage by inhalation of dust to the respiratory organs, and conglomerate rock, owing to the large size of the dust particles, produces irritation like a sensation of scratching in the larynx.

To lessen the dust hazard from the drill holes various expedients have been devised. The simplest of these is the placing of wet cloths around the drill hole to catch the dust and mopping up the dust, procedures which are troublesome and time-consuming. A recent invention consists of a pipe attached to the drill at the mouth of the bore through which a fine jet of water is forced under pressure into the drill hole, where it unites with the compressed air stream in mixing the dust into a harmless paste which flows back out of the

hole. Another invention by Korfmann employs an exhaust pipe connected with the drill, by means of which the dust is drawn out of the hole, after the manner of a vacuum cleaner, and discharged into a vessel of water or a moist bag. These inventions have the advantage that they operate independently of the workmen and do not

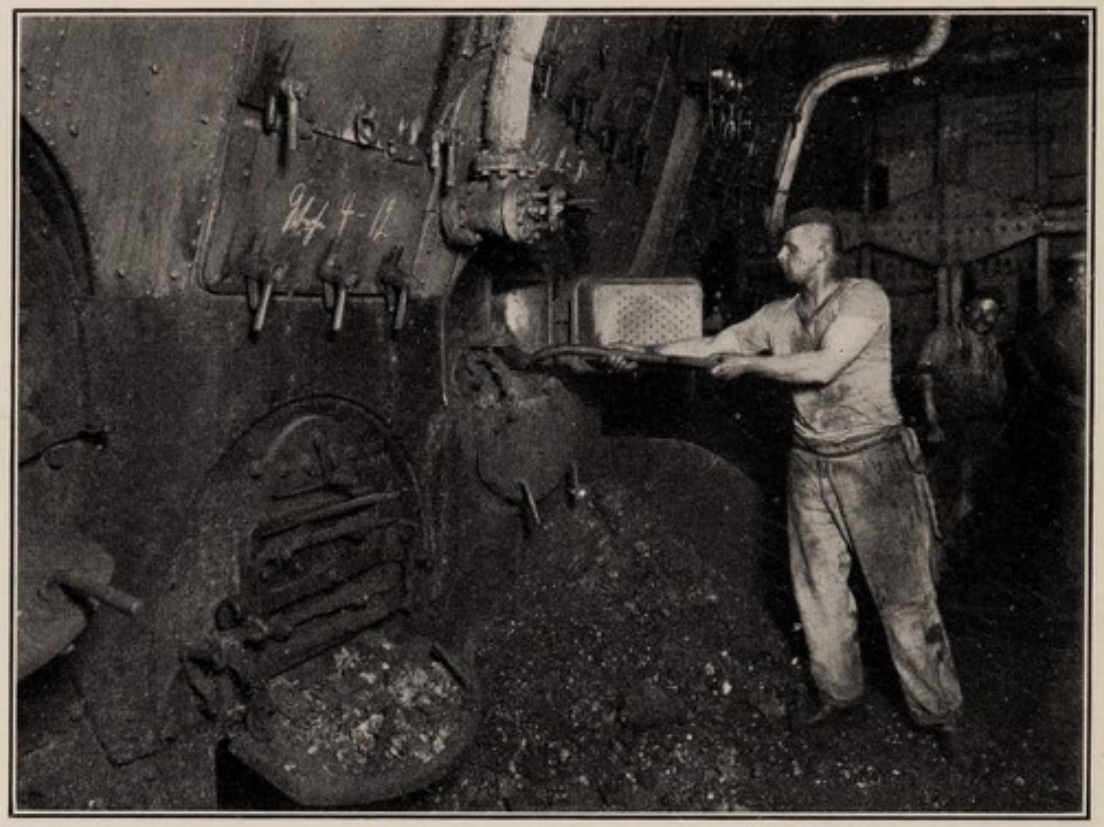


FIG. 73.—STOKER ON THE UNITED STATES WARSHIP *Connecticut*. Hazard: inhalation of fine coal dust and gases of combustion in a confined space.

require precautions, which such workmen are notoriously reluctant to observe.

Coal miners and shovelers who have been much exposed to coal dust (Fig. 73) always store considerable carbon in the lungs. Dr. Eisengraber (*Rauch und Staub,* Oct., 1911) has reported the pathological findings in such cases as follows: The lungs are mottled black, and their texture feels tough and leathery. From the cut surface a thick black mucus exudes. Here and there black nodules are found, which in extreme cases may be as large as an egg. The bronchial and mediastinal glands are infiltrated and contain much carbon. Fibrous pleurisy is common. Carbon may be found stored

in remote parts, as in the liver, where it has been conveyed by leukocytes. Those whose lungs are thus affected suffer from continuous hacking cough, with black-streaked sputum. They are dyspneic and short lived.

A curious case of carbon tattooing is shown in the accompanying picture (Fig. 74) of the feet of a stoker who walked barefooted



FIG. 74.—TATTOOING OF THE FEET OF A STOKER WITH CARBON. The coal dust is deeply imbedded beneath the skin. (From a patient in Bellevue Hospital.)

upon the heated, dust-covered grills in the stokehole of a steamer. The blackness of the feet is not due to superficial dirt, but to carbon particles deeply imbedded or "tattooed" beneath the skin. I have met with similar tattooing of the hands in coal heavers.

Sandblasting.—The sandblast is an apparatus constructed to blow a stream of sand by means of compressed air, with great force, against metal castings to clean them from the earth which adheres from the casting molds, and to smooth roughened surfaces. (Fig. 75.) It is also employed in cleaning stone and marble buildings and for the roughening of the surface of glass to make "ground glass," and sometimes to mark patterns upon glass, which is partially protected. Sandblasting constitutes probably the most dangerous of all the mineral dust hazards, and it is impossible to engage in the work without pro-

tection of the eyes and face, for the sharp particles of fine silicious sand are driven with such force against the objects operated upon that they rebound toward the workman, and, despite the use of long



FIG. 75.—SANDBLASTING CASTINGS. "The photograph shows how a sandblast is used. The cloudiness is due to excessive dust in the open shed. Men who do this kind of work, with the kind of helmet shown in the picture, are not properly protected, since the helmet does not prevent the inhalation of very fine steel, iron and brass dust." (Reproduced with permission of Dr. William C. Hanson, Massachusetts State Board of Health.)

hose to conduct the blast away from the operator, the surrounding air is constantly filled with flying sand, resembling a sandstorm in the desert. The helmets in use for sandblasting cannot have glass win-

dows, but fine wire netting shields the eyes, and cloths are inserted to breathe through.

An important method of reducing the risk of dust from the sandblasting of metal castings is covered by a recent patent of C. Wedemeyer, of Hamburg. The operator stands in a cabinet directing the sandblast away from himself toward the casting. (Fig. 76.) Over his head, at an angle of 45 degrees, a strong blower fan directs a stream of air also upon the casting with such force that the dust of both sand and metal is blown downward toward the opening of a large exhaust tube just above the floor. In this manner a strong, continuous draft blows the dust away from the operator and out of the cabinet through the aspirator duct, which is connected with a powerful exhaust fan.

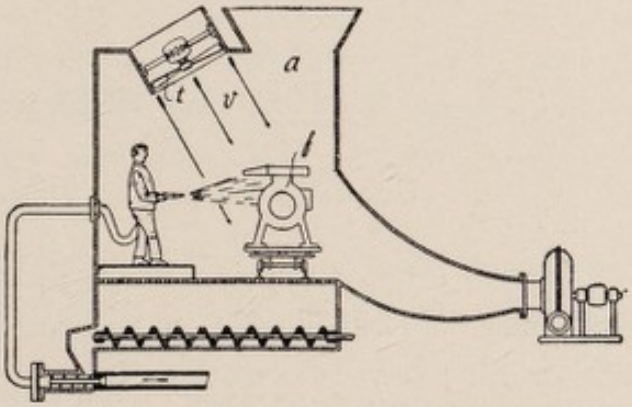


FIG. 76.—CABINET FOR SANDBLASTING INVENTED BY CHRISTIAN WEDEMEYER OF HAMBURG. The operator is enclosed in a cabinet in which he directs the blast of sand and compressed air against the casting (b) in front. A strong air current is forced from directly above his head by the fan (t) and passes outward toward the revolving aspirating drum shown below the floor on the right. (From *Rauch und Staub*, ii, 5, Feb., 1912.)

Silica.—Silica, or the siliceous earths, constitute a serious irritant to the respiratory passages when ground into fine dust in the process of extracting the valuable metals, such as tin, lead, gold, etc., with which they are combined. Continued inhalation of siliceous dust favors the production of chronic bronchitis and pulmonary fibrosis. The hard sharp dust particles irritate the conjunctivæ and may become imbedded in the cornea. Ashmen are particularly liable to this form of dust irritation. (*See* page 422.)

An illustration of an occupational disease due to a heavy dust has lately come to my notice, occurring where one would least expect it, in a soap factory. A friend, while inspecting the factory, was seized with a violent fit of coughing, and he also noticed that the

several hundred girls employed all had their hair protected by paper bags. The particular form of soap here manufactured was mixed with a finely powdered earth containing silica and the spicula of microscopic fossil animalculæ. The operatives become used to the bronchial irritation and cease to cough, but unless the head is protected the scalp becomes affected by disease, with dryness and intolerable itching.

B. SOLUBLE INORGANIC DUSTS

Soluble Inorganic Dusts in General

In this group there is a large number of substances which become more or less soluble in the presence of mucus, hydrochloric acid or other secretions of the alimentary canal. Examples are lime, gypsum, plaster of Paris, phosphates, guano, and certain metals. The latter, chiefly, are injurious through solution and absorption.

The dust of metal filings is not only inhaled in the nose, but is breathed into the mouth or taken into it with food, when such dusts as may be soluble, like that of lead or its salts, may produce specific toxic effects. The dusts of brass, arsenic, zinc, silver and salts of mercury are probably more injurious through being swallowed than inhaled. Their effects are fully described under the separate headings of the metals.

Oxalic Acid

This substance, occurring in the form of white crystals, is much used in solution for polishing copper, brass and other metals, in dyeing and chemical cleaning establishments, and in making straw hats and braiding. As a dust it irritates the respiratory organs, and as a fluid it acts upon the skin. Being a household agent for brass scouring, it is easily obtained and is occasionally swallowed with suicidal intent. It causes intense cyanosis, a feeble pulse, paralyses, and sometimes convulsions. I have seen prolonged coma from its effects, lasting several days, but terminating in recovery. It disorganizes the blood, destroying the red cells. When swallowed it is

highly corrosive in the esophagus and stomach. Acting in solution on the hands, it makes the nails bluish and brittle.

Industrial poisoning from this substance is very rarely encountered.

Ultramarin

Of this substance there are several varieties. Soda ultramarin is made by melting together in an oven kaolin, charcoal, soda and sulphur. In other processes sulphuric acid is mixed with the raw material. The soda ultramarin is at first white, but on exposure to the air oxidizes to a deep blue color.

The dust of the various substances used, which are finely ground, is both mechanically and chemically irritant by absorption to the respiratory passages, and the inhalation of sulphuric acid fumes from the furnaces is highly injurious. The workmen employed in packing the finished, finely powdered product suffer from nasal and bronchial catarrh, and Röpke found cases of erosion, ulceration and, in one instance, perforation of the catilaginous portion of the nasal septum.

A serious case of conjunctivitis occurred in an Austrian workman who in making ultramarin spattered a solution of sulphuric acid into his unprotected eyes. (*Sozial Technik.*, 1912, vol. 4, No. 2.)

C. ORGANIC DUSTS AND FIBERS

Acridin

This substance is encountered in the use of certain organic dyes. It contains nitrogen as well as carbon and hydrogen. It forms colorless needle-shaped crystals which, blown about in dust, are excessively irritating to the skin and mucous membranes, causing violent pruritus, redness and burning of the skin, conjunctivitis, rhinitis, continued sneezing and tracheitis. It affects the skin of the hands and arms of dyers.

Ashes and Street Dust

Street Dust.—Street dust is a highly complex form of respiratory irritant, containing many particles of both inorganic and organic matter distributed by winds and traffic. (a) The inorganic matter is derived (1) from the disintegration of the pavement substance, which may be brick, granite, asphalt, macadam, flint rock, sand, earth, concrete, or other paving material; to this are added (2) scatterings from passing ashcarts, house sweepings, the dust from building operations, particles of iron rust, as from elevated railroads, soot, and dirt of street excavations often containing sulphids. (b) The organic material may be derived from wooden block pavements, tar used to cement stone blocks and fix gravel or sand in the interstices between them, the droppings of oil from automobiles, garbage, the powdered excrement of horses and dogs, sometimes human excrement from children in tenement districts, and the desiccated sputum expectorated by foot passengers. The latter evil is much mitigated by the continued exposure to sunshine, air and dryness, which are inimical to the life of many germs.

Street Cleaners and Ashcart Drivers.—Owing to the dusty nature of the work of this type of workmen, they might be supposed to be especially liable to respiratory diseases, such as asthma, bronchitis and tuberculosis. Nevertheless, the open-air employment counterbalances this risk. A few years ago there was much popular discussion in New York over the alleged prevalence of tuberculosis among these men, and a thorough physical examination of the entire Street Cleaning Department force was made by Dr. John Rogers, Dr. A. Bleiman and other physicians. They found no more cases of tuberculosis among the sweepers and ashmen than the usual percentage arising among any large group of workmen. Among 5,800 men examined less than 2 per cent. gave evidence of incipient tuberculosis and some had had the disease when they entered the department. In 1911 the number of cases was only 1½ per cent.. Street-sweepers are liable to insolation when compelled to work for many consecutive days upon the heated asphalt pavements in strong sun-

light in a hot, humid atmosphere, and, in 1911, there were 220 cases of heat prostration in 9 days among the 6,500 men of the department, including sweepers and drivers.

It has been asserted that the collectors of ashes and garbage are very subject to hernia because they have the strain of lifting heavy barrels to the tops of the carts, which in many cases are 5 feet 9 inches high. In 1911, among 2,695 men examined, there were only 16 cases of rupture, or about 0.6 per cent., which is not above the average among any other group of workmen. Lumbago, ruptured tendons and sprains from strains and falls on slippery sidewalks are observed in about 0.5 per cent. of the workmen employed.

Conjunctivitis and injuries to the eyes from sharp silica spicules or other forms of ash dust sometimes occur among the ashmen, but less often than might be supposed.

Carpet Dust

Carpet cleaners are liable to inhale dust which is a mixture of all manner of dirt, with fibers from the carpet materials which often are dyed with more or less toxic pigments. No very serious ailments, however, appear to arise from the occupation, but germs of influenza, tuberculosis and those producing catarrhal inflammation may be inhaled, and the dust itself is mechanically irritant to the respiratory mucosa.

Cotton

Raw cotton contains much dirt of earth and sand, and in the ginning process the dirt, cotton seed fragments and cotton fibers are blown about so that the air is filled with irritant dust. More or less respiratory irritation results. Epistaxis and nasal catarrh are common and the employees complain of dryness of the nose and throat. Röpke examined 18 cleaners of raw cotton wool and found nearly all had small erosions of the nasal mucosa, which he attributes to the effect of sand and dirt.

Cotton Spinning and Weaving.—Cotton mills are usually large establishments employing several hundred operatives, many of whom

are women and children. In the milling of cotton a number of distinct processes are involved, nearly all of which are productive of much fiber dust.

The baled cotton is first opened by men who place the material by armfuls in the "breakers." The next machine beats and cleans the cotton fibers and mixes them in thick layers or "laps." Another machine cards the fibers, i. e., works them into parallel strips. Thus far the work is principally conducted by men. Combing is the next process, conducted by women, whereby the fibers in the form of loose ropes are coiled in large cans. This is followed by passing through the drawing machine, whereby the cotton is drawn out into coarse strands. Roving strengthens the strands by twisting them on spools, which are then placed in the ring spinning machines. Women and girls also are employed in this process. In a further process, called "mule" spinning, considerable heat and moisture are necessary, so that the men and boys conducting it wear only one or two garments and perspire freely. The thread is now ready for weaving under regulated conditions of moisture and heat, which are necessary to prevent the threads becoming too dry and breaking.

Hazards.—Practically all the above described processes fill the air with fiber dust, so that even in the best ventilated mills the operatives suffer in time from the dust and heat. The long hours of standing over machinery which constantly jars the floor, and which in some of the processes is very noisy, combine to favor ill health, with weakness, anemia, poor appetite and a tendency to bronchial catarrh and digestive disorders. In a study of the conditions of labor among 1,500 operatives made in New Jersey in 1901 by William Stainsby the number of days lost from work in a year on account of ill health reached 3,762, and he groups the more important ailments as follows: diseases of the lungs, 22 cases; of the throat, 15; kidneys, 25; stomach and bowels, 31. The women also suffer much from dysmenorrhea, and any preëxisting uterine disorder is liable to be made worse by the occupation. The death rate among the 1,500 operatives was high, being 5.74 per cent.

Another source of cotton dust exists in the polishing or buffing by means of rag wheels. In some cotton cloth and other cloth mills

the bolts of cloth are examined by girls who sit and draw the long strips of cloth constantly toward them, while searching for imperfections in the weave. This process generates much fiber dust which flies toward the girls' faces and is inhaled.

Symptoms.—In general cotton and flax dust is more injurious than woolen mill dust. The weavers and spinners in the former industry suffer chiefly from tuberculosis, bronchitis, dyspepsia, rheumatism, varicose veins, and uterine disorders. Of these diseases bronchitis furnishes about one-third of all cases. Not all these diseases, by any means, are attributable directly to dust inhalation and poor general ventilation, but lack of home hygiene, poor food due to low wages, constrained positions and general fatigue and overwork must be considered in estimating the hazards.

The bronchitis of cotton weavers is accompanied by a morning cough by which mucus is raised containing cotton fibers. The cotton fibers also are drawn down into the alveoli, which they tend to fill, causing emphysema and localized irritation and connective tissue increase. There is more or less dyspnea, and in time the patient becomes weak and anemic and loses appetite and weight. Hemoptysis is not common from this form of dust. Bronchitis, peribronchitis and pneumonia may result. Promiscuous spitting on the floors by the operatives causes the dust of many germs to be added to the other impurities of the factory air.

In the Southern United States "cotton-mill anemia" is frequently spoken of. C. W. Stiles, whose researches on uncinariasis are historic, has established the fact that mill employment has little or nothing to do with this condition, which is due rather to the low grade of workmen commonly employed, their wretched hygiene and uncinariasis derived from the soil-polluted farms from which the workers are largely recruited during the milling season. Cotton-fiber dust is, of course, an undesirable impurity in the air, causing more or less bronchial irritation as it does, but there is no special variety of mill worker's anemia other than that which naturally is consequent upon poor hygiene in general.

In Lancashire in some years the deaths from tuberculosis of cotton weavers have risen as high as 20 per cent. of the total deaths

from that disease, i. e., one man in five who died of tuberculosis was a weaver. In this case, however, the dampness and high temperature purposely maintained in the weaving sheds to facilitate the weaving are doubtless contributing factors to the ill health of the operatives, who also often suffer from rheumatism.

Feathers

Workers in feathers and down of all sorts are subjected to various forms of irritation, chiefly of the respiratory passages. Not only do the feathers themselves give off fine dust, but they contain much general dust and dirt. In some cases poisonous dyestuffs are used, containing arsenical, chromate and other pigments. Some of the substances used in cleaning bed feathers etc., such as naphtha, may beget further specific irritation, and serious nasal and bronchial catarrhs may result. In a feather establishment in New York State several cases of pulmonary abscess have occurred, the light feather dust from uncleaned feathers having served as a vehicle to convey septic germs into the lungs.

Felt

Felt is made from finely cut fur, from rabbit, hare and other skins, and to some extent from wool. The sorting and trimming of the fur, the cutting and other processes liberate many fine sharp hair dust particles which irritate the respiratory mucosa, causing sometimes catarrh of the nose and throat, with more or less bronchial inflammation. The felt also is treated with mercurial nitrate, and subsequently, under high temperature, the mercury may be volatilized and inhaled, giving rise to mercurial poisoning. In the felt hat industry this problem is so important that it is separately considered on page 293.

Flax and Hemp

The dust from these two substances acts in substantially the same manner. Being volatile, it is easily inhaled, and is often

mixed with natural dirt, oil from machinery, and the vapors or fumes of chemical processes used in bleaching or macerating the vegetable fibers. The stems of the plants are first submitted to a process of beating and subsequent macerating to separate the individual fibers. They are treated in closed vats containing a watery solution of sulphuric acid, and the workmen are liable to inhale fumes of this acid, of ammoniated sulphur, and other respiratory irritants. The process of beating out the fibers liberates a great deal of dust of sharp pointed plant cells, dirt, etc.

The flax and hemp beaters suffer from a so-called "beater's fever," resembling ague, with malaise, headache, neuralgia and acute catarrh of the upper air passages. The patients may suffer from nosebleed, loss of sense of smell, dryness of the nasal and pharyngeal mucosa. Chronic otitis media is also common among them, as well as eczema of the hands and arms.

In a chronic condition of poisoning among these workmen, described by French writers, additional symptoms may be observed, such as brown pigmentation of the skin, dullness, an uncertain gait, and curious odor of hasheesh in the urine.

Among 12 flax carders, Röpke found 3 with atrophic rhinitis and pharyngitis, and among 20 women flax spinners 9 had catarrhal affections of the nose and throat.

The threads are spun several times, and in the final process, being drawn very fine, they are kept moist so there is no more dust, but the spinning rooms are necessarily kept moist and warm.

The Prussian factory laws restrict the maximum of dust allowed in flax mills to 8 milligrams of dust per cubic meter of air, measured at the level of the operator's head.

Hemp as it is fed into breakers, preparatory to spinning into cord or twine, or weaving into gunny cloth, gives off large quantities of coarse dust fibers. In Massachusetts, where much of these materials are made, the operatives fasten bunches of fiber over the mouth and nose to act as sieves for the dust.

Automatic machine hacklers for breaking and binding the flax fibers are gradually replacing the dusty hand methods of this industry.

Fur

The sorting, cleaning and dressing of furs is a dusty occupation which, like working in feathers, may give rise to chronic bronchitis. (Fig. 77.) In exceptional cases the fur particles convey septic germs to the lungs and pulmonary abscess may occur. Furriers are very susceptible to tuberculosis. Some of the dyestuffs used in fur manufacture may give rise to eczema and other forms of cutaneous irritation. One of my cases was that of a man 28 years of age, who for 10 years had been employed in cleaning and cutting fur. On examination he presented a bronchiectatic cavity, extremely fetid expectoration, and tuberculosis, with fever and anemia. Lime, sulphid of arsenic and nitrate of mercury are among the deleterious substances used for "curing" in various stages of



Fig. 77.—Fur Sorting. The hair and the dust on the floor is very irritating when inhaled. In this dirty room in a New York furrier's factory a plenum ventilator constantly stirred the air without removing the dust. (Courtesy of Dr. Price of the New York State Factory Commission.)

manufacture of furs and fur materials, such as felt. (*See* Felt Hats, page 289.)

Six cases of eczema impetiginosum occurred in a felt hat factory in New Jersey early in 1914 from handling infected fur. One of the patients whom I examined had had the eruption for eight weeks. It began behind the ears, spread to the scalp, and seriously involved the hands, arms, legs, thighs and scrotum. The victim suffered from intolerable burning and itching of the skin. The blebs became purulent and sanguineous and superficial ulcers formed with areolas of dermatitis. Staphylococcus pyogenes aureus was isolated from the pus. The man finally was obliged to give up work and seek hospital relief, where he improved under vaccine treatment. In a second case which I saw the eruption did not spread beyond the hands and arms, for the man quit his work after two or three weeks, becoming alarmed by the persistence of the eruption.

In the process of felt hat making, where the rabbit or other fur in a fine state of subdivision is blown upon perforated copper cones enclosed in large wooden drums, the workman, unless the drums be closed before the fur is blown upon the cones, receives the fine fur dust in his face and necessarily inhales more or less of it with resulting bronchial irritation.

Five cases of dermatitis acquired by furriers from the use of dyes were reported within a few months' time to the New York State Labor Bureau in 1912.

Grain and Flour

Millers and those who handle grain and flour are subjected to dust inhalation. The flour dust particles are soft and do not produce much irritation, but those who hammer the lids on flour barrels or sack the flour may suffer from nasal catarrh. The chaff of the various grains is harder. Mingled with it, in threshing, may be dirt from the fields and dust particles derived from the grinding wheels and polishing rollers. Such dust may amount to one per cent. of the grain. (Fig. 78.)

Millers of grain and grain elevator men suffer considerably from

pulmonary diseases, of which Hirt's statistics give 20.3 per cent. pneumonia, 10.3 per cent. tuberculosis, 9.3 per cent. bronchitis, and 1.9 per cent. emphysema. Others state that tuberculosis causes 20



FIG. 78.—FLOUR DUST FROM "HEADING-UP" FLOUR BARRELS BY HAMMERING.

per cent. among all causes of death among millers, or a ratio of one in five.

Dr. F. L. Hoffman states that "the continual and considerable inhalation of flour dust is injurious to health and a predisposing factor in the mortality from consumption and from respiratory diseases generally."

Millers and grain handlers acquire catarrhs of the nose and throat and bronchi, and may have epistaxis, sneezing, rhinitis and dry cough. Those employed in the grain-polishing rooms are especially liable to these complaints.

Flour and meal dust, when breathed into the nose in quantity, adhere, when moistened with mucus, to the mucosa in thick crusts, which may give rise to ulceration and atrophic rhinitis. Otitis

media may result from the nasal catarrh. The dust also enters the external ear, and with the ear wax may become packed against the tympanum, or give rise to eczema and furunculosis of the external auditory canal. Deafness in moderate degree may be caused by the noise of the grinding machinery.

Flour and meal dust may cake in the smaller bronchi, forming obstructive plugs and causing atelectasis. Emphysema is met with and "miller's asthma" is a disease well recognized by the workmen. In the sputum the irritant epidermic layers of grain are found. Oats are the most irritant of the grains. Up to 30 years ago much siliceous dust was derived from the grindstones, which added to the above-mentioned hazards, but steel rollers have now replaced them in the larger mills, and much of the handling of grain is accomplished by enclosed machinery. Cleaning the returned empty grain sacks is a very dusty occupation.

Millers show a high death rate from pneumonia, it being more than double the ordinary rate in other occupations, according to the *Report* of the New York State Bureau of Labor for 1906.

A further menace to grain elevator workers and workers in starch mills consists in the occasional explosion of the dust. In a plant in Illinois 4 men recently were killed in this manner, and in June, 1913, an explosion of dust in a grain elevator in Buffalo caused the death or serious injury by burning of several scores of persons.

Horn, Bone and Shell: Celluloid Combs

In addition to the use of these substances in button manufacture (*See* Button Making), they are ground and polished to make knife handles, combs and a great variety of articles of use and ornament, and the dust is more or less irritating to the respiratory passages. Combs and hair pins are made also of horn, bone, shell, tortoise shell, celluloid (Fig. 79), metal and composition. Leominster, Massachusetts, is a great center for this industry. In polishing such articles a wheel is sometimes used, powdered with fine coal ashes, and both moisture and dust in excess may be generated. The combs are bent on hot asbestos-covered steel tables, and

camphor, an ingredient of celluloid, may be liberated as a vapor. The pins are smoothed with wet pumice stone. In this form of manufacture, also, the articles are dipped into glacial acetic acid,

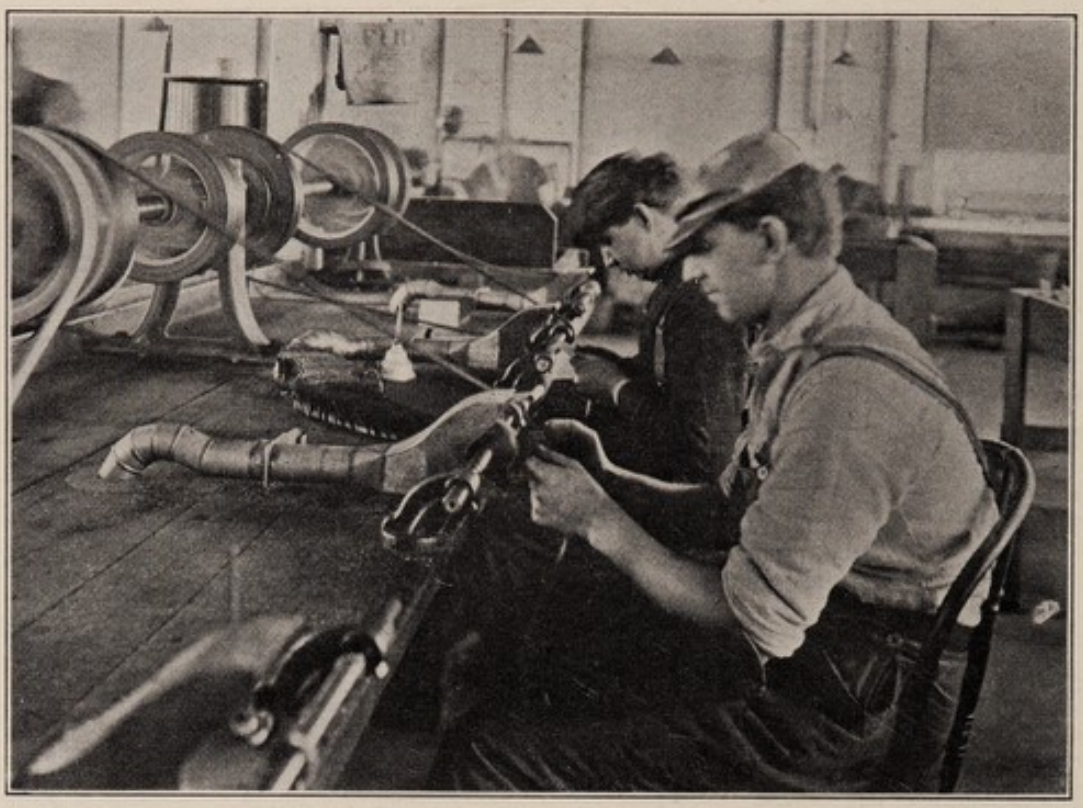


FIG. 79.—POINTING THE TEETH OF CELLULOID COMBS. "Sand wheels or steel burrs are used. The exhaust system in this case is quite as much for protection against fire as to prevent the inhalation of the dust." (Reproduced with permission of Dr. William C. Hanson, Massachusetts State Board of Health, Aug., 1910.)

which gives rise to eczema of the hands, and the fumes of which are irritating to the eyes and bronchi, although somewhat less so than are those of the mineral acids.

HORSEHAIR AND OTHER HAIR

Horsehair is much used in upholstery, and in its handling gives rise to unclean dust of fine hairs, particles of dried epithelium, and sometimes of flesh. (Fig. 80.) Arens inoculated rabbits with this dust, and from the pustules which developed obtained cultures of the Bacillus pyogenes fetidus and Staphylococcus pyogenes aureus.

Upholsterers, brush and paint-brush makers sometimes suffer from pustules and carbuncle. In the latter industries hair and bristles from a variety of different animals are used. Hair is

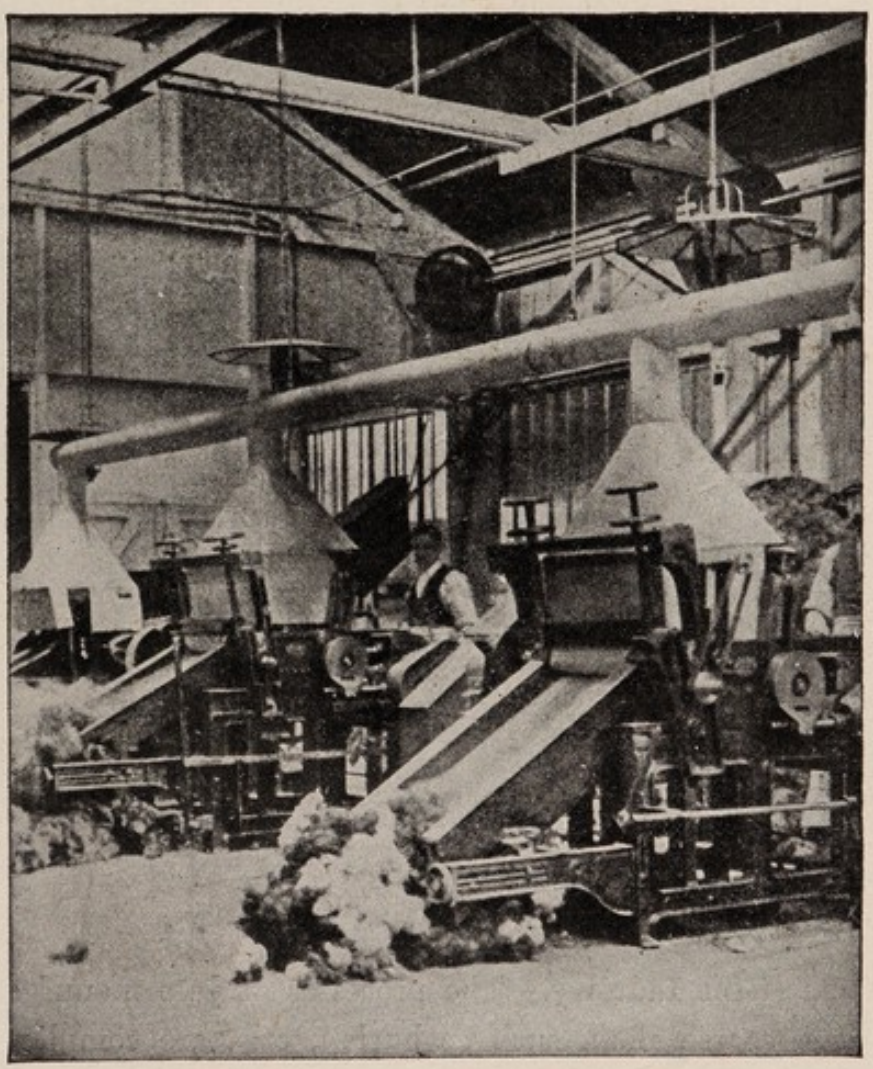


FIG. 80.—HORSEHAIR CARDING MACHINE. (From Shaw Lecture by Dr. J. S. Haldane on "Dust and Fumes in Factories," Royal Society of Arts, London, Feb. 28, 1908.)

employed also in rotating polishing wheels used in burnishing various metals, and more or less hair dust is given off in the process.

Hair dust irritates the nasal mucosa and may give rise to sneezing, epistaxis, ulceration and catarrh, as well as to asthmatic attacks. Some few persons are peculiarly sensitive to horsehair dust, so that they acquire attacks of "hay fever" from inhaling mere traces

of it, as in driving behind a horse. Exceptionally, polypoid degeneration of the nose has resulted from hair dust inhalation.

The hazard of working in hair is very variable. One of my cases was that of a workman who, as a boy of 10 years, began picking and sorting hair, and for 35 years had been occupied upholstering furniture with hair. He had never had any pulmonary or other symptoms referable to his occupation. Another patient had worked for 22 years at the same occupation. While at work he frequently had a cough, as did many of his 75 fellow workmen. He had had recurrent attacks of bronchitis for 15 years and finally acquired tuberculosis, with pneumothorax.

In addition to horsehair, upholsterers make use of a variety of more or less dusty materials, such as oakum, excelsior, moss, seaweed, a coarse grass known as "Mexican fiber," etc., but none of these substances possess any specific qualities of irritation.

Prevention.—Bales of imported goat or camel hair and the like should be opened for sorting either only after wetting or placing over a large wire screen with an exhaust beneath, so that all infected dust may be drawn away from the workman. The walls of the workroom should be limewashed several times a year to cleanse and disinfect them.

Jute

Nature of the Industry.—The processes of jute manufacture for cord, rope, coarse cloth, such as burlap, etc., are complicated and exceedingly dusty throughout. Jute is the inner bark fiber of several species of Corchorus which grow in India and South America. The fiber is stripped from the main stems by hand, moistened, dried, and under hydraulic presses made into compact bales for transportation. On opening the bales for manufacture, the fibers are laid lengthwise in bundles, a process conducted originally by hand, but now to a great extent by special machinery. The fibers are sorted, the shorter ones being discarded and dirt and impurities removed. They are then flattened by running between pairs of rollers and pounded. They are next moistened with sprays of water and oil to limber them. Several processes of carding and spinning follow, and the

fibers are thus finally twisted and drawn into threads, from which they may be made into cord, rope (Fig. 81), or spun into coarse sacking. The entire handling of the jute is exceedingly dusty



FIG. 81.—JUTE ROPE MAKING. A very dusty occupation in a room without ventilation.

work, especially opening the bales and feeding the rollers, and the dust is of a particularly irritant kind, owing to the peculiar structure of the fiber and the dirt which it at first entangles.

Symptoms.—Jute dust is irritating to the eyes, skin, hair and lungs. It gives rise to conjunctivitis and causes itching and eczema of the unprotected scalp. It causes, also, bronchitis, rhinitis and asthma. In chronic jute poisoning, according to Oscar Gerold, of Berlin, there are anemia, weakness and emaciation, with sometimes suddenly appearing fulminating pains in the legs, with softening of the long bones.

Jute spinning begets much coarse dust, so that the nasal cavities become almost filled with it. Among 15 spinners examined by

Röpke, more or less atrophy of the nasal mucosa was present in all, they having been employed two or more years. In several cases polypoid degeneration was observed.

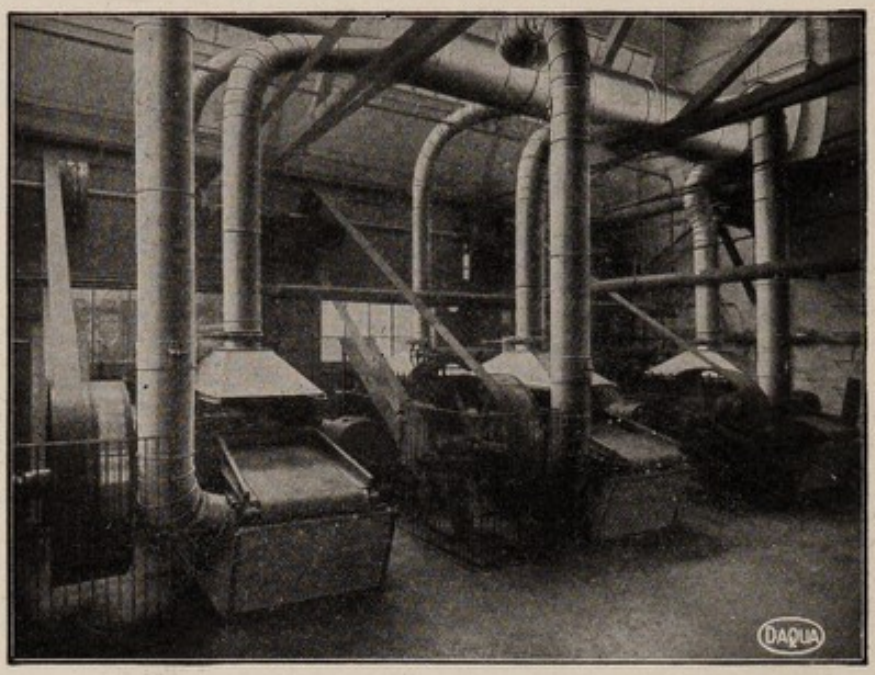


FIG. 82.—DUST REMOVAL PLANT IN A JUTE SPINNING MILL. The jute fibers are sorted on the inclined perforated planes through which dust is aspirated downward. Other aspirating ducts remove the dust from above, connecting with the hoods.

In making jute twine and bags the dust mingling with the natural wax of the ears packs into hard cakes, which lie against the tympanum, causing temporary deafness.

Among 44 jute spinners Röpke found 6 cases of eczema of the hands and forearms. There were also cases of eczema of the ears and alæ nasi. Hüberden found several cases of furunculosis among this type of workmen.

Those employed in making tarred hempen ropes may acquire eczema from irritation by the tar.

Prevention.—Much of the jute work formerly conducted by hand is now performed by machinery, protected by exhaust ducts placed both directly over the machines and, covered by gratings beneath the machines, just above the floor. (Fig. 82.) The hair

should be protected by linen caps, and overalls and goggles should be worn in the more dusty divisions of the work. Asthmatic attacks demand a change of work, at least temporarily.

Rags and Paper

Paper is made from a variety of substances in this country, such as old rags, old paper, wood pulp and burlap. The rags are mainly imported in bales from Eastern countries, and are disinfected before



Fig. 83.—Paper Making. Removing dust from the rag-sorting room by means of metal exhaust ducts connected with a centrifugal fan. (From Shaw Lecture by Dr. J. S. Haldane, on "Dust and Fumes in Factories," Royal Society of Arts, London, Feb. 28, 1908.)

import, but they are still very dirty, and in the thrashing and chopping machines in which they are disintegrated great quantities of dust are stirred up. In parts of the work where the dust is thickest the operatives wear respirators.

In rag sorting (Fig. 83) for paper making there is danger of infection with a variety of diseases; for, apart from the dust of the material, the dirty rags may have been used by those having contagious diseases, although rags imported from oriental countries where smallpox, cholera and typhus fever are often prevalent are always disinfected, and in this country such infections are no longer transmitted in this manner.

Offelmann, in a study of 4,875 employees in this industry, declared that one-half at least become ill during the year in one way or another, and about one-third of them acquire diseases of the respiratory system. The so-called "wool sorter's disease," or actinomycosis, has exceptionally, in foreign countries, been transmitted by rag-sorting. Eberhardt collected 40 fatal cases which occurred in Germany in 17 years; and Dohnal, 13 cases in 5 years; but such cases are extremely rare at this time and in this country, owing to the efficiency of modern quarantine disinfection, are virtually unknown. In some cases the dust of baled rags reaches 20 or 30 per cent. of the weight of the rags. Its inhalation may give rise to acute and chronic bronchitis, bronchorrhea and gastric catarrh.

In the process of macerating and bleaching the rags, hydrochloric and sulphuric acids are sometimes used, as well as chlorid of lime, all of which substances give rise to fumes which are more or less irritant to the respiratory passages, although their strength is usually not sufficient to produce very harmful effects. Parts of the paper-making process are very wet (Fig. 84), and the workman may be obliged to stand all day exposed to dampness or complete wetting. The rags are also boiled or treated with steam, which contributes to the dampness of the trade.

In the manufacture of wall papers and other colored paper a variety of pigments are used. For the production of green shades arsenic was formerly much used, but, owing to the danger of arsenical poisoning, not only in the process of manufacture, but from arsenical dust or vapor which might be given off after the wall paper was hung, lead chromate and other lead pigments and anilin colors have been substituted almost universally. It is probable, however,

that the danger of acquiring arsenical neuritis in sleeping apartments freshly hung with green arsenic-colored paper has been greatly exaggerated.

Chrome poisoning occasionally occurs among the paper makers who handle this pigment Cases of bronze poisoning have also been recorded in this industry. In making velour tapestry papers much

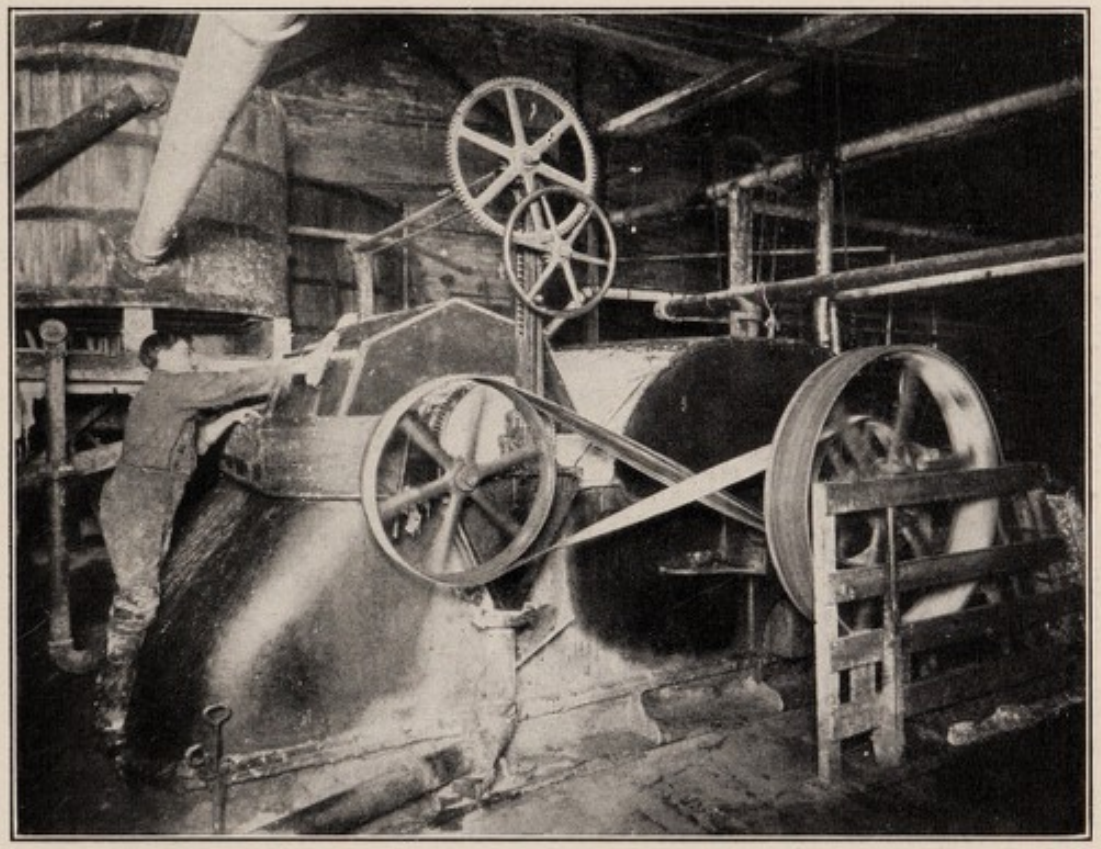


FIG. 84.—PAPER MAKING. Workmen standing all day in the water with inadequate protection.

irritating fine wool dust is given off. The hazards of making sandpaper, emery paper, glass sandpaper, etc., are described under the uses of these materials.

In the making of cellulose or wood pulp paper various processes are employed in which either sodium hydroxid or calcium sulphate may be added to the finely cut wood fiber, which is boiled with these materials under pressure in closed vats. There is opportunity for liberation of sulphurous acid and consequent irritation of the bronchial mucosa. (*See* page 375.) New workmen in the process are

liable to complain of rhinitis and cough, but they soon become inured to the irritation (Lehmann).

Straw and Broom

Workers in straw, such as straw hat makers, inhale more or less dust composed of the straw itself and dirt. In making straw hats



Fig. 85.—Broom Dust.

sulphuric acid is used for bleaching, and solutions of lead salts, such as lead chromate, are used as coloring agents. The dust and acid fumes may give rise to catarrh of the respiratory passages, and the dyestuffs may cause eczema.

Broom and brush makers inhale much dust (Fig. 85), and brushes made from hog bristles give rise to sharp particles of animal dust. Hirt's German statistics show that among the deaths of those employed in this industry about one-half are caused by tuberculosis.

Sugar

In sugar refineries considerable dust of charcoal and sugar is liberated in the processes of cutting the sugar into cubes or pulverizing it to powdered sugar.

Dr. George M. Price, Director of the New York State Factory Investigating Commission, made the following statement in 1911 (*Proceedings Acad. Political Sci.,* New York, Jan., 1912, vol. ii, No. 2): "In a large sugar refinery which I recently inspected I found the sanitary conditions as to care, comforts and toilet accommodations much lower than in any ordinary garment shop which I had inspected during the last year. On several floors of this huge nine-story double building I found the air so filled with charcoal dust that it was impossible to see four feet away, and impossible to breathe longer than a few minutes. On one of the floors of this refinery I found a dozen persons, barefooted, and naked except for a loin cloth, in a temperature of 95° F., with a relative humidity of 96, almost reaching saturation, rinsing and washing dirty filter-bags in half a dozen vats, the water in which was at 130° F. The whole place resembled nothing so much as a scene from Dante's *Inferno.*"

Symptoms.—Sugar refiners are subject to several varieties of skin disorder. They are exposed to heat and moisture, and the residue of molasses contains dirt and may harbor germs and mites. Thus the refiners and molasses stirrers may acquire a lymphangitis due to the Staphylococcus pyogenes aureus (Gaillot), which often develops a furunculosis. They also may have dermatitis involving both upper and lower extremities. Formerly, when coarse brown sugar was much in use, much was said of a so-called "grocer's itch," believed to be due to a parasitic mite. The dermatitis above referred to may resemble impetiginous scabies. A similar mite is

said to find its habitat also in flour, and hence to affect bakers with dermatitis.

Tobacco

The handling of tobacco on a large scale involves much subdivision of labor. The leaves are dried where they are picked, packed for shipment, unpacked from hogsheads, dusted free from



Fig. 86.—Tobacco Sorting.

sand, etc., and moistened. These processes develop either tobacco dust (Fig. 86) or tobacco vapor. The vapor develops in the drying sheds, during the six months of fermentation, and the dust arises in the warehouses where packing and unpacking are done, and where tobacco is ground, as for snuff, cigarettes or for pipe smoking or chewing. In one part of the process the tobacco is steamed and dried on heated trays. Finally the sorting of cigars and packing them in boxes is a dusty process, and the paste used for cigar ring labels is made of starch and tobacco juice.

About 40 per cent. of cigar makers are females, and about 60 per cent. of those employed with cigarette machines also. Many young girls are employed in the tobacco industry, especially for rolling, packing and labeling cigars, and their nervous systems are quite susceptible to tobacco poisoning. In some tobacco factories the operatives are permitted to bite off the ends of the filler and inner wrappers.

Sommerfeld found that in Berlin the mortality from tuberculosis among tobacco workers was nearly double that of workers in non-dusty trades. In the United States, in 1905, in the Cigar Makers' Union, 24 per cent. of recorded deaths were due to tuberculosis.

The quantity of nicotin in tobacco varies from 2 to 3 per cent. in the lower grades to 6 or 7 per cent. in the higher. The exact composition of the volatilized substances given off by moistened and fermenting tobacco is not accurately known, but it appears to have similar toxic effect to tobacco dust. Ammonia is one of the ingredients. Both the dust and the vapor, on entering the respiratory passages, act as mild local irritants, and absorption also takes place, by which nicotin may enter the blood and give rise to constitutional reactions manifested chiefly through the circulation (increasing arterial tension) and nervous systems, but to some extent, also, in the alimentary canal.

Symptoms.—Tobacco workers are more liable to toxic symptoms in the first weeks of their employment, but may be affected at any time under unfavorable conditions. In countries such as France, where children and young girls are much employed in the industry, sometimes more than 50 per cent. are made ill during the first six months of their work, and such children may remain ill for several days. They suffer from cerebral congestion, insomnia, muscular weakness and nervousness, as well as palpitation of the heart, pharyngitis, cough, gastro-intestinal disorders, such as nausea, vomiting and diarrhea. They also have conjunctivitis. Later they may become anemic, owing to continued gastric disorder and insufficient secretion, and eventually become emaciated if not removed from their work. Adults exposed either to tobacco fumes or dust present symptoms

quite similar to those which arise from smoking too much tobacco in an ill-ventilated room. They complain of headache, faintness, vertigo, nausea and vomiting, and diarrhea may be present, due to increased peristalsis. If the worker does not leave the factory, attacks of tachycardia and anemia result. Visual disturbances such as amblyopia may appear. With the latter there is pallor of the optic nerve and sometimes central scotoma for red and green.

These various symptoms are much more common among females than males, and especially affect beginners in the work. In the making of snuff attacks of coryza, lacrimation, conjunctivitis and bronchitis are liable to affect novices. Women workers in tobacco factories often suffer from dysmenorrhea, and abortions are frequent among the married women. Ruef and Stolz claim to have found traces of nicotin in amniotic fluid, and Kostial found it in the breast milk of a nursing woman. Étienne, of Nancy, followed the histories of 93 pregnant women tobacco workers. Eight of them were delivered of still-born infants, and in those instances in which the mothers returned to work after parturition, but attempted still to suckle their young, the infant mortality was double that of children whose mothers were not connected with tobacco works. Pierracini, of Milan, reported similar results in 1905, and found 45 per cent. of premature deliveries among tobacco-working mothers. It is possible, however, that these fatalities were due to other conditions than the influence of tobacco or to exceptionally bad hygiene, for, on the contrary, a research among 17,000 tobacco employees reported in the "Traité d'hygiène industrielle," vol. vii, page 525, shows that morbidity and mortality are not above the average among the newborn children of tobacco workers. In the French tobacco factories a system of infant inspection has been instituted for several years, which is no doubt largely responsible for the favorable statistics. Each month the mother takes her infant to the physician employed by the factory company, and he examines it and gives all necessary directions as to feeding, etc. These opposite statistical results illustrate the importance of accuracy in gathering data upon questions of hygiene which may be influenced by such extraneous factors as alcoholism, syphilis, a desire to avoid having children, etc.

In the United States married women are less employed in tobacco factories than they are in France and Italy and other foreign countries, and statistical data regarding them here are lacking, but it is safe to assert that the occupation is not rated as especially hazardous either for themselves or their offspring, or the matter would have attracted special attention. In the lungs of tobacco workers patches of pigment and brown induration have been found.

Treatment.—The treatment of tobacco poisoning is purely symptomatic, for the symptoms promptly subside under cessation of work or improved ventilation, and no permanent results ensue in any case.

Wood

Wood workers are subject to a variety of disease hazards. Apart from the irritation to the air passages of inhaling fine particles of sawdust, which are less injurious than many other forms of dust, the finer grades of tropical woods, used in cabinet making, veneers, etc., sometimes contain poisons such as alkaloids and other substances. Belonging to this class are the African rosewood, satinwood, teakwood and redwood, sequoia, boxwood, ebony and many others.

In the manufacture of furniture, interior structural woodwork, etc., coloring and polishing materials are used, and wax, oil of turpentine, shellac dissolved in wood alcohol or benzene. Various pigments are either dissolved in these substances or separately rubbed into the wood, but lead pigments are not often used for this purpose. Sandpaper and emery paper are also used to produce a smooth finish, and when this work is done in a confined space, as in the interior veneering work in a Pullman car, much injurious dust is set free. The scraping of hardwood floors is a very dusty occupation, and when the floors being cleaned are old the dust may contain oils, resin, and pigments. Sternberg, of Vienna, describes typical deformities of the chest which are sometimes met with in wood polishers and cabinet-makers who stand in constrained attitudes over work benches. The shoulder muscles are well developed, the clavicles are prominent and elevated, and the thorax is flattened

anteriorly. Flat-foot and varicose veins in the legs are common, sometimes with eczema. A very curious condition, also described by Sternberg, has been observed in polish drinkers. The shellac solution is drunk for the alcohol which it contains, and the shellac gradually coats the stomach, finally rolling up into a ball which fails to pass through the stomach, and in extreme cases has been recognized, he asserts, as a tumor requiring operation for its removal!

Workmen employed in laying parquet floors frequently acquire bursitis at the patella. Wood polish irritates the hands, often causing chronic eczema.

The most frequent illnesses among wood workers, however, are affections of the respiratory organs due to the wood dust and the various substances above mentioned which become mingled with it. The fumes of turpentine, benzene and wood alcohol may give rise to acute poisoning, affecting also the circulation (as described under these several headings).

E. J. Neisser found in a Swiss wooden tool factory that three-fourths of the workmen became ill during the year, mainly from diseases of the respiratory system.

According to Sternberg, among 10,071 wood workers in Vienna in 1904 there were 28.1 per cent. who suffered from tuberculosis and other diseases of the respiratory system. Rhinitis and middle ear catarrh, bronchitis and asthma are common among this class of workmen. Where noisy sawmills and planing machines are used, more or less deafness and sometimes disease of the auditory nerves may result.

Canes and umbrella sticks are often colored with chrome pigments, and Blum has seen typical chrome poisoning with ulceration of the nasal septum (*See* page 182) among workmen employed in their production.

Boxwood is used chiefly for manufacturing rulers and shuttles. The fine sawdust from this wood is quite harmful when inhaled. Men employed in boxwood manufacture for the first time are liable to pain and smarting in the eyes, dizziness, symptoms resembling severe influenza and bronchial catarrh. Later, if they persevere in the work, they may become pale and jaundiced and suffer from

asthma and cold sweats. The heart action becomes markedly slow, and an alkaloid has been obtained from the wood, which, when given experimentally to animals, causes depression of the heart and general muscular weakness. The wood of the California sequoia has similar properties.

In this connection, a man who deals in fancy woods used for veneering told me an amusing incident. A new wood called "Tonquin" was received from an East Indian island for trial in the mills. On being sawed into thin slabs it gave off a most unusual quantity of bright red sawdust which covered the workmen. One of them, thinking to wash the dust from his hair, dipped his head in a bucket of water, when, to his surprise, the hair turned a bright grass-green color. It took him several days of scrubbing to restore the natural color!

Cokus wood contains an irritant oil which may give rise to a papular eczema of the lips and ears and sometimes may involve almost the entire face.

"Coca-bola" is a very hard imported wood used in Massachusetts for making handles for agricultural implements. Its dust is so irritating to the eyes and skin, causing conjunctivitis and dermatitis, that some workmen after trial are compelled to give up working in the wood.

Satinwood (Chloraxylon Swietenii) may give rise to urticarial edema of the hands. Indian rosewood produces similar irritation, which may involve the face.

Others of the woods giving rise to resinous dust, such as ebony and teak, may cause dermatitis in sawyers. Erythema multiforme and pustular acne-form eruptions are also observed.

A Japanese wood called "Tagayasa" is much used in making fine furniture on account of its hardness, fine appearance and property of polishing well. When pulverized by sandpapering, sawing, etc., it gives rise to a dark brown or violet-colored powder which is highly irritant to the eyes and skin. It causes intense conjunctivitis and begets a dermatitis of the hands, breast and face of the workman which results in punctate dark brown discoloration, looking somewhat like gunpowder pigmentation. The powdered wood con-

tains a substance chemically allied to chrysarobin, the irritant action of which upon the skin is well known in medicine. Dr. Iwakawa, of Tokio, has experimented with this toxic wood chemically and upon animals, and found that it produced, like chrysarobinic acid, serious disturbance of the renal and digestive functions. Prevention of the hazard consists in wearing goggles and gloves and observing strict cleanliness.

Teakwood contains an irritant resin. When this wood is finely pulverized its dust, inhaled or swallowed, may give rise to nausea, vomiting and other constitutional symptoms. Locally it produces a severe generalized and very persistent dermatitis which may not be relieved for many weeks, meanwhile giving rise to much burning and itching.

Cork is not only cut for matting, corks, etc., but ground to fine sawdust and mixed with gypsum and acid it is used for patent wood flooring. It is also ground for linoleum making and a variety of other purposes.

Wool

The sorting and cleaning of wool is a very dusty occupation, for the wool is oily and contains considerable extraneous dirt. From wool imported from oriental countries the germ infection known as "wool-sorter's disease" or anthrax is sometimes acquired, although very rarely in this country. It is described on page 452. I have known of two or three cases of anthrax which occurred among weavers of woolen rugs and carpets in factories in eastern New York State. They handled wool which had not previously been disinfected thoroughly. Wool-sorters often suffer from both acute and chronic catarrh of the air passages. In extracting the natural oil from the wool sulphur carbonyl is employed, which is highly toxic if inhaled as a vapor. After washing the wool any remaining particles of dirt or vegetable fibers are removed by hydrochloric or sulphuric acid solutions. This process is conducted in closed vats or large drums, which, when opened, may give forth acid fumes that are irritating. The process of wool carding and spinning is less dusty than those of cotton, flax and jute.

V. GERMS

ANKYLOSTOMIASIS OR UNCINARIASIS: HOOKWORM DISEASE

The *ankylostoma duodenale* or *uncinaria duodenalis* is a parasite of wide foreign distribution, belonging to the Strongyloides family, which inhabits the small intestine of man, as the name indicates. Another species, the *uncinaria americana* (Stiles), appears to be indigenous in the United States. The female parasite is 18 mm. in length, the male about 10 mm. The American species is somewhat shorter. The males possess a terminal fringed bursa at one extremity of the worklike body, known as the "bursa copulatrix," used to grasp the female in copulation. At the other extremity is a wide mouth with four strong upper hooks or teeth wherewith the parasite holds fast to the intestinal wall. At the lower margin of the mouth are two smaller rounded teeth. Further back in the mouth are two more small teeth which serve to bite open blood vessels in the mucosa. On the head also are two large glands of undecided function, but which are believed by some to secrete a substance which is toxic to the human blood. Another theory is that their secretion has the function of preventing coagulation of the blood upon which the parasite feeds. It is believed to survive for years in the intestine, periodically discharging oval segmented eggs, which, being aerobic, must develop outside of the human body under favorable conditions of warmth and moisture such as exist in unhygienic mines. Here, in a few days the larvæ develop, attaining a length of 0.8 mm. They become encapsulated, in which condition they have been kept alive experimentally fully a year. If conveyed by man to the mouth and swallowed, the capsule dissolves and in 5 or 6 weeks the larva completes its growth to a full-sized egg-producing intestinal worm. The larvæ have been experimentally proved by fully a dozen observers to have the power of boring into the human skin and entering the blood and lymph channels, but it is probable that oral transmission is the usual mode of infection in

mines where hundreds of workmen defecate daily and pollute the soil.

The anemia which is so pronounced a symptom of this disease was formerly known as "Miner's anemia" and "Egyptian chlorosis," being of mysterious nature until it was traced to the ankylostoma duodenale, the European species of the parasite. In foreign mines the disease was at one time so prevalent as to assume epidemic proportions, as happened during the construction of the St. Gothard tunnel. In Germany, however, it has been controlled by compulsory periodic examination of the miners.

In building the Simplon tunnel the air became so hot deep within the shafts that sprays of cool water were used to cool it. Thousands of imported workmen of uncleanly habits were employed, who defecated in the tunnels, hence all the ideal conditions for an "epidemic," namely, warmth, moisture and filth, were present.

In the United States, according to Dr. C. S. Hotchkiss, of the United States Public Health and Marine Hospital Service, cases have developed in the coal mines of Virginia, West Virginia, North Carolina and the gold mines of Nevada and California, and exceptionally in Pennsylvania, but he failed to find any in Colorado mines. He reports the finding of Cochin China diarrhea among miners in West Virginia.

Dr. Herbert Gunn, of San Francisco, found 60 cases of ankylostomiasis in Amador County, California, in 1905, all among foreigners, and in January, 1911, reported a large number more, from 50 to 80 per cent. of the men being affected in several gold mines. The miners defecate in the dark cross-cuts and pockets of the mines, where the temperature is warm, often 80° to 90° F., and hence the soil becomes infested with the worm. Gunn found it in the soil of the mines inspected. It is his belief that the infection exists in most of the gold mines of California and in some in Nevada, having been imported by workmen from Austria, Italy or Cornwall, where the disease is endemic.

Dr. C. W. Stiles discovered ankylostomiasis in coal, copper and gold mines in various parts of this country in 1902. One case was found in the Pennsylvania coal mines in 1904 by Wainwright and

Nichols, who stated that "none of the anthracite mines of this country . . . has any privy facilities under ground. The men deposit their excreta in any chamber or gangway handy." The wonder is that other soil infections such as dysentery and typhoid fever are not more common, as well as uncinariasis, among all our miners.

The hookworm disease problem among miners is a very serious economic as well as humanitarian matter, mainly from the large number of victims moderately affected who continue to work, but do so very inefficiently. Gunn estimates the loss to one California mine from this cause as over $20,000 per year. The mortality of the untreated disease, moreover, is very high, and in Porto Rico has reached almost 30 per cent. The disease is by no means confined to miners, but in this country has of recent years been shown by Stiles to affect a large Southern rural population, consisting of farmers, bricklayers, tunnel workers, trench diggers, and similar classes of persons who come in contact with infected soil. Their children who go barefoot and are of dirty habits are very often infected.

A temperature of 80° to 90° F. is most favorable to the parasites, hence they do not thrive in cold or temperate climates outside of mine or tunnel protection. The disease is sooner or later characterized by anemia, which may become so severe as closely to resemble pernicious anemia. Leukocytosis is not present, nor is extreme eosinophilia in many cases, although exceptionally eosinophiles have been present up to 24 per cent., and not rarely up to 5 or 6 per cent.

The other symptoms are striking and peculiar: pallor of the face even when the blood count is not very low; a dull, heavy, listless expression, manner, speech and gait; increasing muscular weakness. The parasites occur abundantly in the stools. In exaggerated cases edema, ascites, progressive emaciation, a protuberant abdomen and increasing stupor complete the clinical picture. Children, when infected, are of stunted growth. The victims often complain of gastro-intestinal pains and cramps, but not in every case, for they often appear too dull to complain of anything.

Prevention.—Prevention consists of the disinfection of infested soil, drying the soil by drainage, disinfection of infected stools of

ankylostomiasis victims, proper foot covering and cleansing of the hands before eating. There should be absolute prevention of promiscuous defecating over the ground in rural districts, and deep trenches should be used so that the stools cannot be washed over the ground by showers, and so that they can be disinfected and deeply buried. In mines pails should be used, which when partly filled with feces should be soaked with formalin before emptying, or some disinfectant which will not further pollute the air of the mine.

Treatment.—The patient should be purged with calomel and next day, upon an empty stomach, two 5-grain doses of thymol should be given in capsules, with an interval of two hours between, after which a saline purge should be administered. Such large doses of thymol sometimes cause alarming symptoms of collapse, but smaller doses are not very effective. With very feeble patients it may be preferable to use felix mas. Castor oil should be avoided, as it may favor absorption of toxic products from the intestine. A single treatment often fails to dislodge all the worms, some of which lie partly imbedded in the folds of mucous membrane. Hence, after an interval of a few weeks, the stools should be reëxamined for ova, and, if any are found, further treatment must be given. In the interval it is recommended to give daily doses of 10 or 20 drops of oil of eucalyptus (Lindemann) to lessen the resistance of the parasites.

ANTHRAX

Anthrax, called also malignant pustule or malignant edema, is an infection caused by the rod-shaped *Bacillus anthracis,* which is obtainable from the patient's blood or from the pustules or edematous areas which the disease exhibits. The disease primarily affects cattle, horses, camels and sheep, which acquire it by inhaling the spores of the bacillus, probably while eating food which has in some manner become infected.

Richter has expressed the belief that anthrax formerly played an important rôle in widespread epidemics, but at present the disease is so much of a rarity in the United States that it is a surprise to find that in eight States it is included in the list of the six re-

portable occupational diseases, but this is accounted for by the fact that the first American reporting laws were copied almost verbatim from the British.

Anthrax appears to be more prevalent in England than in the United States. In the five years 1899-1904, 261 cases were officially recorded in England, including 67 deaths, whereas in Pennsylvania, in 1897, Ravenal reported 12 cases among tanners using hides which came from China. Sixty cattle were also infected. The 261 English cases were divided as follows, as given by Neisser: wool industry 88, hides and tanning 86, hair and brush industry 70, miscellaneous 17.

Drs. E. W. Hope and W. Hanna, of Liverpool, reported at the Fifteenth International Congress on Hygiene and Demography, in September, 1912, 60 cases of anthrax observed in Liverpool during the previous eight years. Thirty-six of the victims were engaged in unloading hides at wharves or in carting them. Six persons acquired the disease through handling horsehair in factories and 13 by handling wool.

In Bradford, England, during a period of several years, 71 cases of anthrax developed in the woollen industry, with 24 deaths, of which 15 were internal and 9 external in type. Two of the recovered cases were treated with Sclava's serum given intravenously, as much as 80 c. c. being used.

In all England only 9 cases of anthrax were officially reported in 1910 and 11 in 1911. In Europe, in 1905, according to Kober, 59 cases were recorded. Under the new reporting law of occupational diseases in New York State, in the year 1911-12 there were only three cases of anthrax reported, one of which was in the leather tanning industry. Anthrax has been seen in butchers, shepherds, cattle salesmen, meat inspectors, workers in horsehair, camel's hair and hair brushes, tanners and those who transport hides or wool, and especially in wool carding and spinning. I know of three cases in the woolen carpet industry. Wool carding machinery separates the fibers, evolving much dust with which the spores are inhaled. The disease was formerly called "wool sorter's disease," but it is the wool carders, not the sorters, who constitute the usual victims.

In London a case of anthrax occurred in a woman, the wife of a dock laborer, employed in unloading foreign hides, who became infected through contact with her husband's clothing. The medical inspector found the anthrax germs in the leather derived from the hides, after they had been submitted to the tanning process.

The following note is from the British laws of 1905 regarding the handling of imported wools, hides and hair: "The germs of the disease (anthrax spores) are found in the dust attaching to the wool, or in the excrement, and in the substance of the pieces of skin, and may remain active for years. In this country and Australia anthrax is rare, consequently there is little danger in handling wools from the sheep of these two countries, but in China, Persia, Turkey, Russia, the East Indies, and in many other parts of the world, the disease is common, and infected fleeces or locks (which may not differ from others in appearance) are often shipped to Great Britain. Hence, in handling foreign dry wools and hair, the above regulations should carefully be observed. Greasy wools are comparatively free from dust and therefore little risk is incurred in handling them. The disease is communicated to man sometimes by breathing or swallowing the dust from these wools or hair, and sometimes by the poison lodging in some point where the skin is broken, such as a fresh scratch or cut, or a scratched pimple, or even chapped hands. This happens more readily on the uncovered parts of the body, the hand, arm, face, and, most frequently of all, on the neck, owing either to infected wool rubbing against the bare skin or to dust from such wool alighting on the raw surface. But a raw surface covered by clothing is not free from risk, for the dust lodging upon the clothes may sooner or later work its way to the skin beneath. Infection may also be brought about by rubbing or scratching a pimple with hand or finger nail carrying the anthrax poison. Use of the nailbrush, and frequent washing and bathing of the whole body, especially of the arms, neck and head, will lessen the chance of contracting anthrax."

Anthrax appears to be conveyed in the blood of the diseased animals slaughtered. This blood stains the wool or hides, and in this manner the anthrax spores, which possess considerable vitality,

are transported to the tanneries or woollen mills. The spores have been found in the dried blood.

In man the disease has been acquired (1) through eating diseased meat, (2) by inhalation of dust from infected wool, hides or hair, (3) through inoculation by means of cuts from knives used in dressing diseased animals or skins, hides, bristles, hair or wool, and (4) through bites of insects which have fed upon infected carcasses or other material. The common practice of carrying bundles of rough hides on the shoulder often causes abrasions of the skin, through which infection may take place. For example, the case was reported by Abner Post, of Boston, of a warehouse porter who became infected in the neck in this manner, and also, by placing an infected finger in the mouth, acquired similar infection in the stomach and intestines, which presented submucous hemorrhagic areas and ulcers from which the victim died on the fifth day.

The anthrax bacillus rods are from 4 to 6 times longer than the diameter of a red blood cell and possess long, slender, threadlike processes in which they develop spores. They are non-motile and undergo rapid fusion. The spores live for a considerable time on open pasture land.

Symptoms.—The incubation period of anthrax occupies less than three days and the symptoms present (a) an external and (b) an internal type.

(a) External Anthrax.—External anthrax is of two varieties, (1) malignant pustule and (2) malignant edema.

(1) *Malignant pustule* begins as an inflamed pimple or boil, usually painless, although a sensation as of itching or burning may be complained of. The papule becomes hard, with a purple center and deep red zone of infiltration surrounding, with which appears a circle of minute papules, or vesicular areola. The central papule becomes vesicular and discharges a thick bloody serum, afterward forming a brown dry gangrene. A painful lymphangitis with hard edema may extend over the neck and down the arm. Local phlebitis also occurs in the edematous area. While this local process is developing the patient complains of chilliness, anorexia, vomiting and prostration. The temperature in severe cases may reach 105° F.,

and delirium sometimes ensues. The victim may die within 4 or 5 days, or linger for a week or two in a typhoidal condition, with tendency to a feeble pulse, syncope and collapse.

The prognosis of this variety of the disease is always grave, but not necessarily fatal, particularly in cases in which the infection is not focused in the neck, but in the leg.

(2) *Malignant edema* involves the loose connective tissue in such situations as the eyelid, neck or forearm. I once saw it in the inner part of the thigh. The skin is not reddened and the inflammation is not well circumscribed, but spreads rapidly, with sloughing and gangrene. The constitutional symptoms are those of pyemia and the patient does not recover.

Diagnosis of both these types is based upon the nature of the patient's occupation, and the finding of the bacilli in the fluid of the pustule or edema, or, in later stages, from the blood.

(b) Internal Anthrax.—Internal anthrax also appears under two types, (1) the intestinal or mycosis intestinalis and (2) the cerebral or pulmonary, which constitutes the typical "wool sorter's disease."

(1) *The intestinal form* is rarely occupational, being caused usually by eating meat or drinking milk from infected animals. The invasion is very acute, with high fever (106° F.), a chill, pains in the head and back, vomiting, constipation, pain and tenderness in the abdomen and a rapid, feeble pulse. The spleen is palpable and there may be hemorrhage from the bowels. Dyspnea and cyanosis occur and the patient dies in two or three days in delirium or convulsions.

(2) *Wool sorter's disease* results from inhalation of anthrax spores, and the lungs are primarily attacked. The constitutional symptoms are those of the internal type with addition of cough, pains in the chest and suffocation. There may be coma or maniacal delirium, and the bacilli have been found in the brain capillaries.

Diagnosis is based upon the suddenness and violence of the respiratory symptoms, together with finding the bacilli in the sputum or blood.

Prevention.—The danger of anthrax infection in this country

may be abolished by disinfection of hides before shipment. Immediately upon flaying they should be subjected to "wet-salting" with common salt, or to treatment with formic mercury, in solution, made, according to Ponder, with 1 to 2 per cent. of formic acid and 0.02 per cent. of mercuric perchlorid. The "soak" with salt solution causes the hides to swell and moistens any dry albuminous matter such as blood in which the anthrax spores may lodge, so that the disinfectant acts more effectively.

A. Schattenfroh found that disinfection may be done effectually by pickling the hides for a few days in a 2 per cent. hydrochloric acid solution to which 10 per cent. of salt is added. Or a solution of 1 per cent. hydrochloric acid and 8 per cent. of salt is equally effective in 6 hours if the process is conducted at 40° C.

Tanners and wool sorters, in handling foreign skins or wool, should not carry them upon the unprotected shoulder, and should guard against exposure from any cuts or scratches or "hangnails." They should cleanse the hands often in a 1:1,000 solution of corrosive sublimate. Wool sorters may be protected by wearing respirators, but thorough disinfection of the materials used is the only reliable preventive measure, and should be insisted upon absolutely.

Treatment.—A suspected focus of infection should be at once burned out with a cautery, and, if too late for this, the entire infected area must be excised, no matter how extensive it may be. Surrounding infected lymphatics should be excised also. Edema which cannot be dealt with by means of the knife should be treated with injections of a carbolic acid solution, dressed with 1:500 corrosive sublimate solution and an ice bag.

Brandy, ammonia and strychnin should be given as stimulants. Preventive inoculations of various sorts, including antistreptococcus serums, have been tried, but, thus far, without encouraging results.

FOOT-AND-MOUTH DISEASE

This disease, called also aphthous fever, is transmitted to man in exceptional instances as an occupational affection derived from certain domestic animals. Hence it may attack butchers, cowboys,

drivers, stablemen and horse dealers. It is characterized by vesicular stomatitis and a miliary, often pustular, eruption of the hands. Besides cattle, it attacks pigs, sheep and goats. In Texan ranches it formerly gave rise to widespread epidemics, characterized by vesicles and ulcers in the mouth, with furrows and ulcers in the feet and udders. The milk becomes yellow, thick, bitter and nauseous. The disease may be transmitted to man through infected meat as well as by handling cattle. Milkmen may inoculate their hands.

Incubation in man lasts 4 or 5 days and the onset is acute, with chill, prostration and fever. Vesicles form on the tongue, lips, buccal mucosa and pharynx. Salivation occurs and the tongue is swollen. The fingers and hands show a miliary eruption and pustules. The disease is sometimes fatal, but recovery is usual at the end of a week.

Treatment.—The mouth should be washed every two hours with a 1 per cent. carbolic acid solution, or a permanganate solution of like strength, followed by a boric acid solution, ten grains to the ounce, of mucilage of acacia or tragacanth. To allay the pain of swallowing a 2 per cent. solution of cocain may be sprayed in the pharynx. Ulcers may be touched with argyrol.

GLANDERS AND FARCY

Glanders is an infective granuloma caused by the *Bacillus mallei,* a non-motile organism resembling the *Bacillus tuberculosis* in appearance, but differing from it in behavior with stains and culture media. It is transmitted through abrasions of the skin or mucous membranes, or by inhalation of the dried mucus from the discharges which it produces. It is conveyed to man from horse, ass or mule, and also by direct inoculation from man to man. When affecting the mucous membranes the disease is called "glanders," but in the skin it is termed "farcy."

It occurs among hostlers, horseshoers and teamsters, and at times has caused serious localized epidemics in cavalry regiments.

Symptoms.—The disease appears in an acute form and a much rarer chronic form.

Acute Glanders.—Incubation lasts from 2 to 4 days. Then the nasal mucosa ulcerates and discharges a fetid, blood-stained fluid. Rapid necrosis of the nasal septum follows and ulceration extends to the mucosa of the mouth, pharynx, larynx and bronchi. The skin of the nose and entire face becomes red, swollen and edematous, resembling erysipelas, but without blebs. There is lymphadenitis, with swelling of the lymph glands. The constitutional symptoms are those of pyemia, such as an irregular high temperature, chills, sweats, vomiting, diarrhea, brown, dry, tremulous tongue, rapid, feeble pulse,

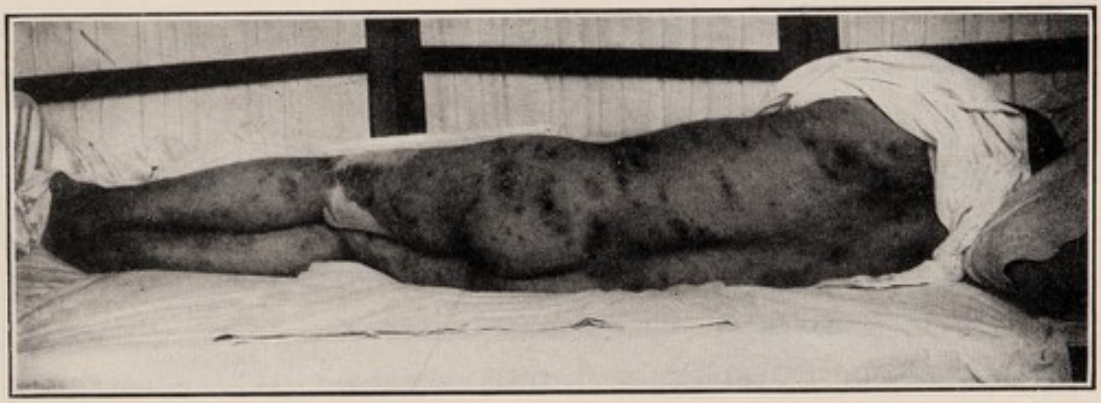


Fig. 87.—Acute Farcy, Showing Extensive Eruption. (From a patient in Bellevue Hospital in 1910. Service of Dr. F. S. Meara.)

delirium and coma. Pneumonia is a common complication, and a pustular eruption may extend over the face and joints, not unlike malignant smallpox.

Acute Farcy.—Around the site of infection there is a rapidly spreading local swelling, with pain and redness. In the vicinity nodules or "farcy buds" form along the lymphatics. A nodular pustular multiple eruption forms in the skin, rapidly extending over the entire body, as shown in the accompanying illustration of a patient seen in Bellevue Hospital (Fig. 87), in whom the infection began near the left eye. The nodules become pustular, at first resembling the pustules of variola, but soon becoming larger and looking much more malignant. They have a purple or black areola and the pustules rupture, forming deep ulcers from one-fourth to an inch in diameter. The patient shown in the illustration presented groups of pustules all over the body, which in some cases followed

the distribution of lymphatic trunks. The joints may suppurate and abscesses form in the muscles. The constitutional symptoms are those of pyemia. Most of these cases are fatal within ten days. The patient shown in the photograph, who was a stable helper, died on the seventh day. Mild cases sometimes terminate in recovery after two or three weeks.

Chronic Glanders.—Chronic glanders resembles syphilitic ozena. There is a fetid, purulent and bloody nasal discharge from deep ulcers within the nose, and subcutaneous abscesses may form, but without such lymphatic extension as occurs in the acute form. The larynx may be involved and a fatal suppurative meningitis may result, but recovery is not impossible in some cases after a few months.

Chronic Farcy.—In this rare condition large, hard, nodular tumors form in the limbs, which later ulcerate or produce abscesses. There are subperiosteal abscesses, and there may be pus in the knee joints. Pustules form at the margins of the serpiginous ulcers (Stein).

Prevention.—Prevention consists in the killing of infected animals and thorough disinfection of their stalls, harness, etc. After handling such animals the hands and face should be washed with a 1 : 20 carbolic acid solution.

Treatment.—The site of inoculation should instantly be cauterized with strong nitric acid or a hot iron. Farcy buds should be injected with a 1 : 20 carbolic acid solution. Iodoform should be insufflated into the nostrils, or they may be douched with chlorin-water or 1 : 1,000 corrosive sublimate solution. Stimulants and concentrated fluid food should be given. An antitoxin known as "mallein" has been of service in treating glanders in animals. I have seen it tried in one or two cases in man without benefit.

SEPTICEMIA

Some occupations expose the workman to the dangers of septic infections. This is most liable to occur in the handling of putrid or decomposing animal products. C. F. W. Doehring, writing of the

tallow industry in the *Bulletin* of the United States Department of Labor for January, 1903, says, "The workmen freely handle the offal in order to assort those parts which seem unsuited for use. The danger of blood poisoning is very great, but it can be prevented if in such work the men are supplied with gloves."

The making of bone fertilizers is another industry in which the workmen are liable to infection if they happen to have abrasions of the hands. The carcasses of dead horses are largely used for this purpose.

The case of a tanner whose fingers became so badly infected as to necessitate amputation was reported to the New York State Labor Bureau in 1912.

The danger from infection by biting flies or insects which gain access to carcasses of horses or other animals used for bone fertilizers is great. A serious case of poisoning in this manner by a large horsefly is reported in the *Bulletin* of the United States Bureau of Labor (January, 1903, p. 105, No. 44).

Men having open wounds or sores on the hands or arms should be debarred from work in dead animal material such as is used for fertilizers.

Treatment.—Localized septicemia should be treated by free incision, when necessary, of an infective focus, with antiseptic cleansing and dressing. Localized lymphangitis or cellulitis should be treated by rest and the constant external application of compresses of a cold saturated solution of aluminum acetate, or with a 1-40 ichthyol ointment. General septicemia should be met by cardiac stimulation and a diet consisting largely of milk, eggs and beef juice. In some cases the use of autochthonous vaccines should be employed.

VI. MISCELLANEOUS IRRITANTS

LINSEED OIL

Refined linseed oil is prepared by addition of one per cent. sulphuric acid in leaden tanks. It is subsequently boiled and, to enhance its drying or hardening by oxidation, some preparation of

lead such as litharge may be added. In the room in which the linseed is originally mashed and pressed a temperature of 125° F. may be developed (Doehring), but the workmen may be protected from the excessive heat, as well as fumes arising in the boiling process, by drafts of compressed air. With ordinary care there is not much hazard connected with the industry.

OILCLOTH AND LINOLEUM

Linoleum is composed of a groundwork of cloth over which is spread a mixture of linseed or cotton seed oil, resin and ground cork. Various colors are subsequently applied, sometimes containing lead. The cork is very finely comminuted by grinding and makes, owing to its lightness, a very fine floating dust, which also contains fine particles of iron derived from attrition of the grinding machinery. This dust is highly inflammable and explosive.

The oil dries as it oxidizes in the air, and, to hasten the hardening process, various oxidizing agents are added, such as zinc oxid, red lead, or litharge, sugar of lead, manganese superoxid, or sulphurous manganese. The oil mixture is heated to approximately 450° F., during which process irritant fumes are evolved. The mass is stirred by hand with ladles, which brings the workmen into close proximity to the toxic fumes. The linoleum, after pattern painting, is hung on long racks in rooms heated by steam or hot air.

The cork dust is very irritating to the mucous membranes, causing bronchitis. The vapors of oil and volatile resins irritate the eyes, nose and bronchi, causing conjunctivitis, rhinitis, purulent bronchitis, and, as Eulenburg states, they may produce hemoptysis. Burns may result from spattering in stirring the boiling oil. Where lead is added as an oxidizing or hardening agent there is some danger of poisoning from its fumes. The careless handling of the resins may give rise to eczema or other forms of cutaneous irritation.

Prevention.—Prevention should consist in the use of ventilating hoods and exhausts, the covering of boiling kettles and provision for mechanical instead of hand stirring. For cork dust, measures recommended on page 391 for protection against volatile dusts may be employed.

RUBBER

The chief poison to which workers in the rubber industry are subjected is bisulphid of carbon, which is used in vulcanizing, in con-

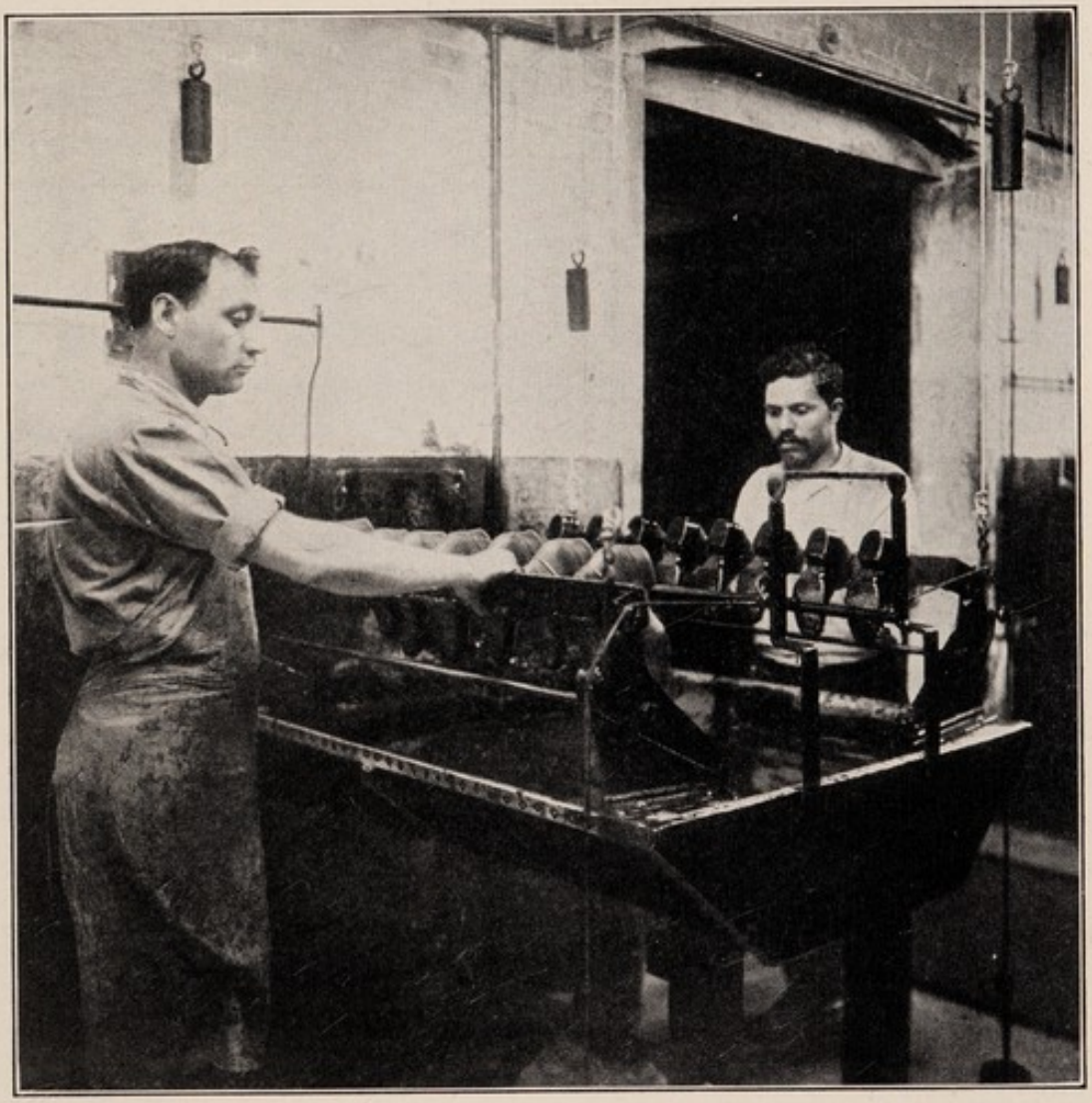


FIG. 88.—VARNISHING RUBBER OVERSHOES. Hazards: naphtha, benzene and wood alcohol inhalation.

nection with sulphur chlorid. (*See* page 360.) The symptoms of this form of intoxication are detailed on page 316. In addition, in polishing and varnishing rubber goods, such as rubber shoes (Fig. 88), naphtha, benzene, wood alcohol, mercury, and various acids are used, all of which develop toxic fumes. In coloring rubber and

whitening it, as in whitening rubber tires, various lead salts and chromates are used.

The smoke of the Brazilian ürucuri fruit, used in obtaining an elastic substance, is highly irritating to the eyes, and cases of total blindness have occurred from it.

SOAP, MARGARIN AND STEARIN

In the manufacture of soaps for textile cleansing and toilet purposes from a variety of fats and oils, such as linseed oil, palm oil, olive oil, etc., sodium and potassium hydrate are employed. Talc, cacao butter, lime, sulphate of iron, various pigments for coloring and "marbling," and, for scouring soaps, powdered silica (*See* page 419) are also used. The processes involve boiling and clarification.

The preparation of margarin and stearin from animal fats is by crushing and tearing the fat tissues, and separating the fats by solution in dilute sulphuric acid, melting with steam in closed drums, etc. With the high temperatures employed, irritant, corrosive and extremely foul-smelling and nauseous vapors may be evolved and inhaled, such as those of acrolein, acetic and butyric acids, pyridin, sulphur ammonium and ammonium cyanid.

Symptoms.—The disease hazards involved in soap and fat-rendering establishments concern chiefly the respiratory and digestive systems, and, according to Heinrich Grün, of Vienna, the former are more prevalent in winter, the latter in summer, which is due in great part to differences in temperature and ventilation. The fatty acids particularly, when vaporized with steam, irritate the larynx, causing chronic laryngitis and cough. Acute and chronic bronchitis also prevail. The workers in the raw fat materials, which are often rancid, suffer much from gastro-intestinal catarrh, with nausea, vomiting and diarrhea. This is in part attributable, according to Grün, to the inhaling and swallowing in the fat-rendering rooms of the hot vapors impregnated with alkalies which neutralize the acid gastric juice and irritate the mucosa. The nauseous vapors further may cause headache, vertigo, abdominal cramps, anemia and malnutrition. The vomitus is usually very foul smelling. Herpes facialis is observed

and fever may be present. Another cause for these symptoms exists in the inhalation and swallowing of the fatty acids, which thereby come into very direct contact with the stomach, irritating it both mechanically and chemically (Grün).

In many cases the gastric catarrh becomes chronic and the patient complains of pyrosis, gastric oppression or pain, a coated tongue, foul breath and anorexia. There may be icterus, phosphaturia and nervous disturbances such as neuralgia and neurasthenia. Toilet soaps which contain perfumery are treated with essential oils, the vapors from which are especially liable when inhaled to induce the above described digestive and nervous disorders. These vapors and the pigments which are added also sometimes give rise to renal and vesical irritation, such as mild grades of acute nephritis and vesical catarrh, with a strong odor in the urine of the essential oils.

It should be remembered that workers in slaughter houses, fat-rendering establishments, etc., work under such gross and unpleasant surroundings that they often are addicted to alcoholism, which is, no doubt, responsible for many of the gastro-intestinal symptoms.

Conjunctivitis is common among soap makers, induced by the irritation of the alkaline and fatty acid vapors. Chronic blepharitis is often observed.

Eczema of the hands and arms arises from contact with the alkaline fatty acid and ethereal oil mixtures to which they are exposed. It also occurs over the abdomen at the waist line from the habit of leaning against the kettles of fat.

The men who clean and prepare the soap fats, which are often rancid, and those who prepare margarin frequently acquire cuts or abrasions which may become infected, showing an erysipelatous eruption with lymphadenitis.

Prevention.—Prevention consists in affording and enforcing means of cleanliness and opportunities for frequent washing. The clothing should be changed before going home, so that all working clothes may be kept in the work place.

The chronic gastritis is best treated by the use of calcined mag-

nesia with bismuth and soda, which tend to neutralize the fatty acids. Mucus may be washed out by lavage or by copious drafts of alkaline Vichy. Occasional doses of calomel are serviceable. (Further treatment of the condition is described on page 155 and that of eczema is detailed under that title.

PART IV

DISEASES DUE TO HARMFUL ENVIRONMENT

I. AIR MODIFICATION

COMPRESSED AIR ILLNESS

Tunnel and Caisson Workers

Historical Experiments and Theories.—Van Rensselaer states: "The first experiment that has been recorded of the employment of compressed air occurred in the beginning of the sixteenth century, when two Greeks, in the presence of Charles V. and several thousand spectators, let themselves down under water in a large inverted kettle and rose again without wetting themselves."

Caissons were first used by the engineer Triger in 1839. He applied them in coal mining through wet strata at Chalons, on the Loire. Shortly afterward the effects of the compressed air upon the workmen and an early study of them was presented by Pol and Wattelle in the *Annales d'hygiène publique,* in 1854. Three years later Hoppe-Seyler advanced the theory that the symptoms of caisson disease are referable to the sudden liberation of bubbles of air which have been forced into the blood by increased pressure. Of the correctness of this view there is no longer any doubt, as it has many times been confirmed both experimentally and clinically.

The first thorough study of the effects of high atmospheric pressure made in this country was conducted by the late Dr. Andrew H. Smith, of New York, in 1873, as a prize essay for the Alumni Association of the College of Physicians and Surgeons.

In 1879 Paul Bert, in "La pression barométrique," demonstrated experimentally that increased atmospheric pressures up to 8

atmospheres are harmless to the circulation and other functions, after which the partial pressure of the oxygen of the absorbed air may exercise toxic effects upon the tissues. He also proved experimentally, what was beginning to be appreciated clinically, that the evil results of compressed air under practical pressures are developed solely through too rapid decompression.

In 1895 Leonard Hill confirmed and added to the experimental work of Bert, and, in 1899, Lorrain Smith showed in animals that exposure to 2 or 3 atmospheres of oxygen for five or more continuous hours may give rise to pulmonary inflammation. No such condition obtains, however, in caissons, where the percentage of oxygen in the compressed air is unaltered. Inhalation of pure oxygen, formerly so much used clinically in pneumonia and other conditions for hours at a time, while it is of doubtful therapeutic value, is certainly not harmful. In such cases much ordinary air enters with the oxygen, as respiratory masks are seldom used.

In 1900 three German experimenters, von Schrötter, Mager and Heller, demonstrated the local ischemia in the spinal cord and elsewhere which is caused by air bubbles, chiefly nitrogen, blocking the circulation in the smaller capillaries, and advocated, for a safety limit, decompression at a fixed allowance throughout of 2 minutes for each tenth of an atmosphere, or 20 minutes per atmosphere. As this would mean a full hour for the decompression of the ordinary tunnel worker in compressed air, it is wholly impracticable, as will be shown further on.

A most ingenious demonstration was made by Leonard Hill. A frog was placed in a small air-tight chamber, with the web of its feet made visible by an arc light projection through a glass window and magnified upon a screen. Quickly raising and lowering the air pressure up to 20 atmospheres and more had no effect upon the rate of capillary circulation, but when sudden decompression was made after long continued complete saturation of the animal's blood with air, nitrogen bubbles developed and became so large as to stop the circulation. Recompression caused these bubbles "to shrink and disappear again." Hill also found that in dog's blood "one per cent. of nitrogen is dissolved per atmosphere." Rats were killed by rapid

recompression from 10 atmospheres. They were then decapitated and their bodies chopped up under water. The liberated gas, collected under a funnel, was found to contain: nitrogen, 80 to 87.2 per cent.; 10.7 to 16 per cent. carbon dioxid, and only 2.1 to 4 per cent. oxygen, because the oxygen absorbed under pressure unites chemically with the blood and is not again liberated. Hence "oxygen bubbles are not a factor in caisson sickness." Hill found that in animals killed by rapid decompression from 7 or 8 atmospheres, gas bubbles form in the fat droplets of the tissue cells, such as the liver and kidney, which actually vacuolize and disrupt the structure of the tissue cells. The liver and kidneys may appear "foamy with bubbles in such a case." He found the alveoli of the lungs ruptured by the violent air expansion, causing emphysema. Such lesions have been observed in men killed by a caisson bursting. Boycott and Damant, of the British Navy, have shown that fat animals are much more seriously affected than lean, and Hill confirmed this observation upon fat and lean pigs. In 1907 Vernon, of Oxford, demonstrated that oils and fats exposed to one atmosphere of increasing pressure absorb 5 times as much air as does water. Haldane showed that "fat dissolves about 6 times as much nitrogen as blood," and animals after death from decompression show many fine gas bubbles in the fat tissues.

The obvious conclusion is that fat men run great risks in caisson work, and caisson workers should not eat much fat-forming food.

Pure oxygen inhaled under high pressure was shown by Bert to affect profoundly the central nervous system, causing convulsions, and Hill found that continuous exposure to 7 atmospheres of air—which is equivalent to 170 per cent. of an atmosphere of oxygen—causes fatal pneumonia, which "can be prevented by using nitrogen to dilute the air, and so lowering the partial pressure of oxygen," but "it is quite safe to breathe one atmosphere of oxygen, equivalent to 5 atmospheres of air, for 3 to 4 hours." As a matter of fact, this is precisely what tunnel workers in compressed air sometimes do, although their usual shift is 2 hours. Men wearing the Fleuss rescue hoods in mines frequently breathe pure oxygen for as long a time, but under moderate pressure.

So long as the lungs receive enough oxygen for the needs of the system, as Hill says, "man cannot be fanned into a greater rate of activity by breathing oxygen," but, on the other hand, greatly increased pressures of oxygen are toxic, lowering metabolism and checking carbonic acid elimination.

The accumulation of carbon dioxid in tunnels and caissons under pressure has been much discussed as a possible factor in compressed air disease, but the heat and moisture of the air are more important factors of discomfort, for there is little motion of the caisson air to promote evaporation from the body surface. In a long tunnel, moreover, the lack of motion in the air results in considerable accumulation of exhaled carbon dioxid in the zone nearest the workmen. Personal comfort is much promoted by the use of electric fans to keep the air in motion, thoroughly mix it, and favor evaporation from the body, even, as Hill found, when the carbonic acid gas may rise to 4 or 5 per cent. in the chamber. These unfavorable conditions naturally promote fatigue and cause discomfort, but it should be borne in mind that caisson and tunnel workers are hardy men, in previous robust health, and their hours of actual work are so short that they can withstand unfavorable atmospheric conditions which would soon become intolerable if maintained continuously for longer periods.

Nevertheless, fatigue adds to the hazard of decompression, because of the coincident depression of the functions of respiration and circulation. The decompression chamber is always relatively cool, owing to the expansion of the air, and, if the outside air be winter air, the shock to the peripheral circulation by the vasoconstriction induced by cold is considerable. Hence one is apt to feel chilly on coming out of a caisson. I have observed this personally on coming out of less than an additional atmosphere of pressure.

For these reasons it is desirable for the caisson worker in cold weather to remain for a time in a warm room on leaving the caisson, and in the caisson the wet bulb hygrometer should not be allowed to register above 75° F., and preferably 70° F. Where this is not possible electric fans should be operated to promote evaporation from the bodies of the perspiring laborers.

In 1890, while engaged in physiological research in the Loomis Laboratory in New York, I conducted a series of experiments upon animals under heavy pressures of normal air and pure oxygen in a small cylinder which I adapted for the purpose from a locomotive piston cylinder. I subjected frogs, pigeons, cats, dogs, guinea pigs and monkeys to pressure, varying it up to 8 atmospheres or 120 lbs. There were no essential differences in any of these animals in their behavior under high pressures, nor was there any apparent difference in symptoms resulting from pure oxygen under pressure as compared with normal air under like pressures. The animals were observed through glass windows in the ends of the caisson. When pressure was first turned on they became restless, but soon after 4 atmospheres were reached they became very drowsy and usually evacuated both urine and feces. On passing 7 atmospheres usually, and on reaching 8 atmospheres invariably, convulsions ensued while the animal was still within the caisson. I experimented with decompression both uniform and interrupted, and even when made very rapidly, as in the case of a monkey, reducing the pressure at the rate of an atmosphere a minute, paraplegia did not follow, and after recovery from a slight chill the animals were as lively as normal upon removal from the caisson.

Of course such conditions with animals at rest are very different from those under which men are doing hard labor in tunnel and caisson work. Nevertheless, the lower animals appear considerably less susceptible than man to sudden great alterations in atmospheric pressure. In the old Hudson River tubes, built many years ago and abandoned, mules were kept for several months continuously under pressure, but suffered in no wise therefrom. On final decompression a few, W. E. Moir states, had the "bends," but soon recovered completely.

My own experience in experimenting with the smaller animals, which showed that they differ very little from one another in the symptoms produced by varying air pressures, is confirmed by William Japp, who says, "Our own experiments showed that we could produce no obvious effects in mice, and very few in rabbits, rats and guinea pigs, by sudden decompression after exposures at pressures

which were invariably or frequently fatal to goats," the average respiratory exchange of which he shows to be about two-thirds more than that of man. This may account for some discrepancies shown by experiments on these animals.

Structure and Mode of Operation of the Caisson.—A caisson is a large box, usually made of wood, iron or concrete, which is weighted on top and sunk, by aid of a bottom cutting edge, into mud, sand or earth, either at the bottom of rivers or in moist earth, which would cave in unless the moisture is kept out by air pressure. (Fig. 89.) If lowered to a river bed, the caisson may be built on a raft or pontoon which is weighted. As the structure sinks, the pontoon is removed from underneath and the caisson is continually built up at the top as it gradually sinks to the bottom. It is often reinforced by driving large piles at the corners, to keep it upright and in place. The caisson is fitted with a hoisting shaft through which excavated material is removed, and a shaft for descent of the workmen, both of which are, of course, furnished with locks. (Fig. 90.) There must also be an exhaust pipe for pumping out water, a series of pipes, usually 4 inches in diameter, for supplying compressed air, electric light wires and some form of signaling system. The necessary pumps to operate these systems may be placed on a boat anchored in the river, or near by on shore, or, if the caisson be sunk on land, as in excavating for a "skyscraper" building, through wet sand, they are placed anywhere near at hand.



FIG. 89.—CAISSON USED FOR BUILDING FOUNDATIONS.

There is also constructed a small house in which the workmen, who are called "sand hogs," may dress for the work and in which they may be warmed on coming out of the air locks. In large caissons 2,000 or 3,000 cubic feet of air may have to be forced in per minute. Timber for shoring and concrete for building tubes or foundations may be let into the caisson through a shaft. Telephone connection is sometimes installed at the bottom of the caisson.

In the smaller caissons sometimes only one shaft and lock is installed for both men and material. According to T. Kennard Thomson (*Scientific American Supplement,* No. 1711, Oct. 17, 1908), a bucket may get jammed in such a shaft. He says, "This has frequently happened, keeping the men in the compressed air for 10 or 12 hours overtime, sometimes with very dangerous results," for they are fatigued, without food, and in great anxiety. In the small caissons used for foundations of tall buildings the men work, according to Mr. Ryan, at pressures varying from 32 to 42 lbs. above the atmosphere. They usually work in 3-hour shifts with 3-hour intervals. (Fig. 91.)

In digging out the floor of the caisson the men begin at the center, "leaving a small bench around the cutting edge, and then removing this just before they are ready to let the caisson

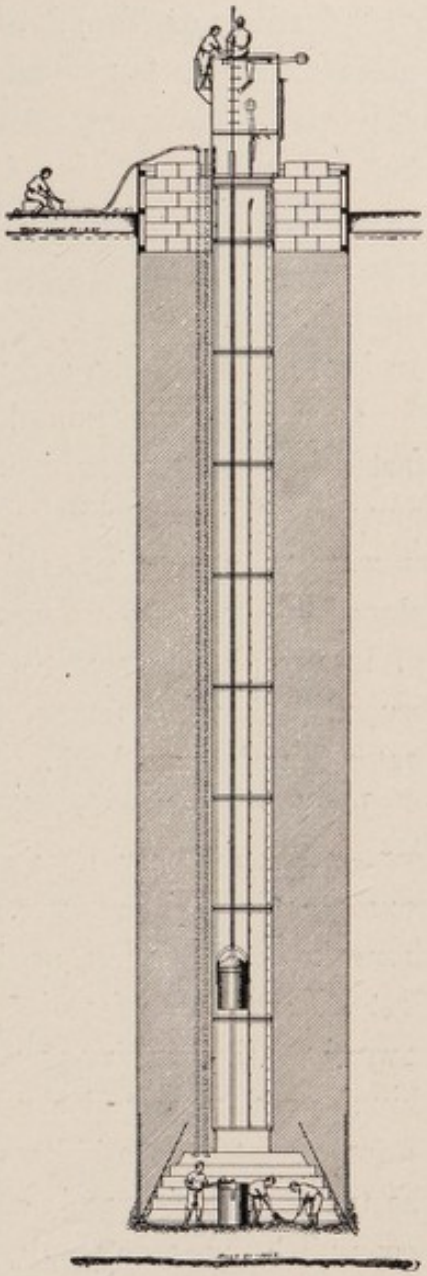


FIG. 90.—CROSS SECTION OF CAISSON IN FULL OPERATION. Workers, "Sand Hogs," at bottom of caisson work under atmospheric pressure sufficient to prevent water from flowing in as the sand is shoveled up. Hazard: compressed-air illness, caused by too rapid decompression, as in going suddenly out into the normal atmosphere.

sink further, or 'drop,' which is accomplished by lowering the air pressure for a few moments." (Thomson.) In tidal rivers, in weighting the caisson, allowance must be made for the rising tide, or the caisson may be ripped from its bed and the men may be killed. In an accident of this sort in the Hudson River Tunnel a workman was shot out into the river, but managed to float to the top and was rescued. On the coast of Nova Scotia, where the tides are very high, an iron caisson broke away and was lost in the sea.

It requires one pound of atmospheric pressure to hold back 2 feet 4 inches of water, i. e., every 33 ft. of water pressure must be countermet by an additional atmosphere, or 15 lbs. of air pressure, or water will leak into the caisson. The ordinary air pressure employed for subaqueous work is about 32 lbs. above the normal, or 47 lbs. in all, but sometimes a pressure of 10 or even 15 lbs. more becomes necessary temporarily where shifting quicksand as well as water is to be held back.

Effect Upon the Workmen of Compressed Air in the Caisson.—When a workman enters the air lock the air at first is of course at normal pressure. He closes the door, which is kept shut from the inside as soon as the air pressure begins to rise. There is at first a sensation of pressure at the ear drums, which are forced inward by the air pressure. If the man closes the nostrils with his thumb and finger and closes the mouth, and attempts to expire, air is forced into the middle ear through the Eustachian tube, so that the tympanic pressure is equalized. An attempt at swallowing may accomplish the same result, if the nose and mouth be closed, by opening the Eustachian tubes. If the workman is unable to do this for any reason, as when he has a cold and the Eustachian orifice is swollen or plugged with mucus, the tympanum may rupture with agonizing pain. Hemorrhage also may take place into the middle ear. Rarely one of the cerebral vessels may burst if the pressure of the air be too rapidly augmented. The sinuses connected with the nose, if occluded by catarrhal exudate, may give rise to pain from modifications in air pressure.

At low pressures, not above 32 lbs. more than the atmospheric, or 47 lbs. in all, workmen may remain in the caisson 8 hours a day,

with a half hour for lunch, but at over 3 or 4 atmospheres of pressure, 47 to 60 lbs., they can only work 1½ to 2 hours twice a day, with a rest of 4 hours between. One of my patients, who had paraplegia,

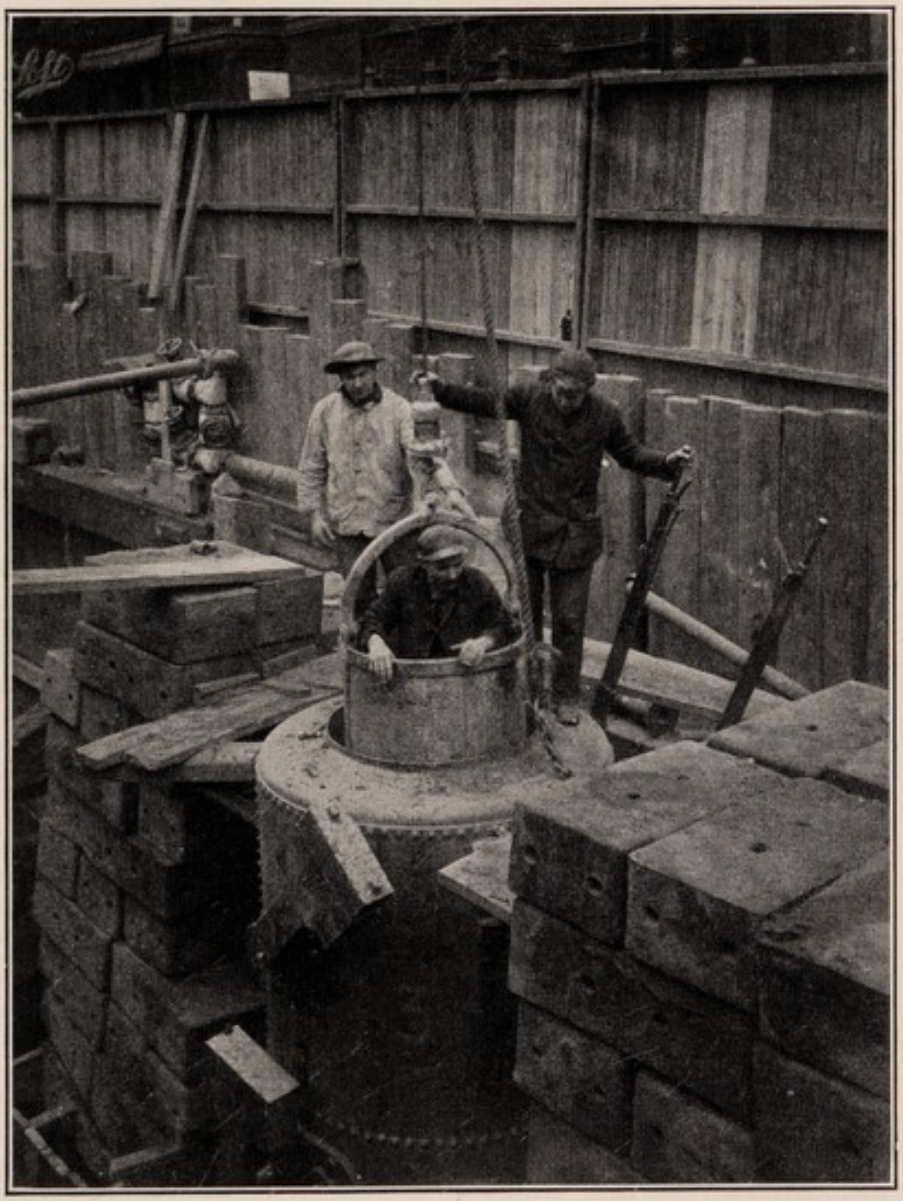


FIG. 91.—SMALL CAISSON SHOWING WORKMAN DESCENDING IN BUCKET INTO THE FIRST LOCK.

had been working for 2-hour periods under 4 atmospheres under the Hudson River, where the New York City aqueduct was being laid at great depth.

T. K. Thomson says, "It is very rare for a man to be paralyzed while in the air chamber, though some have been killed the first time

they have entered, and before they could get out"; and some experienced men claim that they can tell when they are going to get the "bends," or be paralyzed, while still under compression, in spite of the assertion of several writers and experimenters that all forms of caisson disease are contracted "only during decompression."

Hersant, in the Bordeaux harbor caissons, in 1895, tried the experiment successfully of keeping a man under 76.8 lbs. pressure for one hour, consuming ¾ hour to reach this pressure and 3 hours for decompression.

There are no noticeable effects upon blood pressure in man while in the caisson, or upon the rate or force of respiration. Sweating is common, because the compressed air is increased in warmth.

There are some differences which should be borne in mind as to the effect of working in tunnels under compressed air and in the small caissons sunk for making foundations for bridges, "skyscrapers," etc. In the long tunnels bulkheads or cross partitions often are constructed, thus subdividing the tunnel into two or more parts which may be kept under different pressures. Thus, in coming out from the furthest compartment, where pressure is highest, the workman is subjected in the next compartment to an interrupted lowering of pressure. Moreover, in a long tunnel, perhaps half a mile in length, the workman has to walk considerable distances. Many more workmen (sometimes over 100) are together than in the small caisson (Fig. 92), which often holds only one man, as shown in Figure 91, and the air is contaminated with fumes from blasting powder, dust, smoke, carbon dioxid, and sometimes gaseous products of decomposition or organic matter in the river bed. Other symptoms may therefore arise, not due to the air pressure alone. In the small caisson, on the other hand, most of these conditions do not obtain, and the workman is in a confined space, subject only to his own exhalations, for if he sets a blast he must come out, for he cannot retreat otherwise to safety as the tunnel worker may.

The percentage of carbon dioxid present in the caisson serves, to some extent only, as an index of the quality of the air breathed. Hill and Greenwood claim that this may reach 2 per cent. without

harm, and records of the Pennsylvania East River Tunnels failed to show that the percentage of CO_2 had anything to do with the occurrence of compressed air illness. Considerable carbon monoxid was developed in blasting, but this was not shown to be in any way



FIG. 92.—TUNNEL WORKERS IN COMPRESSED AIR. Note the electric lighting and tubes for supplying air and for exhaust ventilation.

made more toxic by the air compression in which it necessarily shared.

Pathology and Morbid Anatomy.—PATHOLOGY.—The men perform hard work, digging, lifting rocks, etc., under an atmospheric pressure of 30 to 45 lbs. or more, i. e., from two to three atmospheres. They enter successive air locks wherein the pressure is slowly increased, and they should come out as slowly, but they are always in a rush to get out after their two-hour shift, and coming out too quickly has the effect of stepping into a gigantic cupping glass, i. e., their blood and respiratory organs, being saturated with air at 45 lbs. of pressure, they suddenly step into the normal 15 lbs. pressure.

Just what happens under these conditions is best explained in the words of Dr. Keays as follows: "The blood of a man or animal when in compressed air takes into solution an increased quantity of oxygen and nitrogen from the air, the quantity of gases absorbed being in direct proportion to the increase of pressure. The gases taken up by the blood are gradually distributed to the fluids of the various tissues. With rapid decompression the nitrogen gas bubbles off in the blood and is eliminated by the lungs. These bubbles act as emboli and block up the capillaries in one or another part of the body, and by cutting off the blood supply, or by direct mechanical violence, cause the various symptoms of compressed air illness. The symptoms may be prevented by making decompression slow enough to allow the absorbed nitrogen to escape from the lungs. The blood supply of the central nervous system suffers proportionately the most, perhaps because of the fact that the blood vessels of the brain and spinal cord are contained within the unyielding bony structures of the cranium and spinal column. Hence it is that the symptoms, although varied, are mainly referable to the spinal cord and its nerves." The size of the nitrogen bubbles and the rapidity with which they are liberated are in direct proportion to the rapidity of decompression.

Body saturation varies in length of time, and the fat tissues become saturated much more slowly than the others, for the blood supply of fatty structures is relatively poor, and Haldane and Boycott estimate that its coefficient of nitrogen absorption is six times greater than that of other body tissues or fluids. They estimate that the average human body may become half saturated with nitrogen under high pressure in 25 minutes and the entire body in an hour and a half. Keays places the limit for full saturation much later, making it about 3 hours for workmen under a pressure of 32 atmospheres above the normal; hence little if any more gas is absorbed after that period. The practical bearing of this subject is shown in the fact that many of the severer cases of "bends" follow the comparatively brief exposures of men working in the shorter shifts. The symptoms, therefore, are proportional to the duration of exposure to the pressure only up to the period when saturation has been reached,

and Keays believes that better results may be obtained by working a continuous 6-hour shift, for example, than by dividing it into 3-hour periods. Doubling the number of decompressions doubles the risk.

Morbid Anatomy.—The post-mortem findings comprise two classes of cases: (1) Those cases in which death has been sudden and in which the blood and tissues are found saturated with gas, but in which there has not been time for organic lesions to develop. Of this group von Schrotter collected 11 in the literature reported prior to 1897, and Keays has added 8 more from personal experience. (2) Those cases in which death results after protracted illness. In this group spinal cord lesions of disseminated and transverse myelitis with hemorrhages are present, with such usual complications of these lesions as pneumonia, cystitis and pyonephrosis, with trophic disturbances such as bed-sores, purpura, etc. Von Schrotter found 20 such cases reported in the literature prior to 1897, and Keays has added two more. In a certain number of rapidly fatal cases no lesion is discoverable, and Keays supposes this to be "due to the involvement of vital centers by emboli too small to be detected."

Howard Van Rensselaer, in an exhaustive study of 27 reported autopsies upon victims of compressed air illness, says they "permit the conclusion that most, if not all, cases of caisson disease are due to lesion of the cord, which attains its greatest intensity in the lower dorsal region, and which attacks the white matter rather than the gray, and which is of a degenerative nature, or due to a diffuse parenchymatous myelitis. The greatest amount of degeneration occurs in the posterior and adjacent portion of the lateral columns, diminishing anteriorly so that the anterior columns are but slightly affected; the gray matter being for the most part normal. Even in the most intensely degenerated portion there is no total destruction of all the nerve substance. Above and below this area of disease in the lower dorsal region are, respectively, the usual ascending degenerations of the columns of Goll and the direct cerebellar tract, and descending degenerations of the pyramidal tract."

Symptoms.—As stated above, workmen under compressed air rarely show serious symptoms while under compression, although there are occasional exceptions. It is upon leaving the tunnel or

caisson that the symptoms are manifest, either immediately or sometimes after an interval of half an hour, or rarely several hours. In either case the symptoms begin with great suddenness. The patient doubles up with weakness and vertigo and pains in the back and legs, and cannot stand erect. Hence the names, "the bends," "screws" and the "staggers," which the workmen apply to their symptoms. Shortly afterward complete paralysis of the legs, and sometimes of the arms, results, and the disease is often never recovered from. In some cases there is painful constriction of the chest, which the workmen term the "chokes." Some patients are benefited by putting the victim back into the high pressure, which stops liberation of the bubbles, and then very slowly liberating him, for the symptoms almost never occur while under compression. In many cases, unfortunately, more or less permanent paralysis results. In cases with cerebral hemorrhage there may be aphasia, and coma may also result. Subcutaneous hemorrhages sometimes occur. In many cases there are pains in various parts of the body besides the back, as in the abdomen, head or arms, and the arms may become paralyzed exceptionally.

The symptoms in detail cannot better be stated than by quoting again from the large experience of Keays, which comprised 3,692 cases, in which he classifies the symptoms in groups as follows:

	No.	Per Cent.
A.—*Cases showing pain in various parts of the body, "bends"*	3278	88.78+
Cases with pain also having local manifestations	9	.26+
B.—*Cases showing pain and prostration*	47	1.26+
C.—*Cases showing symptoms referable to the central nervous system:*		
1. Brain (hemiplegia)	4	.11+
2. Spinal cord:		
(a) Sensory disturbance	36	
(b) Motor disturbances	34	
(c) Sensory and motor disturbance	10	
Total (Spinal cord)	80	2.16+
D.—*Cases showing vertigo, "staggers"*	197	5.33+
E.—*Cases showing dyspnea and sense of constriction of the chest, "chokes"*	60	1.62
F.—*Cases showing partial or complete unconsciousness with collapse*	17	.46+
Grand total	3692	99.98+

		No.
Fatal Cases	Group B.....	6
	Group C.....	5
	Group F.....	9
		20 or .54+ per cent.

In exceptional cases localized subcutaneous emphysema has been observed. Erdman met with this symptom twice, occurring in the leg, and Keays records 9 cases.

There is great variability in the mode of occurrence of the symptoms of compressed air illness and the results of treatment. The same man may suffer less from high pressures on one day than he has previously with much lower pressures. Moreover, methods of treatment, successful on one occasion, may fail completely on another. There is no means of forecasting what the effect may be in a given case on different days.

T. K. Thomson, engineer to the Harlem River caissons in New York, reports the following very interesting observation (*Scientific American Supplement,* No. 1711, Oct. 17, 1908): "In sinking caissons in the Harlem River we found that men suffered severely from the bends while passing through the foul silt and just below the bottom of the river, and that when this material had been passed through and the caisson had entered the clean (no sewage mixture) clay, the trouble with the bends disappeared, although the pressure was necessarily very much greater."

Observations of this kind illustrate the complexity of the problem of explaining all the phenomena of compressed air illness, and I have heard both Dr. Keays and Mr. Ryan state that the more one studies these phenomena the more difficult of explanation they become. In the example of the Harlem River caissons, doubtless foul gases from sewage or other decomposing organic material, sulphuretted hydrogen, marsh gas, carbonic acid gas, etc., contributed to the hazard, so that the mere formation of bubbles, which may act mechanically by obstructing the circulation, does not completely explain the phenomena. When such noxious gases arising from blasting or candles obtain access to the atmosphere of a caisson they, too,

are placed under partial pressure, together with the chemically inert nitrogen of the air, and doubtless exert powerful chemo-toxic effects on the tissues of the body.

Thomson points out that, in excavating, air is constantly passing out from under the cutting edge of the caisson and is replaced by fresh air from the compression pipes, thus maintaining a fair circulation in the caisson. When a concrete floor has been laid, however, this air escape is checked, the air supply in the caisson becomes foul, and the size of the air space is diminished by the concrete foundation. In such cases, Thomson writes, "Sometimes old-timers have gone in to uncouple the bolts in the upper sections of the shaft and in a short time have been taken out dead." They are, no doubt, killed as much by the foulness of the air as by the compression, or, in other words, the breathing of compressed foul air is naturally much more promptly fatal than the breathing of pure air under the same pressure. Hence in such cases the effect is due more to chemical changes in the tissues than to mechanical effects of bubbles. In an illustration cited by Thomson a rubber pipe once caught fire, and, the fumes being forced into the chamber, the workmen barely were rescued. In another case the fumes of a blast penetrated an adjoining air chamber where were a number of workmen under pressure, one of whom was taken out killed.

From the experiments on bubbles in the circulation, above cited, Hill offers an explanation of the recurrence of symptoms after recompression, unless subsequent decompression be made extremely slowly. It is that, owing to coalescence of some of the air bubbles in the capillaries to form larger ones, "on recompression some of these bubbles persist when the pressure is raised again to +90 lbs., and enlarge again on lowering the pressure," hence the reason for very slow redecompression after coming out of the medical lock used for treatment.

Symptoms of any kind rarely occur in workmen who have not been exposed to more than one additional atmosphere of pressure even for 6 or 8 hours, and fatal results are rare below 2 atmospheres or 30 lbs. pressure above the normal. Keays met with one fatal case at 28 lbs. and one at 29 lbs., and among more than 4,000 workmen

employed at an average of 32 lbs. pressure there was an average of nearly one per cent. of instances of compressed air illness. The men who enlist in tunnel and caisson compressed air work in this country are usually Irishmen, Swedes and negroes. They work hard and eat well, so that, Thomson says, "we seldom see a lean sand-hog."

Personal idiosyncrasy plays a considerable rôle in the acquisition of caisson disease, and Keays found that occasionally new workmen who appeared perfectly sound promptly succumbed to the disease, and, on the contrary, it happened occasionally that long-tried workmen who had never shown symptoms under high pressure would be attacked while working under identical conditions to which they had been accustomed, but with lower pressure. In a series of 190 cases reported by Silberstern in Weil's "Handbuch der Arbeiter Krankheiten," 1908, there were 94 with pains in joints and muscles, 35 with spinal cord symptoms, only one of which showed permanent paralysis, 17 cases of Ménière's syndrome, 5 cases of other cerebral symptoms, and 27 cases of tympanic or middle ear affection. In addition were 12 cases of asphyxia, only two of which proved fatal.

Dr. Peter Bassoe, in a *Report on Compressed Air Disease,* published by the Illinois State Commission on Occupational Diseases (January, 1911), tabulates the symptoms of the following cases recorded in St. Louis and Chicago as follows:

"Of the 161 cases, 87 had various affections of the ear, and 65 of these had resulting impairment of hearing, some of them also more or less permanent ringing in the ears. One hundred and forty-one had pains, chiefly in the limbs, and very severe at first, the so-called 'bends.' Thirty-four had paralysis, which was generally temporary, though three men have permanent partial paralysis of one arm and two of the legs. Eleven were left with considerable stiffness and pain in bones and joints. Twelve presented symptoms of some degree of permanent disease of the spinal cord. Thirteen were delirious or unconscious during the acute attack. Thirty-three complained of dizziness as a prominent symptom, six of vomiting, and eleven of incontinence or retention of urine. Five had numbness without paralysis. Six had 'blind staggers' and two had 'chokes.' From

reliable sources it was learned that three men, two of them negroes, died this year of compressed air disease at East St. Louis (Mississippi bridge), and one during the construction of the Traction bridge at St. Louis."

Clinical Cases.—One of the caisson patients shown at my clinic, in 1906, was a Russian, 33 years of age. He was not syphilitic or alcoholic. He had worked in a tunnel in Chicago under air compression, and had been attacked with numbness and weakness in the feet and legs, with occasional darting pains. He managed to work on, however, until some time later he experienced the same sensations in the arms. His head felt "heavy," he had vertigo and more or less epigastric pain. He next acquired incontinence of urine and feces. He complained also of mental depression and lack of concentration of mind. When seen four months later the same symptoms persisted.

Another patient whom I saw in the Presbyterian Hospital had paraplegia and complete suppression of urine, which lasted four days, when he died.

Another patient seen in 1909 was attacked during a period of caisson work with severe pain radiating from the right hip down the leg which had lasted six months at the time the case was first seen.

My colleague, the late Dr. Andrew H. Smith, reported a case seen, in 1894, in the Presbyterian Hospital of a caisson worker who had extensive purple mottling of the skin, which disappeared under friction, indicating vasomotor paresis. In addition were some true ecchymoses.

Prognosis.—Recovery from the milder symptoms of moderate pain and other sensory disturbances, vertigo, nausea, chilliness, etc., is usually prompt and complete within a short time under treatment. Complete paraplegia and suppression of urine may be recovered from, even after the lapse of two or three days. In other cases recovery from paraplegia may be only partial, leaving a spastic type of paraplegia, and most of the cases of this type which do not improve in the medical lock linger along for several weeks while the myelitis is progressing, and finally succumb to static pneumonia or infection through bedsores or cystitis and pyelitis or

pyonephrosis, following the repeated catheterization which is necessitated.

One of my patients who entered Bellevue Hospital about two years ago had been working 400 feet below the surface of the Hudson River, where the tunnel for the Catskill aqueduct crosses. He had worked under 4 atmospheres of air pressure and had complete paraplegia, with almost complete suppression of urine. His arms were unaffected and he had no constant pain when seen, but the legs were thrown into painful spasm when passively flexed. To my surprise, he made a complete recovery after a week, the urinary secretion being resumed on the second day. He had had 3 or 4 previous severe attacks of the "bends," but, tempted by wages of six dollars to eight dollars a day, he insisted against advice on returning to work, which he should not have been permitted to do.

Another patient, with complete paraplegia and retention of urine, gradually grew emaciated and died after 8 weeks of asthenia.

Twenty years ago, before the use of the "medical lock" for recompression, in the boring of an attempted tunnel under the Hudson River, 12 deaths among half a hundred workmen took place, besides a number of non-fatal cases, some of which came to my service in the New York Hospital.

In the building of the Ead's bridge across the Mississippi River at St. Louis many deep caissons were required. In the work 600 men were employed, of whom 119 (20 per cent.) acquired compressed air illness, with 14 deaths among them. Von Schrötter collected from the literature 137 fatal cases reported between 1854 and 1897. ("Die Luftdruckerkrankungen," Wien, 1900.)

Dr. Frederick L. Keays, of my staff, in 1909, in the *Researches* of the Medical Department of the Cornell University Medical College, in the most complete treatise on this subject which has yet appeared, describes 3,692 cases, with 20 deaths, and many cases of permanent disability, among the 10,000 caisson workers who came under his observation, who were employed in four of the great river tunnels constructed by the Pennsylvania Railroad Company—the most extensive work of the kind ever undertaken under compressed air.

On the other hand, Japp found, in 1909, among 330 employees in one of the East River Tunnels, that with stage decompression combined with the exercise of walking experienced workmen ran very little risk. Under the new compulsory reporting law for occupational diseases there were reported 8 cases in the State of New York in the year 1911-12.

Decompression Methods.—There are two distinct methods of decompression, (a) that of Haldane and (b) that advocated by Keays and the majority of those who have had large practical experience with workers in compressed air. These methods may be described respectively as (a) interrupted or "stage" and (b) continuous or uniform decompression.

(a) Stage Decompression.—Haldane's method of rapid partial half decompression and subsequent interrupted slow decompression is illustrated diagrammatically under the heading, Divers, on page 496. This system he worked out theoretically, experimentally with goats, and then practically upon divers with great success. In applying it to caisson workers, with whom he has had less practical experience than Dr. Keays and others, he admits that the conditions are somewhat different, for in the diver saturation of the body with nitrogen, owing to the relatively short exposure, is always incomplete. In the caisson the pressures are usually, though not always, less high, but the duration of exposure is always longer, 2 to 3 hours or more. Dr. Haldane said, in a lecture before the Royal Society of Arts in 1907, "Bearing in mind these circumstances, it seems desirable to adopt a somewhat slower rate of decompression in the case of caisson workers than in the case of divers, and to make the decompression more gradual toward the end" and "the slow part of the decompression then becomes theoretically very nearly uniform, so that a uniform rate may well be adopted." With only one additional atmosphere of pressure it is quite safe to decompress in 3 minutes without any slow stage, for accidents under this pressure are very rare. To avoid injury to the ears, however, at least 3 minutes should be taken for this single additional atmosphere of pressure reduction. With a higher pressure of, say, 55 lbs. of absolute pressure, by Haldane's method the reduction should be

to one-half or 27½ lbs. absolute pressure in 3 minutes, followed by 7 periods of 12½ minutes each, or 88 minutes after 3 hours of work. For 6 hours he would require 112 minutes for the second stage, or almost two hours. Where men return to work in a tunnel the same day for a second or third shift he suggests the construction of a large chamber kept at a low pressure, where they could wash, eat luncheon, etc., and save the time lost in emerging into normal air. The pressure in this chamber could be maintained at about ⅓ or ½ an atmosphere above normal. This would add construction expense, but in long tunnels with work extending over months, much of the workmen's time would be saved.

Hill and Greenwood ("Caisson Sickness," Longmans, New York, 1912) compared Haldane's method with the uniform decompression method by experiment upon animals and found little or no advantage in his method in cases of long exposure to the pressure.

(b) Uniform Decompression.—Keays' experiments are far more conclusive, having been conducted where about 1,000 men daily were employed for more than 500 days in the Pennsylvania tubes. One minute for each two pounds of pressure was the uniform decompression rate, and he strongly advocates the uninterrupted method. The difficulty of making workmen take sufficient time for safe decompression is very great, especially under low pressures. The French caisson physicians favor requiring 20 minutes for both compression and decompression for each added atmosphere, but practically up to two additional atmospheres the workmen insist on being released in 5 minutes.

In January, 1912, a law was introduced in the New York State Legislature, having, among others, the following provisions controlling work in compressed air: (1) For absolute pressures up to 28 lbs. duration of labor must not exceed 8 hours a day, with at least one return to open air for half an hour; (2) between 28 and 36 lbs. absolute pressure work is limited to two daily periods of 3 hours each, with one hour interval between; (3) between 36 and 42 lbs. work is limited to two daily periods of 2 hours each, with a 2-hour interval; (4) between 42 and 46 lbs. work is limited to two daily periods of 1½ hours each, with a 3-hour interval; (5) between

46 and 50 lbs. work is limited to two daily periods of one hour each, with 4 hours' interval; (6) work in pressures above 50 lbs. is prohibited "except in case of emergency"; (7) every workman in tunnels must undergo decompression in a lock at the rate of 3 lbs. every two minutes unless the work has been done at or above 36 lbs., when the decompression rate shall be one pound per minute; (8) in caisson work the decompression rate for work up to 10 lbs. pressure is one minute, from 10 to 15 lbs. 2 minutes, 15 to 20 lbs. 5 minutes, 20 to 25 lbs. 10 minutes, 25 to 30 lbs. 12 minutes, 30 to 36 lbs. 15 minutes, 36 to 40 lbs. 20 minutes, 40 to 50 lbs. 25 minutes; (9) a competent physician must be in attendance during the work, and all employees must pass a medical examination at the outset of work, and be reëxamined after every period of absence exceeding 10 days; (10) no alcoholic workman may be employed; (11) novices must begin with half-time work and be reëxamined physically; (12) at intervals of 3 months' work each employee shall be reëxamined; (13) dressing rooms must be provided, heated, lighted and ventilated, with lockers, baths, hot and cold water and a sanitary toilet; (14) a medical lock shall be maintained in charge of a trained nurse; (15) double systems of air pipes and electric lighting are required. New York State is the only one thus far in which such provisions have been made.

In the subaqueous work, during decompression, the air often becomes quite cold and foggy, which adds much to the objection the workmen have to prolonging the time. In the tunnel between New York City and Brooklyn, according to Walter I. Aims, heated air was supplied during decompression, which he believes contributed to the comparatively low rate of illness in that work.

It is easy to write out formulas for the time required for decompression after exposure to air pressures of varying degree and duration. It is quite another matter to compel workmen to follow them, and intelligent constant supervision of their work is most important.

Prevention.—Conclusions Formulated from the Preceding General Statements.—The longer the workman is employed in the caisson the more gas is absorbed by his blood. The greater the air pressure, the greater the danger from absorption. The quicker

the release from the pressure the greater the danger. The greater the muscular fatigue, the greater the danger. The more rapid the increase of pressure the greater the danger. It is dangerous to work in a caisson while having an empty stomach. The lower the external temperature on leaving the caisson, the greater the danger from chills and circulatory disturbance. Very stout workmen and anyone having weak lungs, weak heart or arteriosclerosis should positively be excluded from caissons. Boys and men past 40 years of age and all alcoholic persons should be excluded positively from the work.

An important precaution followed by Keays in the Pennsylvania tunnels has often been neglected elsewhere. This consists in subjecting all new caisson workers to a preliminary test, by exposing them to 30 lbs. of pressure for 90 minutes without work and then decompressing them at the rate of 2 lbs. per minute, or 15 minutes for the entire decompression period. Should any mild symptoms develop, such as slight pains or weakness in the legs, the workman is discarded as unfit.

All caisson men should be thoroughly instructed as to the hazard of their work, and cautioned not only to be patient with slow decompression, but to refrain during their period of work from drink, over-fatigue and unhygienic modes of life of every kind. They should undergo thorough physical examination at least as often as once a week.

The Austrian Government regulations are as follows:

(1) Going into the caisson, at least 20 seconds must be allowed for each 0.1 atmosphere of pressure increase.

(2) Coming out of the caisson, for every 0.1 atmosphere of increased pressure up to 30 lbs. absolute pressure, 1 minute must be allowed, and for every 0.1 atmosphere thereafter, 2 minutes' time for decompression.

(3) Only 5 persons are allowed simultaneously to undergo compression and decompression. [Which is impossible where tunnel work is conducted upon a large scale.]

(4) Pressure must be uniformly increased and diminished and fresh air must be supplied.

(5) On emerging the workmen must go to the barracks, take warm soup, and keep in motion for 15 minutes.

Working in marl and asbestos requires special precautions as to ventilation.

Treatment.—In all serious cases the patient should be returned at once to the medical lock, which should be provided wherever many caisson workers are employed. Barracks for the workmen should be near at hand, for everything depends for successful treatment with the medical lock upon returning the patient to it as promptly as possible. If he is attacked by symptoms after a long walk to his home, it may be too late to benefit him by recompression.

The Medical Air-Lock.—This structure, first used for recompression by E. W. Moir in the Hudson River tunnel more than 20 years ago, is placed on the surface of the ground and operated independently of the caisson. It is used where extensive works require the employment of a large number of men, but under other conditions the victims of compressed air illness may temporarily be returned to the regular caisson and then slowly decompressed. The air lock is a steel cylinder (Fig. 93) having an inside diameter of about 6 feet, and a length of about a dozen feet. It is permanently closed at one end, the other being fitted with a door opening inward to admit the patients, for, in emergencies, several may be placed within at a time. A transverse median door divides the interior into two compartments, so that, with the patient in the further one, a physician may enter and leave the outer compartment, and through it gain access to the patient, who thus may be kept under uniform positive pressure as long as desired. A system of pipes and valves permits the fresh air supply and the pressure to be regulated either from within or without the lock. In the patients' chamber are placed cots, a telephone, electric light, clock, pressure gauge, a thermometer and an electric heater. The lock is also supplied with glass windows, like a calorimeter, so that the patient may be kept under constant observation. The gauge and thermometer also may be seen through the windows.

On being placed in the lock, the pressure is promptly raised to that under which the patient has been at work, and after an interval

is reduced by a pound a minute, or more slowly in urgent cases. In such cases massage and passive movements of the limbs are made by an attendant, who also conducts artificial respiration for unconscious patients.

In Dr. Keays's experiments with the lock he tried Haldane's

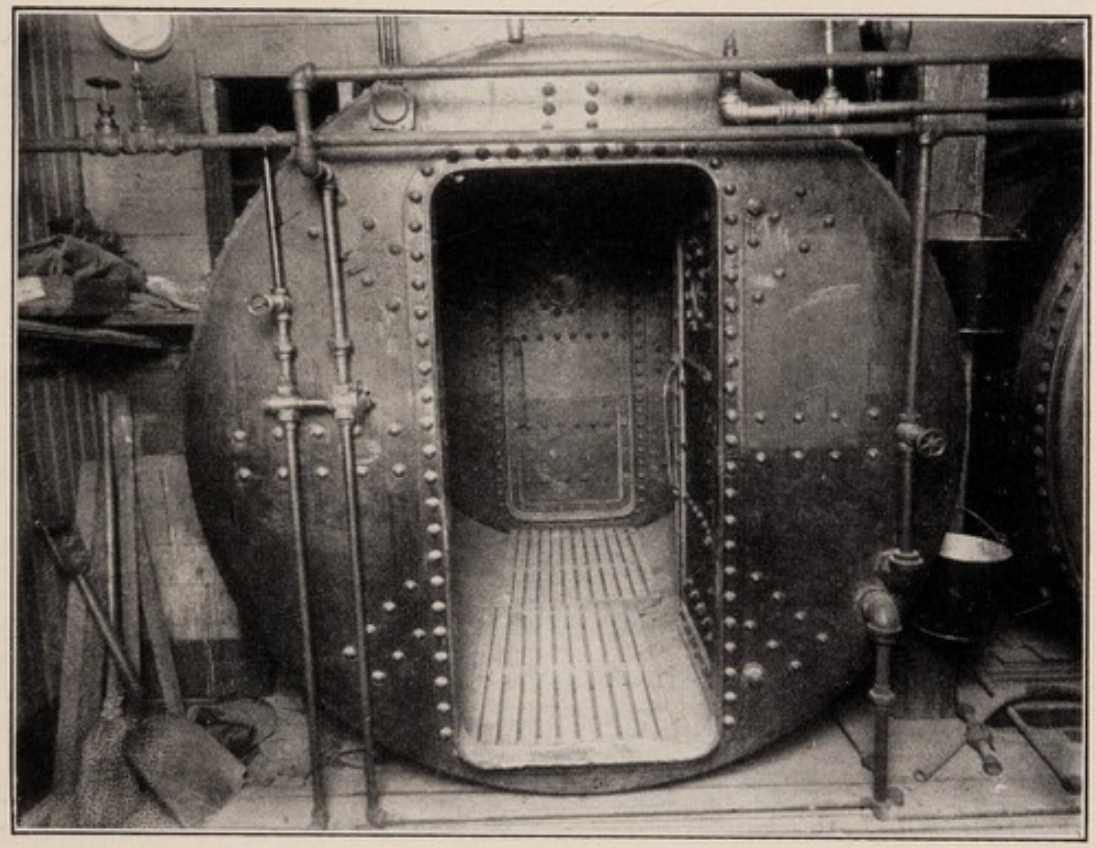


FIG. 93.—MEDICAL AIR LOCK FOR RECOMPRESSION IN CASES OF THE "BENDS." This is in a building outside of the tunnel.

partial decompression plan, with good results, decompressing suddenly down to about one atmosphere above normal and thereafter very slowly. In some cases it was necessary to repeat the treatment 3 or 4 times. In 3,278 cases with pain he obtained relief in about 90 per cent. When the patient is able he should exercise his limbs while decompression is going on, so as to promote activity of circulation. The details of treatment of these cases are thus summarized by Keays:

"In 80 cases with symptoms referable to the central nervous system the results were as follows:—

"Four cases of hemiplegia were all cleared up permanently by recompression; of 36 cases of sensory disturbance, 34 were relieved by recompression, 2 refused the medical lock and were improved by medical treatment; of 34 cases of motor disturbance, partial or complete paralysis of the legs, 23 were benefited by recompression and either cleared up at once or recovered later, in 11 recompression caused no improvement, and of these 5 ultimately died, 3 had permanent spastic paraplegia, and 3 were lost sight of; of 10 cases of sensory and motor disturbance, 9 were permanently relieved, and one was improved, but the final result was not learned.

"In 197 cases showing vertigo, with or without vomiting, pain, prostration and dyspnea, 108 had complete relief from recompression, 82 had partial relief from recompression, and 7 refused the medical lock.

"In 60 cases of dyspnea and sense of constriction of the chest, all cleared up with one recompression except two which required a second recompression.

"In 17 cases of partial or complete unconsciousness and collapse, 8 were cured or relieved by one or more recompressions, but 9 had little or no relief and died. Oxygen given to several of these severe cases during decompression afforded no appreciable benefit."

As soon as a patient shows any signs of compressed air illness such as chills, circulatory disturbances, dyspnea, weakness in the legs, painful cramps and dysesthesia or paresthesia, he is to be treated by application of warmth and stimulation. In winter a fire should be kept burning in the dressing room adjoining the caisson and warm dry clothing should be supplied, for the danger of acquiring pneumonia or nephritis is much enhanced by going into a cold atmosphere with wet, soiled clothing.

T. K. Thomson found from his own experience with the "bends," which he had twice from working in the caissons in the Harlem River silt, that hot coffee induced profuse perspiration and, temporarily only, relieved the pains in the back and legs. A hot bath had similar temporary effect. He next tried mild electric shocks, which gave temporary relief, but failed on a second occasion.

Care should be exercised to examine the bladder, for there may

be paralysis, which results in great distention and must be relieved by catheterization once in 6 or 8 hours. If, on the other hand, there is suppression of urine, the patient should be given a hot pack to induce perspiration, with a large draught of hot fluid, such as lemonade or the "imperial drink." A five-grain dose of theosin may be prescribed and dry cups applied over the region of the kidneys. Paraplegia should be treated, after a few days, with massage, passive movements and the galvanic current.

Divers

Nature of the Industry.—Divers, like caisson workers, are subject to compressed air illness. They are much employed in the navy to examine the hulls of sunken vessels, and as workmen to inspect the foundation piers of bridges, submarine mines, etc., and one of the largest industries employing them is the collection of sponges. The latter industry is mainly conducted by Greeks and Turks along the shores of the Eastern Mediterranean Islands and north coast of Egypt, but it is also followed in the Gulf of Mexico and along the coast of Cuba and the Bahamas. In Florida the headquarters of these fishermen is at Key West and Tarpon Springs, where, in 1900, 418,125 pounds of sponges were brought from neighboring waters.

Deep-sea diving is conducted by wearing an apparatus called a "scaphander," consisting of a helmet attached to a metal corselet, which in turn is fastened to a rubber suit made to fit the body so tightly as to exclude water. Only the hands are free, passing through elastic cuffs. The helmet is connected at its back to a tube through which compressed air is supplied either from an air pump on shore or carried on a vessel. (Fig. 94.) The exhaled air escapes into the water through a spring valve whenever the pressure within the helmet becomes slightly greater than that of the surrounding water at whatever depth the diver may happen to be. Every 10 meters of sea water, or approximately 33 feet of depth, correspond to an increase of one atmosphere of air pressure, or about 15 lbs. per square inch. For fresh water the ratio is 34

feet of water to one atmosphere of pressure. If the air be not compressed in the proper ratio, breathing becomes impossible.

The diver also carries a signal rope or telephone with a receiver in the helmet. The air pipe is also useful for signaling. As he



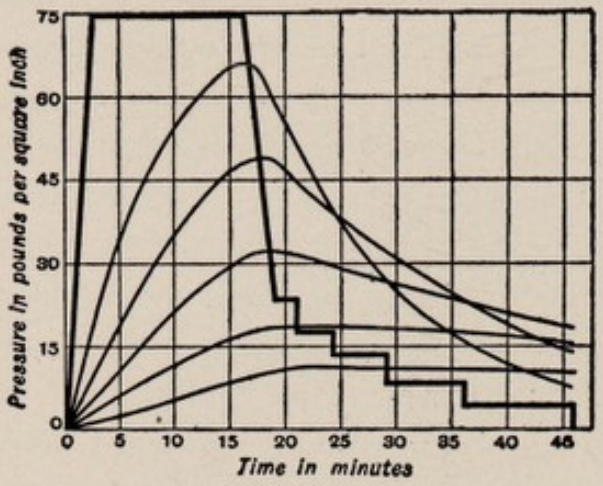
FIG. 94.—DIVING APPARATUS OR "SCAPHANDER," SHOWING HELMET WITH COMPRESSED-AIR INTAKE TUBE, AND WATER-TIGHT RUBBER SUIT.

descends by carrying a weight, the water pressure becomes greater and the air pressure must be increased. When he is ready to ascend he leaves the weight, gives a signal, and is pulled slowly to the surface. If he comes out too quickly, and the air pressure is too suddenly reduced, he is subject to similar conditions with the caisson worker, but with the difference that he is more subject in the confined air space to carbon dioxid poisoning. For some purposes a large diving bell is employed in which the diver sits and works on the bottom of the river or sea, the compressed air escaping around the rim of the bell.

The operation of sponge fishing was originally conducted by naked divers who became so expert through training, and in early Greece, often through several generations of heredity, that they could reach a depth of over 200 feet and remain two minutes below the surface. Some, in fact, could remain as long as $2\frac{3}{4}$ minutes, according to C. Flégel, of Vienna, who has made a special study of the subject. As the demand for sponges increased it became necessary to remain longer under water to gather them in depths where they cannot be reached by grappling hooks, dragnets, or ordinary diving. Hence the diving suit came into requisition for the purpose, and, although used for more than forty years previously in Greece and Turkey, it was not introduced into Florida until 1905. The use of this apparatus is quite harmless at depths within 50 feet, but at much greater depths many fatalities have occurred from compressed air illness. In foreign countries where the use of both diving suits and pumps are often entrusted to careless or incompetent men, according to Flégel, "the yearly mortality among sponge fishermen in the diving apparatus is about 20 per cent., and the seriously and slightly diseased reach annually 25 per cent." He also estimates that in 42 years there have been 5,300 deaths from the use of scaphanders and 2,300 cases of serious disablement. Flégel quotes Petros Zotos, commander of a Grecian man-of-war detailed to control the diving industry, as asserting that, of 900 Greek divers using 140 scaphanders, more than 100 die in a single summer's sponge cruise. Samos and Turkey have laws prohibiting the use of the scaphander for this murderous purpose, but the United States have not yet progressed so far, and merely prohibit its use in certain months of the year, and in depths of less than 50 feet, in which the sponges are easily obtainable by other methods.

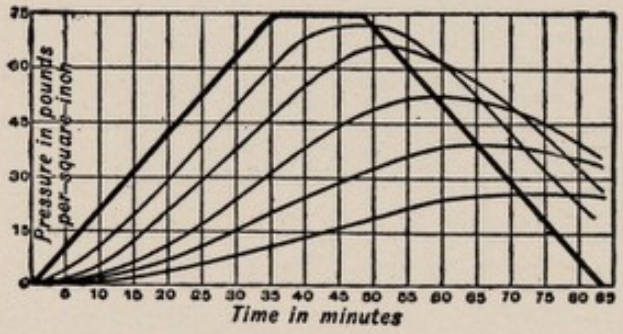
Symptoms.—The symptoms produced by abuse of the scaphander are substantially the same described for the caisson workers on page 480, and the etiology of the disease through the production of air emboli is identical. There are, however, two additional factors, first, that the suit worn compresses the legs so tightly (in order not to inflate and thus buoy the diver up) as to modify the distribution of the blood and sometimes cause subsequent gangrene, and, second, that

the diver, receiving a comparatively small volume of air, suffers more from its vitiation. At depths of 70 to 90 feet there is considerable dyspnea, and from that pressure onward the distress increases and work becomes increasingly difficult. This distress was formerly referred to the pressure exerted by the water on the body, but Dr. J. S. Haldane, of Oxford, has shown conclusively that it is due solely to the increase in CO_2 pressure. It will not do merely to maintain a proper pressure within the helmet, but the volume of air supplied must increase proportionately with the depth, to keep it fit for breathing. When this condition is properly met, Haldane has shown, through two officers of the British Navy who experimented at the greatest depth attained by divers, 210 feet ($7\frac{1}{3}$ atmospheres of pressure), that they not only could breathe comfortably, but could descend rapidly.



By Haldane's New Method.

The curves from above downward represent respectively the variations in saturation of parts of the body which half saturate in 5, 10, 20, 40, and 75 minutes. The thick line represents the air pressure. Diver remained 14 minutes on the bottom, and 46 minutes under water.



By the Old Method.

The thick line represents the air pressure. The curves, from above downward, represent respectively the variations in saturation of parts which half saturate in 5, 10, 20, 40, and 75 minutes. (Haldane.)

Fig. 95.—Diving to 28 Fathoms.

Unskilled divers or beginners may become stupefied by the CO_2, and it is equally dangerous to let them down and draw them up too quickly.

In 1907 the British Admiralty Committee, headed by Haldane, reported upon the conditions to which divers are subjected in deep

water and pointed out the danger of CO_2 poisoning from lack of adequate air. Haldane maintains that rapid decompression up to one-half the maximum pressure employed results in no harm provided the remaining half of the increased pressure is very slowly brought to normal, so as to give plenty of time for the circulating blood to discharge through the lungs the volume of gas which it has been made to absorb by the pressure.

The intensity of the symptoms of the diver's illness depend upon the depth at which he works, the volume of air supplied, the duration of his ascent, and such unfavorable conditions as fatigue, eating heavily, etc. Hemorrhages in various parts of the body are quite common among divers, also deafness, vertigo, gastric disorders, permanent lameness from paralysis of the legs, and paralysis of the bladder.

Prevention.—The Russian Government maintains a diving school at Cronstadt for its fleet, so that familiarity with the use of diving apparatus may lessen its hazards, although divers in the navy usually work under much more favorable conditions than do sponge fishermen, being under no stress of competition. The British Navy also maintains a diving school.

In 1904 Queen Olga of Greece founded a hospital in Tripoli for the treatment of divers, because there are more than 600 machine divers who are Greeks.

No one should be permitted to use a scaphander who has any organic defect of the heart, lungs or ears, or who is beyond the limits of 20 to 40 years of age.

Dr. Katsaras, professor of nervous diseases in the University of Athens, has formulated the following rules for divers:

Duration of work should depend on depth of water, as follows:

(1) 10 to 15 fathoms, 1 hour
15 " 20 " ¼ "
20 " 25 " 10 minutes
25 " 28 " 5 "
28 " 30 " 3 "
30 " 32 " 1 minute

(2) In rising, stop one minute after each 2 fathoms.

(3) Avoid diving more than once a day.

(4) Do not dive while having a cold or full stomach or intestines.

(5) Avoid fatigue and use of alcohol.

Two and a half hours should be the maximum limit per diem for any diver to work.

The deeper a diver descends the more air must be pumped through his helmet to prevent asphyxiation from his exhaled carbon dioxid. Dr. Leonard Hill has recommended the carrying on the back of the diver of a receptacle filled with caustic soda through which air from the helmet may be aspirated to absorb the CO_2. He has also devised a self-acting diving outfit carrying cylinders of 50 per cent. compressed oxygen gas and a caustic soda chamber. This renders the diver independent of air pump and tubes, a great advantage in climbing about in the interior of sunken vessels, where air tubes are liable to become twisted or cut off. Such apparatus, Hill claims, may be used for half an hour at a depth of 100 feet.

Hill has furthermore devised a decompression chamber for divers' use. It has two compartments, one open at the bottom to the sea, the second opening by a manhole only into the first. After quitting work the diver climbs into the first chamber, which is lowered to the bottom of the sea, and from it climbs through into the second chamber. The entire apparatus with the man inside is then hoisted on the deck of a boat and slow decompression is made.

Haldane's method of prevention of compressed air illness in divers is that of rapid decompression, i. e., rapid raising toward the surface until half the maximum pressure is reached. The remaining half is reduced by interrupted stages, bringing the diver up a few feet, stopping a few minutes, raising him again, etc. By this work, for ordinary depths down to 120 feet, the diver may be brought to the surface safely by taking half an hour for the process. The original system required the diver to descend and ascend at the uniform rate of about 5 feet per minute, but Haldane recommends quick descent, quick ascent until half the maximum pressure used is reached, then slow, interrupted ascent. As tried experimentally with animals and practically with divers in the British Navy, this method has proved

a very successful preventive of "diver's palsy" and the other phenomena of diver's illness.

The reasons given for this method are principally two. First, the diver is exposed to high air pressure for comparatively short periods, so that his body becomes less completely saturated with nitrogen than it does in tunnel or caisson work where the exposure is longer. Hence, to slowly reduce a high pressure in the diving apparatus means that the diver is still absorbing nitrogen, although the pressure is all the time being reduced. It is therefore a gain to bring him as quickly as may be safe back to a low pressure under which he absorbs less gas. To take him out at once would be to liberate the absorbed nitrogen too freely and cause paralysis or death. To take him out halfway, or to half-pressure, is a safe means, as proven both practically and experimentally. The second reason given is a considerable saving of total time spent in the water.

The following table and the diagrams on page 496 elucidate Haldane's system more fully:

PORTION OF DIVING TABLE FOR BRITISH NAVY (*Haldane*)

Depth		Total Pressure in Atmospheres	Time from Surface to Beginning of Ascent	Depth and Duration in Minutes of Stoppages during Ascent				Total Time for Ascent
Fathoms	Feet		Minutes	40 Feet	30 Feet	20 Feet	10 Feet	Minutes
18–20	108–120	4.6	Up to 15	—	2	3	7	15
			15–25	—	5	5	10	23
			25–35*	—	5	10	15	33
			35–60	5	10	15	25	57
			60–120	10	20	30	35	97
			Over 120	30	35	35	40	142

* Ordinary limit of time.

RAREFIED AIR

Balloon ascensions, and recently aviation, give opportunity for study of the occupational effects of rarefied air upon professional "airmen"—effects first described by Da Costa in the fifteenth century under the name of "Malades montagnes," or "mountain sickness." Many fatalities have occurred from too rapid entrance into rarefied air, and, in 1875, Tissandier and several comrades made a fatal balloon ascension from Paris. In rapid air ascensions a height

of 9,000 feet or more may be attained in half an hour or less, and the return may be made in 5 to 7 minutes. From 20° to 30° F. difference in temperature may simultaneously be experienced. These conditions necessarily profoundly affect the respiration and circulation and, in addition, in aviation is the strain of physical and mental effort. As the ascent is made the pulse is quickened and respiration becomes shallow and rapid. Symptoms which further have been observed are vertigo, tinnitus aurium, deafness and frontal headache (at 4,500 feet), acute desire for micturition, and chilliness. On landing there are irregularities in reflexes and voluntary motions resulting from fatigue and nerve tension, the body feels warm, the face is flushed, the eyes may be painful, blood pressure is increased, and there is tachycardia. Drowsiness may also be a prominent symptom. Visual hallucinations have been reported, with loss of the sense of orientation. Nausea is less common among aviators than mountain climbers. The latter, as well as balloonists, on ascending to great heights, may have hemorrhages, rarely fatal, from the nose, bronchi, and sometimes the eyes and ears. None of these effects appear to be permanent and considerable immunity is acquired in time, as it is also possessed by some persons originally.

AIR CONCUSSION

The effect of sudden air concussion, arising from blasts, boiler or other explosions, big gun firing, etc., is often serious. One or both ear drums may be ruptured, hemorrhage may take place into the middle ear, labyrinthine injury may follow, temporary unconsciousness may be produced, and the victim may be knocked down and injured by cerebral concussion or otherwise. Miners, quarrymen and gunners are those most liable to such injuries. Permanent deafness in one or both ears may rarely result, tinnitus and headache or earache may be produced by certain sounds, but complete or partial recovery usually takes place after healing of the ruptured membrana tympani.

Dr. E. P. Fowler, of New York, has studied the result of the alternate sudden compression and rarefaction of the air caused by

the rush of trains through the tunnels leading from Manhattan Island into Long Island and New Jersey.

Although the maximum depth of these tunnels is not great, barometric pressures are constantly varying with the speed of the train, the extreme range being ½ inch of mercury pressure, or ¼ lb. to the square inch, with constant oscillations and variations in the different cars. Suddenly diminished pressure tends to draw the walls of the Eustachian tube together, whereas increased pressure may separate them. Hence the former produces more blocking of the outlet of the middle ear, and acuteness of hearing is more diminished temporarily thereby. "Especially is this the case if the ears are exposed first to an increase and then immediately to a sudden diminution in air pressure."

To the normal ear no harm results from such changes in motormen and guards or others constantly exposed to them, but preëxisting tubal or other ear disease may be accentuated.

To lessen the deleterious effects, one should close the nostrils, attempt expiration through the closed nostrils, and simultaneously swallow, thereby increasing the nasopharyngeal air pressure and forcing air into the Eustachian tubes. In the vertigo and earache produced by such injuries as boiler explosions, etc., treatment with pilocarpin often gives relief.

CONFINED AIR

In certain occupations, as in cleaning flues, boilers, vats, tanks, etc., it is necessary for the workman to remain for some time in an exceedingly confined space. In so doing he is exposed not only to the deleterious effects of whatever noxious dusts, gases or fumes may be present, but to rapid exhaustion of the oxygen present and pollution of the air with his own exhalations. In a series of experiments in which men were kept in a small air-tight chamber Hill found that it is "the heat, moisture and stillness of the air which cause discomfort and fatigue, and not the excess of carbon dioxid exhaled or deficit in the oxygen of the air breathed." By introducing an electric fan in the chamber, and thus keeping the confined

air in constant motion, it was found that much of the discomfort and fatigue was mitigated. This was true when the carbon dioxid percentage was as high as 4 or 5.

Personal "comfort," however, is an entirely unreliable criterion by which to estimate the fitness of air to breathe. Conditions of anemia produced, of blood pressure, etc., are far more important. This topic is elaborated further in the section on Ventilation of the Workroom, page 106.

II. TEMPERATURE MODIFICATIONS

EXCESSIVE HEAT AND MOISTURE; EXTREME COLD

The effects of temperature vary greatly in accordance with the dryness or moisture and motion of the atmosphere, suddenness of temperature changes, and duration of exposure. Temporary exposure to dry air may be endured up to 150° F. or more. In the stoke holes of the steel warships when in the tropics the temperature may rise to 130° or 140° F., and the stokers may endure a two-hour shift, provided they perspire freely and motion be imparted to the air to accelerate evaporation from the body, which is almost completely stripped. Other classes of workmen who have to endure *great dry heat* almost constantly are puddlers and foundrymen, pottery bakers, glass-blowers, bakers, cooks, miners, workers with electric furnaces, roofers, and workers in asphalt paving who labor in a hot sun. Apart from insolation, which is described upon page 507, these types of laborers are subject mainly to rheumatism, bronchitis, and chronic nephritis, which appear to be due more to the sudden cooling off of the body, which checks perspiration and affects the vasomotor system, than to the heat itself. Hot, moist, still air checks evaporation from the skin and taxes the cooling mechanism of the body. Blood goes to the relaxed vessels of the body surface to be cooled that should go to brain and muscle, hence the physical and mental languor which ensue under such conditions.

Painful muscular cramps in the legs and abdomen are sometimes experienced by workers in intense heat. Such a case (with

reference to others) is described by Dr. L. Clendening, of Kansas City (*Jour. Amer. Med. Assoc.*, May 7, 1910). The patients are usually cooks in Pullman dining cars who, in summer, are exposed to great heat, having to lean over ranges in a very confined space.

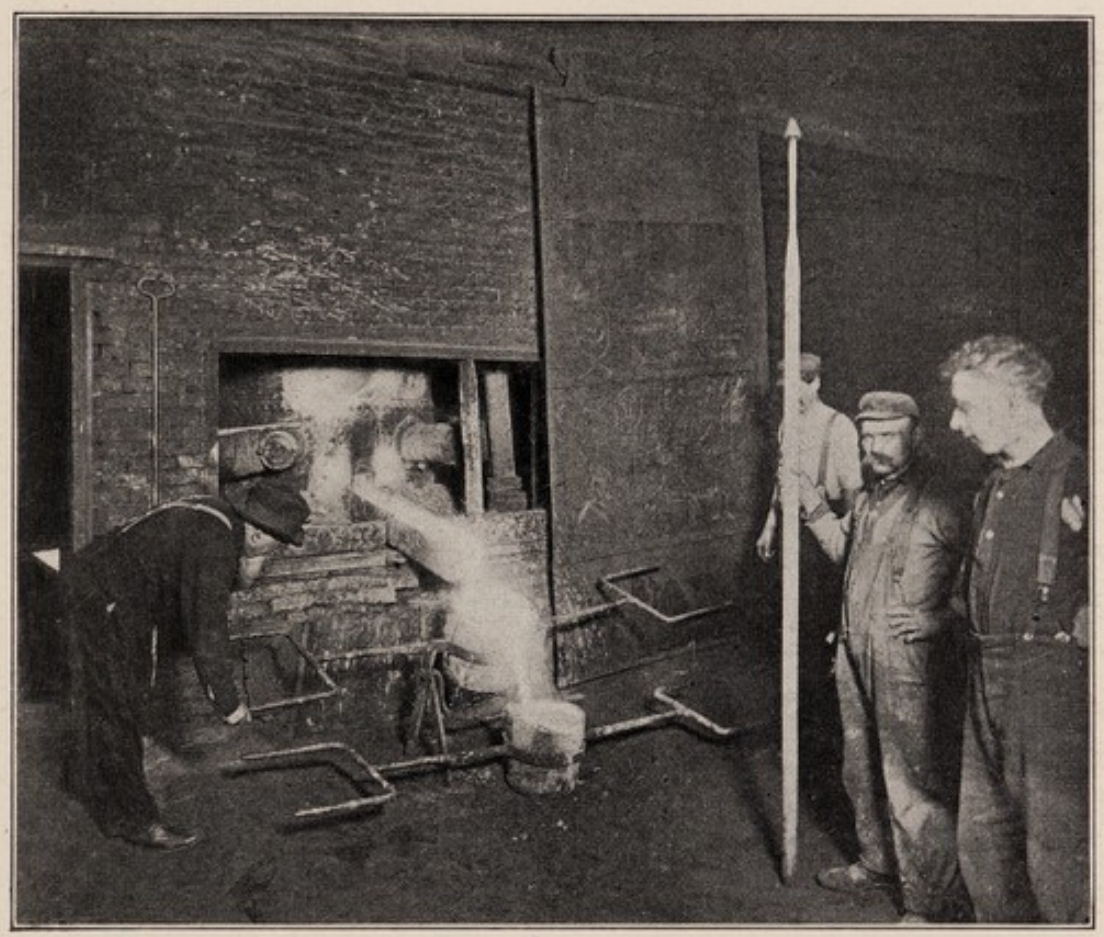


FIG. 96.—WITHDRAWING MOLTEN METAL IN A FOUNDRY. Exposure to excessive heat and light. Hazards: burns, injuries to eyes, dermatitis, rheumatism.

The condition has a tendency to recur with increasing frequency. Excessive heat may cause localized burning of the skin, as of the face and hands when molten metal is withdrawn from a foundry furnace. (Fig. 96.)

In facing excessive heat, as in foundries, glass furnaces, electric furnaces and smelting works, glasses do not serve, although colored blue and red goggles may be worn until the heat is very great, say over 1,000° F. Above that temperature asbestos masks should be

worn over neck and face, with eyeholes protected by fine wire netting of aluminum or galvanized iron.

Workers in great heat become gradually accustomed to it, so that



FIG. 97.— EXPOSURE TO STEAM IN COOKING FOOD FOR CANNING.

they can endure temperatures which to novices would appear almost insupportable.

Exposure to constantly alternating extremes of temperature, as in going in and out of baking ovens, cold storage plants, etc., may give rise to attacks of cholera morbus, with excessive watery diarrhea

and intestinal cramps, particularly if the workman has eaten indiscreetly or drunk too much cold water besides.

Excessive moisture is encountered by many classes of workmen, especially pottery clay mixers, paper makers, fishermen, canners (Fig. 97), oystermen, and flax spinners. In sugar refineries the



FIG. 98.—EXPOSURE TO EXCESSIVE HEAT AND MOISTURE IN THE LEATHER INDUSTRY.

temperature is sometimes 95° F. where the humidity reaches 96. Heat and moisture combined check perspiration and oppress the breathing. The kidneys are overworked and the nervous functions are depressed. For these reasons a lesser degree of moist heat than of dry heat is endurable for continued work. Examples of this type of exposure are found among caisson workers in under-river tunnels, damp mines, hothouses, laundries, tanneries (Fig. 98), dyeworks, flax mills, and many other occupations. The cleaning out of many tanks and vats, and all occupations in which much steam is liberated indoors, involve similar exposure. The workmen are liable to chronic

rheumatism, chronic bronchitis, and disturbances of the circulation sometimes occur.

Occupational exposure to *excessive cold* is experienced by ice-men, makers of artificial ice and workers in cold storage plants. Among such workmen rheumatism is common, and also neuritis and chronic nephritis. Girls are sometimes employed in the trimming rooms of lard packing plants at a temperature below refrigeration.

Cold, damp indoor air chills the body surface and tends to produce visceral congestion. Expenditure of body heat is increased, resisting power of the organism is lowered, and such infections as pneumonia, tuberculosis and catarrh are very easily acquired.

Exposure to sudden extremes of outdoor temperature affect particularly those classes of employees whose occupation keeps them for long hours under conditions in which they cannot always protect themselves from sudden temperature changes often combined with wetting. Such are fishermen, sailors, motormen and drivers. They are prone to rheumatism, chronic nephritis, chronic bronchitis and catarrhal pneumonia.

Prevention.—Prevention of the ills arising from exposure to temperature extremes consists mainly in the avoidance of too sudden changes from heat to cold, the protection of the perspiring body from cold and drafts by thorough drying and friction of the skin, and putting on of woolen undergarments to absorb moisture and act as non-conductors. Attention should also be given to the urine, and, if it becomes scanty and highly colored, more water should be drunk.

The British legal standards for the air in textile fabric mills, in rooms such as those where hackling, carding, net spinning, etc., are conducted, besides prescribing exhaust ventilation, order as follows:

"1. In every room in which persons are employed the arrangements shall be such that during working hours the proportion of carbonic acid in the air of the room shall not exceed 20 volumes per 10,000 volumes of air at any time when gas or oil is used for lighting (or within one hour thereafter) or 12 volumes per 10,000 when electric light is used (or within one hour thereafter), or 9 volumes per 10,000 at any other time.

"2. The temperature shall not fall below 50° F. and no person

employed shall be exposed to a direct draft from any air inlet, or to any draft at a temperature of less than 50 degrees.

"3. The humidity of the atmosphere shall not at any time be such that the difference between the readings of the wet and dry bulb thermometers is less than 2 degrees."

INSOLATION

Insolation or sunstroke results from a combination of prolonged high temperature with excessive atmospheric humidity. It is an occupational disease in the sense that it is avoidable by anyone whose occupation does not compel him to endure the deleterious conditions which produce it. It is true that children without occupation may have it, but usually only those of the working class, living in unhygienic tenements. Sunstroke, moreover, is not necessarily due to direct exposure to the sun's rays, but to the peculiar "lifelessness" of the air in prolonged periods of hot humidity; for the same or greater degrees of heat and moisture are repeatedly endured in various industries for short intervals, but daily for a long time, without detriment to health. It is quite possible that there are properties in atmospheric air which are not fully determinable by present instruments of precision. (*See* Ventilation Experiments, page 105.)

Insolation affects chiefly metal roofers, stokers, foundrymen and puddlers, cooks, layers of asphalt pavement, street cleaners working upon superheated pavements, and the like. It is always greatly intensified among alcoholic subjects, and, in fact, the most serious cases are usually met with among hard working but chronically alcoholic men. Among women, excepting cooks and laundresses, true insolation is not common, being in the proportion of 1 to 14, as compared with men, nor is it usually observed among the well-to-do, who can take life less strenuously during heated terms. Direct exposure to the sun's rays is by no means essential for the production of insolation, for it occurs also among those working indoors, as in foundries, stoke holes of the hot steel warships when in tropical climates, and in the kitchens, often underground, of large hotels during periods of protracted humidity. Contributing factors, besides

alcoholism, are overwork, overeating, sexual excesses and debauchery of any kind. Lack of abundant fresh water for drinking and bathing is another factor, such as may affect troops on forced marches, carrying heavy equipment over dusty roads. Negroes are almost entirely exempt.

Morbid Anatomy.—After death the left ventricle is found empty and in systole, but the right ventricle is engorged with venous blood. Subpleural and pericardial hemorrhages may be found. The late Ira van Gieson described in the brain and cord, neurons exhibiting acute parenchymatous degeneration. Such changes are marked in the anterior gray horns of the cord and the Purkinjé cells of the cerebellum. The cell nuclei are shriveled, or sometimes absent. Similar changes are produced by other acute auto-intoxications and metallic poisons. The liver and kidneys may exhibit parenchymatous degeneration. The blood is thick and dark, showing as much as 125 per cent. of hemoglobin, with increase in both erythrocytes and leukocytes. The red cells also may be misshapen. The serum, perspiration and urine are all highly toxic to animals; for the disease is a definite auto-intoxication produced primarily by checking of normal processes of elimination, marked depression of the nervous system and altered metabolism.

Symptoms.—After a few days and nights of extreme heat and humidity of the atmosphere, or after a single exposure sometimes of a few hours to these conditions, the patient complains of headache and malaise. Suddenly, often at night, he becomes comatose or sometimes maniacally delirious. The urine is scanty, and among preliminary symptoms may be vertigo, thirst, a quick pulse, and a temperature of 100° to 101° F. Vomiting and constipation are present. The temperature rapidly rises to great height. I have seen a large number of recoveries after a brief period of body temperature of 111° F., and a few after 112° F. One case at the Presbyterian Hospital ended in recovery after a rectal temperature of 115° F., and in 1896 a patient died in my service at the New York Hospital after sustaining for some time a temperature of 117.8° F. The latter temperature is incompatible with prolongation of life, as heat rigor of the muscles occurs at a slightly higher de-

gree (120° F.). Special thermometers must be procured for recording them, as the ordinary clinical thermometer does not register so high. In robust persons coma does not usually supervene before the temperature reaches 104° or 105° F., but in feeble or elderly subjects it may appear at a much lower degree. The delirium may be of homicidal or suicidal type. The urine becomes suppressed, blood pressure is high, and death often results, with edema of the lungs. In favorable cases under treatment the maximum temperature is sustained only a few moments, and the rate of fall may be at 2° or 3° F. every 15 minutes. When it has fallen to normal or slightly above normal consciousness is regained, the pulse improves, edema disappears, and recovery may take place. More often, however, after very high temperatures—above 106° or 107° F.—there is a return of the rise of temperature later in the day or on the following day to 102° or 103° F., and a mild remittent fever may last for a few days or a week. In reducing the body temperature by external cold it may go down so rapidly as to become subnormal, when the patient goes into collapse and stimulants and hot applications may be required. It is best, therefore, to desist from cold applications as soon as the temperature in sthenic cases has fallen to 102° F.

Sequelæ.—Sequelæ consist of weakness and inability to concentrate the mind for some time, or exercise the memory. Increased susceptibility to heat is persistent, sometimes through life. Anemia, peripheral neuritis, encephalitis and dementia have all been observed in exceptional cases. Delusional and other insanities have followed in about 4 per cent. of the most severe cases.

Prognosis.—Prognosis is fair in direct proportion to the promptness with which treatment can be applied and the length of time the high temperature has lasted. It is made many times worse by a previous state of alcoholism. Even very robust persons, if alcoholic, succumb much oftener than less strong non-alcoholic subjects. In a fulminant type of the disease death may take place in an hour or two in convulsions or coma. Alexander Lambert collected data of 520 cases treated in the New York Hospital in August, 1896, with a mortality of 25 per cent. Rarely patients pass into a typhoidal state and die from asthenia after two or three weeks.

Diagnosis.—Uremic coma presents albuminuria, thickened arteries and usually edema of the extremities and advanced anemia, constituting an entirely different blood picture. The temperature, moreover, may remain normal and rarely is above 105° F.

Apoplexy presents focal symptoms such as paralyses, contractures and irregularity of the pupils. At the onset there is no increase in temperature. A temperature of 106° or 107° F., coming on suddenly without chill, is almost certainly due to insolation.

Prevention.—The workman during heated terms should live carefully, eat moderately, avoiding much meat, and take no alcoholic beverages at all. He should drink abundant fluid, such as plain cool water, acid lemonade or oatmeal water. Ice water should not be drunk. He should protect the head while in the sun by a lightweight hat with a good air space above the head, and he may lay a wet cloth or large green, moist cabbage leaf beneath the hat. Clothing should be as light as possible and cool sponge or plunge baths should be taken night and morning. It is much more sensible to rise early, do one's hardest work in the coolest part of the day, resting 3 or 4 hours in the hottest period, say from 12 to 3, or later, as is done in the tropics, but insolation conditions occur so irregularly in the insolation belt of the United States that it is difficult to adapt conditions of work to temporary emergencies and rearrange hours. Labor laws and labor union customs do not provide for such contingencies.

Treatment.—The patient should be removed to the shade and as cool a place as possible, stripped and douched with cold water from head to foot. He may be rubbed also vigorously with cakes of ice and a towel wet with iced water should be kept upon the head. Every five minutes the rectal temperature should be recorded. My favorite method is to fill a common garden watering pot with ice water and pour the water over the patient's body from a height of 3 or 4 feet. This process should be accompanied by constant vigorous rubbing of the skin to promote capillary circulation, prevent collapse and obtain a good reaction. The mechanical shock to the cutaneous nerves of so many small jets of water combined with the sudden cold and friction often will arouse a patient from deep coma.

Another method less well adapted for emergencies, except in hospitals, is to put the patient in a tub of cold water and rub him vigorously with ice, turning him frequently to rub the back and all parts of the body. Two or three persons are needed to conduct the rubbing, for it is most important, and without it there is danger of collapse. As the temperature of the body nears 103° F. the efforts may be relaxed and safely suspended at 102° F. Subsequently a dose of croton oil, ♏ ii, should be given and a stimulating enema of castor oil, ℥i, and turpentine, ℥ss, in hot soap suds. As soon as possible the patient should be made to drink water. In cases with high tension and tendency to convulsions or maniacal delirium, the patient should be bled about 16 ozs. Threatened pulmonary edema should be treated as described on page 154. After apparent recovery the patient should be closely watched and the temperature observed every hour, for in some cases a fatal relapse with secondary high rise of temperature may take place.

Heat Exhaustion

This condition may affect workmen who are feeble or old, and is due to similar causes with sunstroke, but the temperature is only slightly elevated (100°-101° F.), or it may be subnormal. The pulse is feeble and sometimes abnormally slow. There are cold perspiration, a tendency to vertigo, syncope, nausea and vomiting. There are also muscular prostration, a tendency to somnolence, and semi-coma or mild delirium. The urine is scanty and may show traces of albumin.

Prognosis.—Recovery is usual, but the very aged may succumb and die in asthenia. Recovery is often greatly protracted perhaps for several weeks.

Treatment.—Treatment should be by rest, cool air, and simple cardiac stimulants such as aromatic spirit of ammonia or camphor water. Patients who once have suffered from either insolation or heat exhaustion are quite often rendered liable to subsequent attacks from comparatively slight degrees of exposure to fatigue during conditions of prolonged atmospheric depression.

III. LIGHT MODIFICATIONS

EXCESSIVE LIGHT

Electric Light and the X-Ray

Electric light and X-ray burns differ from ordinary burns in their slower development, less immediate and violent pain and very protracted healing. The tissues are destroyed to a considerable depth, and bones which are near the surface, like those of the cranium, may have the outer layers necrosed. In some cases of extensive burn the lesion is painless, in others the pain is constant and severe. Burns of the skin of the hands may leave them hypersensitive for years, especially toward changes in temperature and wetting with antiseptic solutions. With all these forms of light irritation, superficial redness is followed by dermatitis, exfoliation of the skin and finally ulceration which may extend to muscle and bone beneath. Suppuration, unless the wound becomes independently infected, does not follow. Maintenance of an aseptic surface by protective dressings is, therefore, of importance.

The making of Röntgen-ray tubes, which has become an extensive industry, involves considerable exposure to the X-ray light. The effects are insidious, consisting of burns, nervousness, mental depression and, in males, loss of sexual power, which may last for months or become permanent in extreme cases. These symptoms may not become serious for several weeks after exposure has been suspended.

The skin lesions begin as an acute dermatitis. There are redness and infiltration of the burned area, which is distinctly circumscribed and often intensely itching. Blebs form, with serous and often purulent secretion. In severe cases, after protracted exposure to mild currents or brief exposure to intense currents, gangrene of the skin and subcutaneous tissues has been observed. In healing the cicatrices are extensive, and atrophy of the skin and telangiectases remain.

Chronic skin lesions also develop in the hands and face. There

are an hypertrophy and hardening—hyperkeratosis—of the skin of the entire hands. The skin becomes extremely rough and pigmented, and deep fissures form in which desquamated epithelium gathers as a white powder. (Unna.) Multiple warts also appear, which are punctate and hypersensitive. They gather especially about the nails and lateral surfaces of the fingers. Subepithelial abscess may form. In a case of Mühsam's the paronychia of one finger was so intractable and painful as to require amputation of the joint. The finger nails become thin and very brittle. Telangiectases appear on the backs of the hands, forming stellate dark spots. The hair of the face may be permanently lost. The histological changes present an hypertrophy of the epidermis, with atrophy of the hair, nails, sebaceous and sweat glands. In the deeper layers of the skin there is a chronic interstitial edema with atrophy of the elastic fibers. The vessels are little altered, but the musculature is thickened.

The X-ray has special predilection for lymphatic tissues, as shown by its sometimes favorable temporary action in splenic and glandular types of leukemia, but its protracted action may cause leukemia. Von Jagic (*Berliner klin. Woch.*, 1911, xlviii, 1220) has reported 3 cases of lymphatic leukemia in X-ray workers and a fourth in a chemist who prepared radium. In ten X-ray workers he found decided lymphocytosis, amounting to 35 to 52 per cent. Animal experiments with both X-rays and radium confirmed these observations. The X-ray acts upon the bone marrow cells and stimulates the lymphatic tissue activity.

The cutaneous irritation caused by prolonged use of the X-ray, or by its less prolonged use when followed by other forms of irritation, stimulates the epithelial cells so as sometimes to cause epithelioma or malignant granuloma which demands excision.

All these chronic cutaneous symptoms and lesions are exceedingly inert and rebellious to treatment. Moreover, they are made worse by many substances with which the hands may come in contact, especially the antiseptics used by surgeons, photographic chemicals, etc. One of my colleagues who was an enthusiastic pioneer in X-ray work was finally obliged to abandon his profession on account of the constant pain and annoyance experienced from his hands.

The testicular atrophy resulting from prolonged X-ray exposure is accompanied by azoöspermia, and rabbits exposed experimentally to the rays show absence of the epithelium of the seminal canals.

Protection.—Protection consists in making all exposures to the X-ray as brief as possible and in the use of sheet-lead screens and armor. Lead-glass observation windows and goggles also should be used to protect the eyes.

Treatment.—Burns from electric light, X-ray or radium should be protected by anodyne liniments or soothing ointments, containing oil, vaselin or simple cerate with opium or other anodyne. Protection from the air, as by wearing rubber gloves, and from too-frequent washing is important. Later dressings with alkaline carbonates with soaps and stearates are recommended. The hard warts may be touched with glacial acetic acid, salicylic acid soaps and ointments, and hydrogen peroxid.

Radium

Radium is somewhat similar in its effects upon the skin to the X-ray, but owing to its very restricted use and comparatively short duration of exposures, cases of serious damage by it are few. It causes acute dermatitis after brief exposure of the skin, with redness, hyperemia and intolerable itching. In weaker applications no symptoms may appear for a fortnight, when the reddened areas gradually become thickened and necrotic. Desquamation follows. In the more severe burns from radium there is deep ulceration and sometimes pus formation from infection.

Prevention.—As in the case of the X-ray, protection consists in the use of sheet lead screens and careful limitation of the time of exposure. The acute dermatitis is relieved somewhat by compresses of cold aluminum acetate and the use of simple unguents like cold cream to protect the surface from the air.

Various Lights

Effects Upon the Eyes.—Light from burnished surfaces which is reflected to the eyes of metal polishers and buffers, when the eyes are constantly focused upon it, gives rise to retinal hyperesthesia, with

pain and annoyance, which results in dimness of vision. The wearing of smoke-colored glasses cures the difficulty.

Light from steel and iron furnaces is accompanied by temperatures ranging from 1,800° F. for cast iron to 2,800° F. for molten metal, and in the Bessemer steel process up to a maximum of 3,200° F.

A workman with practice can look into a furnace up to a temperature of 2,000° F. without glasses, but with higher temperatures requires dark blue glasses; and with the highest temperatures observations are made at a distance of 30 feet or more through a spectroscope. As some of the smelting processes require many hours of intermittent watching, the work at best is very trying and some workmen cannot continue it. If one looks directly into the furnace without colored glasses, one is unable to see for several minutes afterward, as in looking directly into the sun.

Blast furnaces sometimes become clogged with iron which has solidified after incomplete emptying. This iron is cut away with an electric arc, and to shield the eyes the workmen must wear triple-faced glasses, one blue between two red ones.

Cataract occurs sometimes both in glass blowers, especially bottle makers, and steel foundrymen as a result of prolonged overstimulation of the eyes with great heat and light. Parsons and Gunn, in England, in 1908, found a variety of cataract in some bottle blowers which presented an opaque disc in the posterior cortex of the optic lens, frequently surrounded by several lesser opacities as if by satellites.

Cataract has also been observed with some frequency in blacksmiths, cooks, bakers, and puddlemen in foundries. In such cases great heat appears to be a more powerful agent than the light.

Electric arc welding implies a temperature up to 7,000° F. or more. And in this process, as in short circuits of electric power currents, the eyes may be damaged by repeated flashes of brilliant light, unless protected by helmets, shields or screens made with a half-dozen alternate layers of blue and red glass. (Fig. 99.) When the eyes are thus injured they are blinded immediately and after some hours the lids swell, the tears flow freely, and there is intense

burning pain. Serious ophthalmia and retinitis may result which are very slow in recovery and may damage vision permanently.

The intense electric arc light decomposes the visual purple faster than it is regenerated, and gives rise to retinal exhaustion, causing asthenopia. In the so-called "electrical ophthalmia" the patient com-

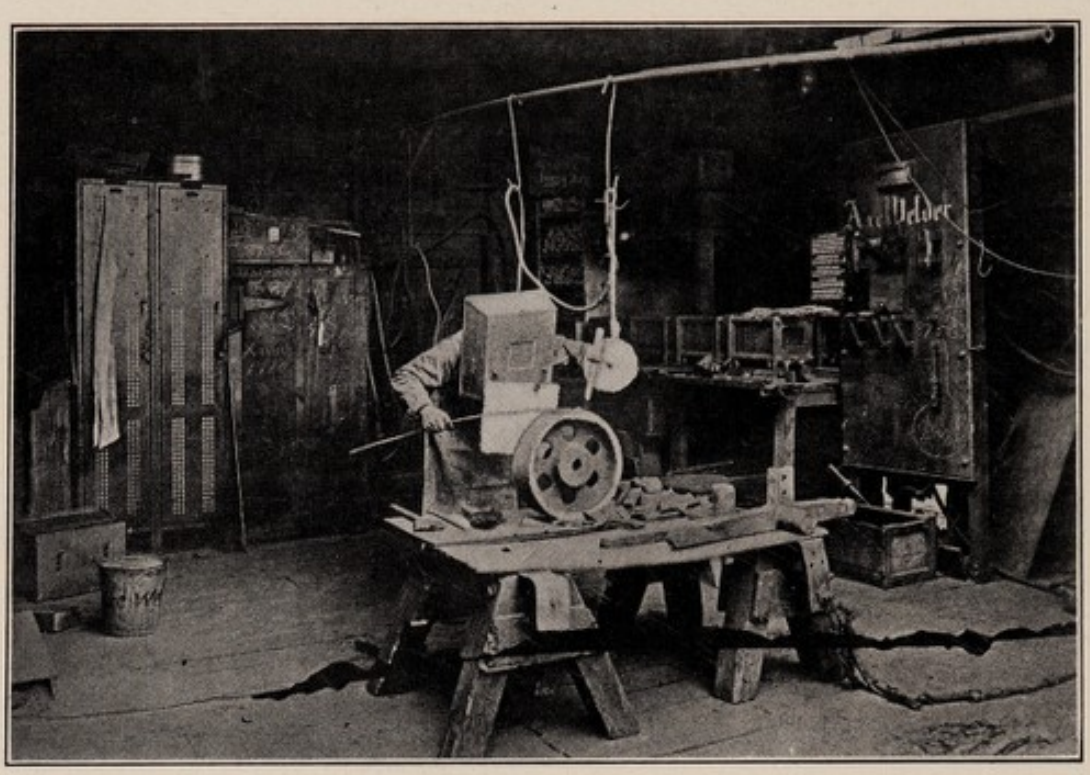


FIG. 99.—ELECTRIC ARC WELDING. A shield is provided for the arc welder which is fitted with colored glass and suspended in front of the workman so that he watches the work through the colored glass and is also protected from the heat. (Illinois Steel Company.)

plains of persistent after-images and photophobia. Severe conjunctivitis may involve the submucous tissues of the eyelids. In some cases cataract has followed exposure to intense electric light flashes. Serious injury to the eyes of workers in electric light and power wiring may occur by a single sudden short-circuit flash, as it sometimes does after lightning stroke.

Surgeon-General Stokes has called attention to the harmful effect upon the eyesight of men in the navy who are called upon to work much with the searchlight. This form of intense arc light may cause coagulation in the retinal cells or changes in the optic nerve.

The mercury vapor arc light does not appear to affect vision materially, as it was at first claimed that it would. In a study of 28 persons, some of whom used it for four years, Dr. W. H. Williams found it produced no more strain than any other bright lamplight. Temporary color fatigue results, but this is common to all bright-colored illuminants. In this color fatigue there was much confusion between green and blue, but very little between green and red. The matter is mainly of scientific rather than practical interest. The oxy-acetylene light is very liable to strain the eyes seriously.

Dr. G. L. Apfelbach reports an interesting series of cases of ophthalmia in electricians produced by sudden blinding flashes of electric light caused by short-circuiting. (*Bull.* Illinois State Dep't of Factory Inspection, April, 1914.)

Protection.—In all cases of danger to the eyes from excessive light or light and heat combined, protective measures by means of colored glasses and screens and shortening the duration of the exposure are of the utmost importance, for, beyond prolonged rest of the eyes and continued protection from daylight by deeply colored glasses, little can be accomplished by treatment. There are many forms of protective colored glasses. Euphos glass absorbs the ultra-violet electric rays, and color combinations of various sorts are used, as a layer of blue glass between two of red. Hallaner glass also absorbs actinic rays.

The United States Steel Corporation has a hygienic rule which prevents workmen who use protective glasses from exchanging them with one another on account of the danger of transmitting eye infections.

In only 11 States is there any legal control of factory lighting, according to E. L. Elliott (*Amer. Labor Legislation Rev.,* June, 1911, vol. 1, No. 2), and in some of these the regulations are so vague as to be of little use, although the effect of good light upon the worker is both physical and moral to a very important degree. Continued eye strain not alone impairs efficiency, but often begets headache, nervousness and digestive disturbances, and tends to increase many sorts of accidents from machinery, etc. It often happens where men are working with bright tools upon brightly polished metallic surfaces

that a bright light is focused on the cutting point, and all through the rest of the room there is semi-darkness, which adds to the eye-strain. This bright light on the tools often greatly exceeds the intensity of daylight, yet by virtue of the surrounding gloom appears less brilliant to the operative. In such cases very much better results are obtained by a more diffuse light reflected from white ceilings and walls. (Calder.)

As Elliott says, "It is impossible to produce an abundance of *light* and a resulting *illumination* that will produce such a severe strain upon the eyes as to result often in permanent injury to the eyes themselves and severely affect the general health. Any adequate law must therefore go farther than this and prohibit such uses of light as are harmful."

He also points out that a much brighter illumination is required for dark-colored materials than for light ones, and that women are so often employed upon delicate work necessitating good vision that they especially need the best conditions of well-diffused light.

In Holland a fairly definite law regulates the minimum artificial light intensity for the workroom at the standard of one foot candle, but one and a half foot candle is required in industries demanding keen vision and which are much sought by women, such as knitting, embroidery, jewelry making, etc., as well as engraving and printing.

When electric light bulbs are swung over machines close to and on a level with the operator's eyes the effect becomes in time very trying. Writing of garment workers, C. T. Graham-Rogers states: "Another danger to which these operators are exposed is that of having to work with artificial illumination on a level with the eyes, especially that from incandescent electric bulbs. Reports show this has a deleterious effect, not only upon the eyes, but upon the general health."

Wireless telegraphers work in small dark rooms in which there is constant overetherization of the air they breathe by reason of the alternating currents used to generate the waves. German physicians have lately called attention to a serious type of anemia which may affect such operators. The illumination of the workroom is further discussed upon page 86.

IV. ELECTRIC SHOCK

Electric shock, arising either from contact with live wires or more often merely from unexpected electric flashes or supposed contact with dangerous currents, produces in neurotic subjects hystero-neurasthenia. It is not common among telegraph or telephone linemen, or those who work on third-rail construction or about dynamos, and hence is, properly speaking, not a true "occupational" neurosis. The symptoms, moreover, are apt to be directly proportioned in intensity to the extent of damages which it is hoped to secure. Such patients exhibit various hysterical contractures, as of the fingers and hands, lameness, muscular tremors, paralyses, dysesthesia and anesthesia, and sometimes deafness and blindness with complaint of flashes of light. In a series of cases reported by Dr. John J. Moorhead, arising in New York (*Jour. Amer. Med. Assoc.*, April 2, 1910) was one of pseudo-Dupuytren's flexion of the fingers. The patient had been holding a wire when a current of 110 volts was unexpectedly turned on and produced slight burns of the hand. A month later he had recovered, but had many subjective sensations. It has been established by Dr. George W. Crile and others that high-tension currents cause no demonstrable chemical or other changes in the nerves or tissues, apart from possible contact burns. Hence in these cases of hysteroneurasthenia there are no objective phenomena to record. On diverting the patient's attention, or on watching him recover from primary ether anesthesia, it is easy to demonstrate the lack of genuineness of contractures and paralyses.

PART V

SPECIAL OCCUPATIONAL DISORDERS

I. THE BLOOD

The occupational poisons which exert their toxic influence specifically upon the blood, in so far as their influence is concerned, affect mainly the red blood corpuscles or their hemoglobin content, or both. The white cells (excepting by the action of benzol) are usually only influenced secondarily in consequence of serious anemias, being unaffected primarily or specifically, as in the case of bacterial toxemias and special types of blood diseases. Some of the occupational poisons act by lessening the duration of life, so to speak, of the red cells, others by directly dissolving them, and in some cases the first effect is produced by small doses of the poison, and the second effect follows with stronger doses (E. Grawitz). The first or plasmotropic effect results from accelerated destruction of the red cells in the liver and spleen, and is characterized by the morphological changes of poikilocytosis, polychromatophilia, and the granular degeneration which is so prominent a feature of chronic lead poisoning, known as granular basophilia. With poikilocytosis the red cells present shriveled, irregular and distorted forms. With polychromatophilia they present differences in reaction with staining agents, and with basophilia they become filled with minute granules uniformly distributed.

The second or solvent effect upon the red cells, or plasmolytic effect, is manifest through immediate solution of the erythrocytes in the plasma, thereby liberating hemoglobin, which condition is described as hemoglobinemia. Some of the corpuscles may merely lose their hemoglobin without themselves dissolving, but appearing

as transparent, colorless discs. Some of the dissolved hemoglobin is converted into bilirubin in the liver and part is stored as hemosiderin in the liver, spleen and bone marrow. The bile pigment being thus increased, some of it is reabsorbed in the lymph passages and jaundice ensues. This form of icterus, originally known as the "hematogenous" type, has recently been termed by Naunyn and others "resorption icterus." In extreme cases some of the hemoglobin, or more often methemoglobin, passes off in the urine, causing methemoglobinuria, and, if the tubules of the kidneys become occluded by an excess of pigment, anuria may result (Grawitz).

Arsenuretted hydrogen is a strong solvent of the red blood cells without formation of methemoglobin.

Liebermann found that "lead, mercury and phosphorus increase the resistance of the red corpuscles, while benzene and benzol reduce it. The Liebermann test is based on laking of the red cells in distilled water and the absence of laking in physiologic salt solution. The unit is two minutes for the laking of one drop of undefibrinated blood, that is, 0.05 c. c. The blood is generally used for the test with a salt solution between 0.4 and 0.7. After two minutes salt solution is added of a concentration which brings the new solution to 1 per cent. For example, to 5 c. c. of a 0.5 per cent. solution is added 5 c. c. of a 1.5 per cent. solution, thus bringing the concentration to 1 per cent. The resistance quotient is the number of red cells which fail to lake under these conditions in proportion to those which are dissolved." (Abstract from the *Medical Record,* Nov., 1912.)

Another group of poisons consisting notably of nitrous oxid and carbon monoxid affect the blood, not through dissolution of the corpuscles, but by forming permanent union with the hemoglobin, thereby preventing the exercise of its normal function of oxygen carrier to the tissues. Carbon monoxid hemoglobin is very similar to oxyhemoglobin, but differs from it in that it remains quite unaffected by reducing agents.

Sulphuretted hydrogen, as developed in sewers, trenches, decomposing cadavers and in chemical laboratories, forms another compound known as "sulphomethemoglobin," which presents a definite

absorption band in the red of the spectrum. In decomposed cadavers it imparts a greenish color to the blood and tissues.

Prussic acid poisoning imparts a red color to the venous blood, because, according to Grawitz, the tissues cease to appropriate oxygen, hence it accumulates in the blood, with excess of oxyhemoglobin.

Poisons which cause morphological changes in the erythrocytes without dissolving them are typified by lead. In 1899 E. Grawitz and Hamel demonstrated the granulations which occur in the red corpuscles in nearly all cases of chronic plumbism. Erben, furthermore, has demonstrated that such blood possesses also a high iron content with an increase in fat in the serum. In general, the number of the granular basophiles bears direct relation to the severity of the lead poisoning, but the phenomenon is also observed as an early symptom sometimes in those who have not developed any other symptoms. Grawitz has shown that, in patients previously saturated with lead which has been stored in the body, such lead may be liberated from the organs where it has long remained after change of occupation of the workman, and suddenly give rise to basophilia.

Poisons which destroy the blood through formation of methemoglobin and associated dissolution of the erythrocytes act both through oxidization, like iodin, chlorin, nitrites and ozone, and reduction, like phosphorus, pyrogallol and hydrochinon. Other compounds there are which act in neither of these ways, like anilin and the carbolic acid series. Lime chlorid, for example, may cause, in addition to methemoglobinemia, methemoglobinuria or anuria and uremia. Nitrobenzol and nitroglycerin fumes, when inhaled, may cause serious methemoglobinuria. Chromic acid is one of the most powerful of the poisons of this order, and anilin and its derivatives have similar action. Acetanilid and other coal-tar depressants, when taken in overdose or for long periods of time, cause chronic cyanosis with marked blueness of the lips and finger-tips.

Serious grades of simple anemia result in many trades, often as a combination of poor ventilation, poor food and toxic fumes in the atmosphere. Such anemia is commonly present in the metal poison cases, and may reach a degree bordering upon pernicious anemia.

Typical chlorotic anemia is common among young girls who are employed as garment workers or in the various textile industries.

Treatment.—Treatment of the grave forms of anemia above described consists in affording abundant fresh air, animal food, rest, and attention to digestion, especially the avoidance of constipation. With the methemoglobin cases the object of treatment is to rid the system of any poison which may be in circulation, and to rid it of the useless methemoglobin corpuscles while fluid is supplied to dilute the blood and maintain blood pressure. To this end venesection to the extent of 14 to 16 ounces should be performed, and the blood withdrawn should be replaced by an equal volume of normal saline solution. In extreme cases direct blood transfusion may be employed. Salines may also be given per rectum and by hypodermoclysis in those who, being in coma, cannot swallow. Warmth should be applied to the body, and with anuria saline diuretics may be given and hot saline rectal injections, while the renal region may be cupped and poulticed. During convalescence arsenic appears of some value (in cases not due to arsenical poisoning), and the syrup of the iodid of iron may be used, although iron in general is of doubtful utility in the types of acute grave anemia under discussion. It certainly should not be relied upon, as it often is, as the only measure.

II. THE NERVES

OCCUPATIONAL DISEASES OF THE NERVOUS SYSTEM IN GENERAL

It is difficult to limit the influence of occupation upon the diseases of nervous and mental character. In some few instances the relationship is definite and easily established, as in the locomotive engineer's sciatica or the lead worker's palsy. These may be called primary occupational diseases. In a second large group of cases, mainly functional, like neurasthenia, hysteria, etc., the symptoms may be due to unhygienic and depressing conditions of work rather than to anything intrinsically harmful in the work itself, such conditions,

for example, as are so frequently met with among garment workers and textile fabric makers. These may be called secondary occupational diseases. A third group of cases, still less definite, are those due to unusual conditions of exposure or mode of work, as exemplified in various occupational psychoses and insanities, where the combined influences of alcoholism, syphilis, irregular hours of work, strain of "speeding up," etc., make it extremely difficult to adjust the balance of one factor over another. These may be called occupational nervous diseases of mixed origin.

The primary occupational nervous diseases usually affect the upper limbs (in about 90 per cent. of cases, according to Charles L. Dana), although the legs, face or trunk nerves are sometimes involved. They include paralysis, atrophy, neuritis, neuralgia, spasms, and a variety of sensory disturbances. Helene R. Baraks, in a Paris thesis of 1901, mentions 119 varieties of occupation especially liable to cause localized neuritis and other troubles from overwork.

The secondary occupational nervous and mental phenomena are often less amenable to treatment than are those of the preceding group, for they are not only general rather than local, involving many organs, but are often referable in part to conditions of home environment difficult or impossible to control, even where well appreciated. The same statements apply in even greater degree to the third group of mixed cases. As Dana says, it may not be the occupation itself in such cases which does the chief harm—it is merely a contributing factor. "It is what is done between times, what kind of rest is taken and what kind of home life is lived. It is this which does the harm." Occupation in general under wholesome conditions is far more healthful than idleness, and he believes that one reason why women are more "nervous" than men is that they have fewer occupations. Hence "it is not occupations themselves, but the industrial and domestic conditions to which working people are subjected, which cause the mass of nervous and mental diseases.

"Scientific management, therefore, which speeds up the human machine, must give it longer rest and an absolute change of nervous and mental interest." (Dana.)

GENERAL FATIGUE

Fatigue of muscles, nerves and the mind constitutes an important factor in predisposition to disease among many classes of workmen and operatives. Its effects have become very noticeable of recent years, owing to the practice of "speeding up" or increasing the output of work under contracts where time-saving is an essential matter. (*See* Speeding up, page 64.) General fatigue is most often met with among mill and factory operatives in the textile fabric industries. In these industries much complicated machinery is employed, and the faster it is operated and the longer the hours of work, the greater the physical and mental strain and consequent fatigue reaction. These problems have been most comprehensively studied by Josephine Goldmark in her admirable book on "Fatigue and Efficiency," comprising the results of studies made under the auspices of the Russell Sage Foundation.

Potent factors in inducing fatigue found in large factories are incessant floor vibrations, as where many looms are working, constant noise, the confusion resulting from overcrowding, poor air, poor light and monotony of work. Fatigue is known to diminish the quantity of antibodies in the system, and hence to increase its susceptibility and lower its resistance to infectious diseases such as grippe, pneumonia and tuberculosis. General fatigue further acts by inhibiting digestion and ultimately interfering with nutrition. Another important result of general fatigue is in the decided increase in frequency of accidents from machinery which it occasions by lessening the alertness of the operative.

In many industries, such as those of clothing manufacture, fruit and vegetable canning, etc., the season of the year makes the work periods very uneven, so that the employees may alternate idleness with physical strain and mental worry. For women and children this is particularly bad. Women possess, as a rule, less reserve strength than men for endurance in such tasks, and, owing to the menstrual function frequently becoming disordered under fatigue, they are liable to suffer serious and sometimes permanent impairment

of health. They also are more liable to suffer from constipation, digestive disorders, and anemia, especially of chlorotic type.

In some industries, such as work with blast furnaces, men are sometimes required to work in 24-hour shifts, although of late years this has been found to be an economic disadvantage, and is therefore less common than formerly. Engineers of fast trains are liable to the strain of long hours of concentrated work and attention, and the fatigue thus induced so lowers their power of alertness that serious accidents have in the past resulted from it.

Continued fatigue results in muscular tremor and weakness, somnolence, or sometimes insomnia, and has a marked tendency to lessen the activity of the digestive functions. If greatly prolonged, it results in neurasthenia, hysteria and a variety of functional nervous disorders. Fatigue of individual muscle groups is described under the heading of Neuroses, on page 546. Neuralgias also are induced by it. Very similar to the effects of physical fatigue are those of worry which are more or less associated with occupation. Among these must be reckoned the fear of losing work, inability to complete allotted tasks on time, and a host of domestic anxieties, most of which resolve themselves into the matter of low wages and the consequent inability to secure adequate food and housing.

NEURASTHENIA

Neurasthenia is very common among many classes of workers. It is a dystrophy involving nerve centers in the brain and spinal cord and not originating in peripheral nerves, although the vasomotor and sensory impulses become ultimately involved. As the disease is not fatal, opportunities for minute pathological study are unobtainable unless the patient dies from some acute disease or injury, but there is believed to be hyperemia of the gray matter of the brain, medulla and cord, and basilar headache is very common. There is a weakness of vasoconstrictor inhibitory centers, with consequent irregular dilatation and contraction of the vessels all through the body (Dana), and the vascular and glandular organs fail to obtain properly regulated blood supply in response to physiological

demand, hence all manner of functional digestive disorders arise and general metabolism is impaired.

To recount all the varied phenomena of this disorder would comprise very many of the symptoms known to medicine, for the victim of it is rarely lacking in imagination, no matter how dull his other faculties may be. The distinctive characteristics, however, may be summarized as a general mental and bodily exhaustion, often without external appearance of any illness. The physical state is characterized by disproportionate fatigue reaction to the slightest muscular effort, and the mental state by depression, vacillation, complete loss of decision, vague but constant apprehension of impending ill, and the discovery of neuralgic pains in every part of the body in turn. In some patients it may become a state of the utmost wretchedness, which is the more unendurable because there often seems to be no real physical cause which might be removable. Others regard their ailments with equanimity. While there may be actual physical ailment, the condition is predominantly a psychic disorder, for often much more serious local disease exists without the mental depression or apprehension of the neurasthenic. The disease is commonest in middle life, the very young and aged being equally free from it. I do not recall an octogenarian neurasthenic. By that time, if ever, one has found an equilibrium of life which is little disturbed by occupation or environment.

The cause of the disease might tersely be described as worry and hurry; hence at times of "speeding up" in different employments the foundation of the trouble is chiefly laid. Overwork, work in depressing surroundings, as in dark, ill-ventilated, crowded rooms, monotony of piece work, are all conditions which strongly predispose to neurasthenia. To these must be added depressing home conditions of poor housing, poor feeding, family illness, drunkenness, the dread of losing work and facing starvation, and all the manifold trials and hardships engendered by poverty.

Another important cause of neurasthenia is the experience of sudden shock such as is liable to occur in many industries where accidents from machinery, or possibly explosions or fires, may endanger the lives of employees. Such shocks may injure the victim

of subsequent neurasthenia directly or be witnessed as they endanger others. Overwork alone does not give rise to neurasthenia, but when accompanied by any of the foregoing deleterious conditions or wrong habits of life, as in dietetic, alcoholic or sexual abuses, it becomes a determining factor of importance.

Neurasthenia may result from numerous types of reflex irritation such as gastro-intestinal or menstrual disorders. Statistics as to the relation of sex to the occurrence of neurasthenia vary, and, as far as occupational cases are concerned, the grouping of the sexes necessitated by special lines of work has more to do with the matter than the question of sex *per se*. In general it may be said that it is more common among girls and women than among men, chiefly because they possess less physiological reserve of nervous energy to meet the strain of unaccustomed tasks or that of the enforced haste to finish allotted tasks in quick time, or to perform extra hours of work made necessary by seasonal or other conditions of the market. The long hours of saleswomen at the height of the shopping season, and the long hours and haste often demanded in the textile and garment industries, are illustrations of these conditions. Race is another strongly predisposing cause of neurasthenia among some peoples, although it operates in great part from the fact that certain races elect occupations which themselves provide many conditions which are unfavorable. Among the great variety of races and nationalities which at all times find representation among the immigrants who find their way to Bellevue Hospital and the clinics for the sick poor in New York City, it is my experience that the Polish and other types of foreign Hebrews are more prone to neurasthenia than are any others. Because many thousands of them follow the garment industries, they afford a fertile field for its study. Prof. Sidney I. Schwab, in an essay upon "Neurasthenia Among Garment-workers" (*Amer. Labor Legislation Review,* vol. 1, No. 1, Jan., 1911), reports a study during the decade 1900-1910 of 7,000 garment-workers in the Jewish Dispensary in St. Louis, fully one-fourth of whom had pronounced neurasthenia.

Symptoms.—The symptoms of neurasthenia may be divided into two classes, the *physical* and mental. To the former belong head-

ache, dyspepsia, muscular lassitude and feeble circulation. The appetite fails, the tongue is coated and constipation is the rule. Excessive indicanuria is common. Insomnia, restlessness and undue irritability in response to external conditions are characteristics. The victim awakes unrefreshed from sleep, and dreads to resume the day's task. Pains in the neck and at the back of the head are usually complained of, and many patients become hypochondriacal and complain of neuralgic pains and sensory disturbances of all sorts, particularly hyperesthesia. These latter symptoms may be located in any part of the body, often disappear when attention is diverted, or may be produced by suggestion. Soreness of the scalp and intercostal neuralgia are common localizations of these ailments. If the occupation requires close use of the eyes, as in sewing, for example, blurring of vision, photophobia, pains in the eyeballs and muscular insufficiency may be complained of. Hypersensitiveness to sounds is common, especially among those who are employed near noisy machinery such as looms. Tremor of the hands affecting the handwriting and other delicate movements of coördination is common, as well as tremor of the eyelids, when closed tightly, frequent winking and failure to look one directly in the eye. The hands and feet are often referred to as feeling cold and may present a mottled cyanosis and clammy perspiration. Palpitation of the heart, with frequent variations in arterial tension, is common, and the latter is usually low (often 110 to 120 mm.). The sexual functions are weakened and intercourse is followed by exhaustion. The pulse volume is often small. Sighing respiration may be observed, with general feebleness of respiratory movement. The urine is of low specific gravity and often loaded with phosphates and oxalates. Dysmenorrhea is common. The skin may appear pale or yellowish and there is marked functional inactivity of the liver. Deficient biliary secretion gives rise to flatus and often foul-smelling stools. General metabolism is affected so that most neurasthenics tend to become thin, some of them markedly so. There are those, however, who eat and sleep well and maintain good nutrition, their symptoms being largely psychic. There are others who add to their weight. Owing to muscular weakness and mental inertia, they exercise little,

breathe poorly and hence suboxidation favors the storage of fat. Such cases are very common among elderly women who already tend toward obesity, but are less often seen as an outcome of industrial occupations than are the other types.

In the lean type of cases visceroptosis is exceedingly common, chiefly among women, especially after childbirth, but I have also seen many cases among men. The stomach may descend halfway below the umbilicus and become vertical. The intestines are low and a floating right and often left kidney may be palpated. Pyloric spasm or twist is common from the gastroptosis, and gastric dilatation with succussion and catarrh of the stomach result. Such cases are extremely common in my clinic, especially among laundresses, shirtwaist and other female garment-workers. Thus a vicious circle is established between the neurasthenic state, with weakness and indigestion, and the gastroptosis which follows loss of weight and of tone in the abdominal muscles and gives rise to serious digestive disorder and further weakness. Not all neurasthenics have visceroptosis, but very many do, and, if the gastroptosis develops first, it is very liable to lead to neurasthenia as long as the patient is compelled to work hard and be much on her feet, stooping, lifting or standing for hours at a time.

The *mental* symptoms comprise an intense egoism toward the patient's own physical and mental state, depression, hopelessness of betterment, constant introspection and comparison of symptoms, and marked exaggeration and reiteration in the description of them. The patient may seek all manner of advice as to a given line of conduct and then be wholly unable to arrive at a definite conclusion or carry out a definite plan of action. He worries incessantly over trivial occurrences and apprehension of ills which have no foundation in fact. He may become hypersensitive to criticism, morose and suspicious. He becomes selfish and morbidly self-analytical and introspective.

Prognosis.—Occupational neurasthenia is the commonest of the affections of the nervous system referable to special industries. It is liable to become chronic and very intractable unless the working conditions of the individual are capable of rectification. In minor

grades, while the patient still continues at work, it so greatly impairs efficiency as to become a grave economic problem in many industries. Occupational neurasthenia may not be curable while the patient remains at work, and it may be necessary to secure a long period of rest. In mild cases, however, a change of occupation rather than entire cessation of work may not only be possible but desirable, in that it occupies the mind and prevents the introspection which is so common a feature of the condition.

Prevention.—Careful consideration of the causes of occupational neurasthenia above described will suggest methods of prevention. Bearing in mind that it is not work alone, but conditions of environment in the workshop and home, and of hurry and strain, which conduce to the establishment of the neurasthenic state, many such influences may be avoided by attention to hygiene, proper intervals of rest, diversion and relaxation of nerve tension. Temporary exchange of monotonous or strenuous tasks for others less taxing may prove preventive of nervous breakdown without adding the worry of being out of employment. Periodic medical examination of working girls particularly and of working women may prove an economic gain to both employee and employer.

Treatment.—In serious cases the best results are obtained by rest, with massage, spinal douching, dieting and intestinal treatment. The nutrition should be improved by an ample diet containing especially fats and cereals such as eggs, cream, oil, crisp bacon, and butter, with hominy, rice, cornmeal "mush," and light breadstuffs. Milk may be given if pains be taken to counteract constipation. In general a low proteid diet is preferable and for a time meat should be excluded. The regular meals should be supplemented by light luncheons of such foods as gruel, cream diluted with Vichy, beaten eggs, custards and junket. The aim of dieting should be to lessen intestinal fermentation and putrefaction, and promote assimilation of foods which will increase the body weight and strength without overtaxing the digestive organs with too much variety. As improvement takes place, fresh green vegetables, white potatoes and fresh fruits, such as apples and oranges, should be given, and fresh fish may be eaten.

Intestinal treatment consists in the use of saline laxatives such as sodium phosphate or the saline mineral waters, the giving of antifermentative remedies such as salol or creosote, and daily high irrigation of the colon with a hot normal saline solution. The latter procedure often proves of very great benefit if thoroughly performed, using four or five quarts of water with free return through a double rectal tube while the buttocks are well elevated.

Hypoacidity or anacidity is often present, and dilute hydrochloric acid (♏ xx) with tincture of nux vomica (♏ x) should be given after each principal meal. In the large group of cases in which gastroptosis is present a dry diet should be prescribed and no fluid should be drunk with meals, for the reason that a glass of water or cup of coffee or bowl of soup merely adds weight to the prolapsed stomach and dilutes the already weakened gastric juice, thereby greatly retarding digestion. A low abdominal binder giving uniform support to the lower abdominal wall is most helpful in these cases. It should be worn beneath the corset, which, if tight, merely makes cylindrical compression and crowds the viscera downward. Tight-lacing, in fact, in young women seriously promotes gastroptosis. Neurasthenic patients are very apt to beg for sedatives and "tonics." As a rule, the less medicine they take the better, and on no account should strong hypnotics be used. The multiple neuralgic pains complained of may better be relieved by local treatment with anodyne liniments or ointments as described on page 542. Insomnia may often be relieved by a lukewarm general bath (95°-98° F.) or spinal Scotch douche of alternating hot and cold water, followed by vigorous rubbing, given at night, and the taking of a cup of hot milk or gruel on retiring. As the patient improves, deep-breathing exercises should be performed twice a day, and during the day reclining in the open air as much as possible is to be encouraged. In a tenement, where a balcony may be wanting, a fire-escape or the roof often may be utilized for fresh-air treatment. Lying down to rest for an hour or two after meals greatly favors digestion, particularly in the visceroptosis cases.

The psychic treatment is often as important as the physical. The neurasthenic lacks decision and each detail of treatment of every

kind should be definitely prescribed, giving, for example, the exact number of minutes for exercise, douching, etc., the hours of meals, quantity and quality of the food, etc. Much tact and patience are required to deal with the manifold minor ailments which are complained of, which often are magnified by well-meaning but too sympathetic friends. The patient should be taught not to expect a different remedy for each complaint, but that all are part of a general fatigue condition which will soon yield to the hygienic measures prescribed. So soon as the patient is strong enough, simple means of occupying the hands and diverting the mind should be initiated. For this purpose something new that yields definite, tangible results is most desirable. For example, in the Out-Patient Service of the Massachusetts General Hospital many neurasthenic working women are taught clay modeling of such simple things as cups and saucers or vases. While at work they are forbidden to discuss or think of their ailments. Remedial occupation of this type is one of the most important and successful adjuncts to treatment. The laboring poor cannot command the benefits of travel and costly diversions open to the rich, but, when possible to secure it, a few weeks of country life may do much to accelerate convalescence and prevent the relapses which are so common when the question of future work or starvation is the alternative which constantly hangs over the patient.

HYSTERIA

Closely allied to neurasthenia, but occurring more frequently in younger subjects, especially females, is hysteria. Similar causes may produce it, but especially modern occupations, which, like telephone operating, for example, tend to overexcite and stimulate both mind and body, so that the higher brain centers lose their inhibitory control or restraining influence over the general nerve functions of the body, and leave it a prey to exaggerated response to external stimulation of great variety. Acute hysteria may result from sudden fright or shock, sustained in escaping from a burning factory or an explosion, or from accidents from machinery which have befallen the patient herself or others. Although many of these cases may

scarcely be classed as strictly occupational, chronic hysteria is often occupational. It may result from overwork and the strain of "speeding up" to finish allotted tasks in short time, or in not a few instances it is the direct outcome of some form of chemical poisoning. A notable example of the latter is met with in bisulphid of carbon, which may produce hysteria in both men and women, sometimes of middle or advanced age. This type is described under Carbon Bisulphid on page 317. Lead encephalopathy, described on page 240, affords another example of a toxic hysteria, and so does poisoning by mercury (page 293).

Hysteria, then, is a psychosis due to either mental or toxic disturbance of the brain cortex. It is characterized by emotional or convulsive crises of greater or less severity, with intervening periods in which certain mild stigmata are observable. The disease may appear in a major or minor form, according to its severity, and is at present without known pathological basis.

It is, in its occupational type as in others, much more common in girls and women up to middle age than in men, although the latter are by no means free from it. The common factors of heredity, race and harassing home surroundings are accentuated by occupations involving great fatigue, long hours of work and unhygienic surroundings. Alcoholism is a predisposing factor when it exists. Among the working classes of different nationalities met with in this country the foreign Hebrews present a very large proportion of cases, as they do those of neurasthenia.

Symptoms.—*Hysteria minor* is characterized by mental depression, uncontrollable attacks of weeping or laughing without due cause, restlessness, general nervousness, apprehension, undue reflex response to external stimuli, vertical headache, spinal pains, the sensation of choking or globus in the throat, vasomotor irritation with flushing and sensation of chilliness, tremor of the hands and awkward, ill-controlled movements. There may be vomiting and a variety of hyperesthetic symptoms. It differs mainly from neurasthenia (with which it may be associated) in the peculiar, unreasonable mental state, strong emotional crises, and the stigmata described below. Volubility may alternate with taciturnity and

peevishness. The appetite is capricious and food may be refused.

Hysteria major is less common among the class of occupational cases than hysteria minor and hysterical stigmata. There are crises of convulsions, violent shouting, loud weeping, violent jactation, fainting, and semi-coma. This form of attack particularly is induced by shock or fright, and in such cases the crisis may be almost immediate, when occurring in a previously neurotic subject. There may be gastric crises with pain and violent retching. The sphincters usually remain under control. Rapid respiration (40 to 60) may be observed without complaint of dyspnea or cyanosis. The pulse is quick (110-120) and soft or feeble. Violent outbursts of temper with beating of adjacent objects or persons may be present, and there may be ceaseless reiteration of some fancied desire. The convulsions are accompanied by cries and constant jactation, but the tongue is rarely bitten, as it is in epilepsy. If the patient falls or throws herself down, she usually contrives to do so without serious injury. Certain movements such as kicking or threshing the arms may be continuously repeated. The pupils are dilated and there may be temporary strabismus. Marked opisthotonos may occur, or the patient may lie quiet with general tremor of the body and limbs. There is passage of much urine of low specific gravity and light color, following the crises.

The crises may be aborted often by an emetic, a dash of cold water, or, what is particularly useful, playing a syphon of carbonic water over the face. In some cases rigidity of the limbs follows the crisis. The crises may last a few minutes or an hour or two, and may be repeated several times a day, with equal suddenness.

The *stigmata* (or interparoxysmal state) comprise paralyses, contractures and sensory disturbances. There may be ataxic and chronic voluntary types of movement in the extremities, and one or more of the latter may be paralyzed, paraplegia being common. The laryngeal muscles may be paralyzed and aphonia is often observed. It is frequently combined with anesthesia of the mucous membrane of the pharynx. The ocular muscles and eyelids may show various types of paralysis. All these symptoms may develop suddenly, last for

a few hours or days, and disappear with equal suddenness. Amyasthenia, or sudden muscular weakness, is common whereby the patient may suddenly drop an object carried in the hand or have the legs give out. The deep reflexes are not exaggerated, but skin reflexes may be.

Contractures are met with oftenest in one or two toes or fingers to which attention is directed, but sometimes involve an entire limb. They are unaccompanied by atrophy and are easily overcome. Tremor may involve any of the voluntary muscles, including the tongue and those of the head. It is especially marked in the fingers and ceases during rest or sleep. The oscillations are from 5 to 7½ times a second (Dana). Tremor of the eyelids is very common with frequent winking.

Hyperesthetic and anesthetic areas are present in varied distribution as segmental or hemianesthesia, etc. Tactile and thermic sensations are much less often involved than the pain sense. The retina is also often anesthetic. The visual field may be limited and color sense disturbed. The senses of taste and hearing may be lessened in activity or temporarily abolished. Typical points or zones of hyperesthesia are usually present. They are most often found over the ovaries, beneath the left nipple, at the inner margin of the scapulæ, over the epigastrium and manubrium. Migraine and neuralgias are common. There may be attacks of vomiting without nausea, of food regurgitation and rumination. All food may be refused, or indigestible substances may be eaten or harmful substances swallowed, such as buttons, pins, etc. Vasomotor symptoms persist, such as flushing, areas of mottled cyanosis and cold, edema of the hands or feet, and local perspiration. "Hysterical fever" is a very problematical entity. I have seen a number of cases which on careful examination proved to be due to deliberate deception. The interparoxysmal mental state is characterized by selfishness, complaints, craving for sympathy and attention, rapidly changing moods, intensified perceptions and lack of will or definite purpose. The mind is left to drift and yield to any passing whim or impression. Deceit is common, in order to attain notoriety or sympathy.

Diagnosis.—Diagnosis of hysteria is rarely difficult in the occu-

pational cases. The symptoms are often simulated from a desire to exaggerate accidental injuries from machinery and secure financial damages, but a careful study of the stigmata above described will always lead sooner or later to detection of fraud. In the grouping of the manifold symptoms there is always something omitted or not under voluntary control by those who are malingering hysterical phenomena. I have frequently detected such frauds by placing the patient under the initial stage of slight general anesthesia. On recovery there is an interval, before the patient fully has her bearings, when previous symptoms disappear. For example, aphonia may give place to shouting, the paralyzed legs kick out vigorously, anesthesia may change to hyperesthesia, etc. Diverting the patient's attention momentarily and introducing the element of mild shock or surprise also often reveals the temporary hysterical nature of symptoms.

Prevention.—Those of neurotic temperament or inheritance should not enter industries which demand fixed attention and celerity of action such as are required of telephone operators and those employed with many kinds of machinery. It is in just such cases that a "clearing-house" for medical examination to determine efficiency would prove beneficial to employee and employer alike. Further suggestions for prophylaxis are given in the section on Neurasthenia, page 531.

Treatment.—Practically all that has been said of the treatment of neurasthenia on page 531 is applicable to hysteria. In addition the need of strong mental and moral support, and of isolation from home environment or too-sympathetic friends, is of the utmost importance. Hydrotherapy, particularly spinal douching and wet packs, is of great value. Static electricity profoundly impresses patients and may be quite useful in the cure of paralyses and contractures. For hysterical convulsions Dana recommends apomorphin, gr. 1/12, given hypodermatically. There is nothing like genuine severe nausea to distract the patient's attention from hysterical exaggerations. In general, as few drugs as possible should be used in the treatment of hysteria, and, when employed, the most should be made of their anticipated effect. Zinc valerianate, ammoniated tinc-

ture of valerian and asafetida have achieved the first reputation as sedatives for these cases.

NEURALGIA

Neuralgias are common as a result of occupational poisons and local or general fatigue. Foul air, irregularity of meals and of action of the bowels, with intestinal autotoxemia and anemia, are common causes. The inhalation of toxic gases, vapors and fumes may produce neuralgia of the nerves of the head and face or of the extremities. Chronic illuminating gas poisoning (page 323), sulphuretted hydrogen poisoning (page 362), benzene poisoning (page 311), and a number of similar toxic agents give rise to anemia, of which neuralgia is a very common accompaniment. Gastralgia results from swallowing many varieties of the common metal poisons, and enteralgia is common in lead poisoning. Among girl mill hands working in textile industries, or those employed in the several branches of the clothing industry who either stand for long hours tending machines, such as looms, or who sit in cramped positions in dusty, ill-ventilated rooms, neuralgia of facial and ovarian type is very common.

Symptoms.—The chief characteristic of neuralgia is a sharp, lancinating, stabbing or boring pain, which attacks the patient in frequent paroxysms with intervals in which there is merely a dull ache or feeling of soreness. The pain usually follows the definite course of a nerve distribution, but may irradiate from it. It is accentuated by thermic changes and superficial pressure, although deep pressure sometimes affords momentary relief. There may be accompanying sensations of numbness, formication, weight or cold. Sometimes there are transient vasomotor disturbances such as local congestion, slight elevation of superficial temperature, edema or sweating, but such changes are usually due to the organic lesions of neuritis rather than the functional disturbance of neuralgia. In chronic cases tenderness on pressure is observed over the exit of nerve trunks from bone foramina, or from between muscles and fascia. Paralysis and atrophy do not ensue. The pains of neuralgia are transitory and may be migratory, appearing successively in different parts of the

body. They may be distinctly periodic, especially when due to an occupation which establishes a fatigue rhythm. Often they are worse at night. Where constipation continues or anemia progresses they become more frequent and severe.

Diagnosis.—Neuralgia is to be distinguished from neuritis by the migratory, fleeting character of the pain and the appearance of points of superficial hyperesthesia without paralysis, atrophy or anesthesia.

Treatment.—Attention should be given to securing good ventilation and food, and, in so far as possible, rest. The use of a hot poultice often gives great relief; a menthol liniment or ointment (page 542) should be applied to the course of the nerve. A dose of calomel should be taken. The diet should consist mainly of fresh fruit and vegetables and fish with cereals. Fat foods, such as butter, cream, eggs and crisp bacon, are desirable. Water should be drunk to the extent of 8 or 10 tumblerfuls daily, to promote activity of the kidneys. For internal medication morphine should be avoided, for the condition is liable to return and the drug habit might be induced. Many patients having neuralgia find that they secure temporary relief so that they can continue work by taking large doses of aspirin, phenacitin, etc. Such remedies, if continued, depress the heart action and may cause serious cyanosis. Like the anodynes, they are palliative merely, not curative, and this should be explained to the patient. What is needed is a tonic, upbuilding treatment, with promotion of elimination of fatigue or other waste products. Abundant fresh air, simple, well-digested food, regulation of periods of rest and exercise, catharsis and an alkaline diuretic afford the most sensible means of cure. In many occupations neuralgias are not so much due to a specific poison, even when such risk is present, but to the subsidiary factors of fatigue, worry, poor air, lack of a normal amount of exercise, etc. In cases distinctly due to indigestion and constipation, as many of them are, the use of catharsis should be supplemented by nux vomica and dilute hydrochloric acid, if there be hypoacidity of the gastric juice, or the rhubarb and soda mixture if the reverse is the case. If intestinal flatulence is present, salol (gr. v., t. i. d.) may be given, or two or three minims of beechwood

creosote in capsule. In many cases of neuralgia, as of neurasthenia, the trouble arises quite as much from home conditions as from those which are occupational, and this fact should be borne in mind and investigated.

NEURITIS

Neuritis and perineuritis may affect either sensory or motor nerves, and may or may not be accompanied by paralysis. They may be caused by trauma, toxic materials in the blood, or simply by overuse and fatigue of the nerves. The inflammation, when traumatic, usually affects a single nerve or nerve group, but, if toxic, may affect many nerves, as in multiple neuritis from arsenical poisoning.

An analysis, in 1911, by Dr. W. E. Paul of 200 cases of occupational neuroses and neuritis demonstrated that the larger number of such cases are not due to cortical fatigue or irritation, but to such peripheral injuries of nerves and muscles as result from squeezing, impact, tension, exhaustion from over-functioning, etc. Such injuries induce myolytic or neurolytic changes, and through them also affect the joints, tendons and fascia. Pains produced in this manner are very often located in or around the joints, movement of which intensifies them.

Localized neuritis with muscular atrophy following overwork of special muscle groups is described by many neurologists as occurring occasionally in such occupations as those of tailor's presser, blacksmith, leather worker, etc. Friedreich observed it in a dragoon who held the reins of his horse taut, and Scheuppel mentions it in a musician who played upon a bass viol. A case of clap drummer's paralysis resulting from occupational neuritis was reported by Dr. C. J. Aldrich in the *Medical News,* Feb. 7, 1903. A woman in my clinic acquired neuritis of the middle finger from its constant use in pressing a needle in the work of cotton embroidery.

The various degrees of occupational neuritis may involve either interstitial or parenchymatous changes in the nerve, or the inflammatory process may be around the nerve or in its sheath—a perineuritis. In many cases trauma is followed by degeneration in the nerve without a true inflammatory process.

In acute types of neuritis, if the lesion be severe, hyperemia and extravasation of blood take place, and leukocytes penetrate into the fibrous network of the nerve. In the chronic cases there is more or less connective tissue increase in the nerve sheath and the bundles which surround the nerve filaments.

Multiple neuritis affects usually the peripheral motor or sensory nerves, or both, and results from such occupational poisons as arsenic, lead, anilin, carbon monoxid and bisulphid, phosphorus and mercury. The several types are described under the appropriate headings. The severer types of neuritis, in which the inflammation may assume a purulent or gangrenous form, do not often result from simple occupational causes.

In the multiple neuritis cases occurring among workmen chronic alcoholism is not only a strong predisposing factor, but may be the only one. Thus, if a worker in lead or arsenic be a hard drinker, he is much more liable to acquire a multiple neuritis than if he were non-alcoholic.

Multiple neuritis due to the chemical poisons is commonly of very chronic type, being slow in onset, in progress and subsidence. Pains in the arms and legs and aching sensations are complained of. Gradually the power to grip tools firmly or other loss of manual strength is noticed. There may be areas along the course of the nerve trunks which are hypersensitive or painful to the touch. Vasomotor disturbances may be present, the skin looking red or moderately edematous. The muscles of the forearms, arms and calves of the legs become flaccid. The muscle pains increase and atrophy ensues, with diminished response to both galvanic and faradic currents. The reflexes of the skin and tendons at the knees and elbows are lessened or absent. The transmission of pain, temperature and tactile impressions is much diminished or retarded. Except in some cases of lead poisoning the occupational cases of multiple neuritis rarely appear to affect the visceral nerves. The peripheral nerves show early changes in electrical reaction with diminution in response to faradic and especially galvanic stimulation. In the later stages reaction of degeneration may be present. In anterior poliomyelitis, on the contrary, loss of response to galvanism

develops much more slowly. In the later stages hyperesthesia may give place to anesthesia. Paresthesia is common and the patient may complain of numbness in the hands or feet and sensations of prickling, burning, etc. The sphincters are almost never affected in occupational neuritis, and the nerves of special sense are rarely affected, although the optic and auditory nerves are exceptionally involved. Of all the symptoms the most common are pain in the extremities, particularly in the arms and hands, muscle tenderness, paralysis, muscle atrophy, and early diminution in electric reaction.

Multiple neuritis of toxic origin differs from diffuse or transverse myelitis by the more gradual onset and progress with sensory disturbances, greater tendency to muscle atrophy, muscle tenderness and anesthesia in excess of cutaneous anesthesia. In myelitis, moreover, there is tendency to development of bedsores and disturbances of sphincteric action. Alcoholic neuritis more often involves the legs in greater degree than does multiple neuritis of toxic origin in which foot-drop is seldom combined with wrist-drop and cerebral symptoms are often present in the alcoholic cases.

Treatment.—At the beginning of an attack of neuritis, whether it be localized or multiple, the first requisite is complete rest of the affected muscles and nerves. In localized neuritis the limb should be supported and prevented from voluntary motion. In the multiple form the patient should rest in bed. The pains may be mitigated by gentle applications of menthol liniment (℞ Menthol, chloral āā ʒi, alcohol, aquæ camphoræ āā ʒii) or ointment of methyl salicylate in lanolin. After such applications, to be made twice a day, the limb should be wrapped in cotton wool. In some cases hot stupes give relief, applied every hour or two. Aspirin (gr. v) and sodium salicylate (gr. xx) may be given three or four times a day. General restlessness may be quieted by codein. After the acutely painful stage has passed and muscular atrophy appears, perhaps in 4 or 5 weeks, gentle massage, hot and cold douches, and 5 or 6 milliampères of galvanic current may be applied daily. Strychnin and arsenic may be given internally. Persistent paralysis or contractures demand passive exercises, and the use of appropriate splints or rubber bands so applied as to reinforce voluntary muscular effort.

NEURITIS WITH ATROPHY OF THE INTRINSIC MUSCLES OF THE HAND

In the various pressure injuries of peripheral nerves of the hand paralyses are more liable to result than sensory disturbances. Such injuries affect metal turners and polishers, jewelers, diamond cutters, and those whose work necessitates frequent alternate grasping and letting go of handles or other parts of machinery requiring pressure. Professional cyclists, accustomed to grasp and lean on the handles of their machines, have occasionally developed this form of neuritis. The pressure may be myopathic in its results, i. e., it may cause a myositis with atrophy or it may be neural as well, acting through injury to the nerves innervating the muscles. Overactivity or oft-repeated muscular actions may result in similarly localized paralyses and atrophy, but in such cases there are accompanying sensory phenomena, such as pain, cramp and paresthesia or anesthesia. Toxic conditions, such as poisoning by lead, arsenic, alcohol, etc., may also cause or strongly predispose to this type of neuromuscular lesion.

Neuritis of the deep palmar branch of the ulnar nerve is due to continued mechanical pressure in the palm or forefinger and thumb. Dr. J. Ramsay Hunt has described the affection and reported 3 cases in the *Cornell University Medical Bulletin,* vol. 1, No. 2, 1911. One patient was a jeweler who grasped articles firmly with the left forefinger and thumb which he filed with the right hand. The resulting atrophy of the muscles of the left hand innervated by the ulnar nerve is shown in the accompanying photograph of this case (Fig. 100). The marked atrophy is seen in the first interosseous space. The second patient was in the habit of grasping a machine handle firmly and repeatedly with the right hand, involving pressure with flexion alternating with relaxation. He acquired paralysis of the hypothenar, interosseous and adductor pollicis muscles, which began after a few days' work. The third patient was a brass polisher who acquired similar paralyses with reactions of degeneration.

In all these cases the sensations of touch, pain and temperature remained unaltered, and the paralysis, atrophy and reactions of

degeneration localized to the distribution of the muscular deep palmar branch of the ulnar nerve made the condition, according to Hunt, a distinct occupational disease. One or two of the patients had slight subjective sensory disturbances, such as pain in the arm and numbness or prickling of the fingers. Hunt further points out the re-



FIG. 100.—OCCUPATION NEURITIS OF THE DEEP PALMAR BRANCH OF THE ULNAR NERVE. Atrophy of the intrinsic muscles of the left hand shown. (Case of Dr. J. Ramsay Hunt, *The Journal of Nervous and Mental Diseases*, 1908, XXXV, 673.)

semblance to the much more extensive Aran-Duchenne muscular atrophies due to spinal cord lesion, but in the disease which he describes the limitation of the affected area to the original pressure area is very distinctive, the area supplied by the median nerve remaining normal, whereas in the Aran-Duchenne type of atrophy this latter area is early involved, the symptoms are progressive, not limited, there are fibrillary twitchings and different electrical reactions. "All other neuritic forms of occupation atrophy of the hands are characterized by definite subjective and objective sensory disturbances."

Herrmann Gessler, in 1896, reported a similar type of hand lesion in gold polishers in Württemberg, which Hunt regards as belonging in the same category with his own cases, i. e., due to pressure upon motor nerve branches in the hand. In one of Gessler's cases, that of a young woman, after 2½ years of work as a gold polisher she became unable to extend or separate the little and ring fingers of the right hand. The hand was cyanosed and cold to the touch. The intrinsic muscles of the hand showed advanced atrophy. She was finally obliged to abandon the work.

SCIATICA

Sciatica results from both toxic and traumatic occupational hazards. Thus it has been observed in cases of lead and arsenic poisoning and as a result of repeated blows or vibrations, as in locomotive engineers (*See* page 548), or from the cramped positions assumed by those who sit cross-legged, like tailors, or who stoop much, or kneel and sit upon the haunches, like workmen who scrape and clean hardwood floors or lay mosaic flooring, etc.

The onset of the symptoms is sudden, consisting of severe cramp-like pain felt in the thigh posteriorly and following the course of the nerve down the leg. The pain may radiate upward to the lumbar region of the affected side. It is usually unilateral, but, when occupational, may be bilateral. Motion greatly intensifies the pain, and the patient seeks relief by posture, tilting the pelvis toward the unaffected side, and inclining the torso toward the affected side. The pain soon becomes severe and continuous, with paroxysms of lancinating, burning character. There are various sensory disturbances, such as formication, numbness, coldness or weight. Special points of tenderness on pressure are elicited over the sciatic notch, at the knee posteriorly, in the middle of the thigh posteriorly, at the middle of the gastrocnemius, behind the external malleolus and dorsum of the foot. If the extended leg be raised, severe pain is felt in the sciatic notch, or, if the leg be partially extended while pressure is made at the back of the knee, pain is felt along the back of the thigh. These two latter phenomena are diagnostic (Dana).

In chronic cases muscular atrophy follows disuse. The affected leg shows vasomotor disturbances and is relatively cold to the touch.

The lesion is a perineuritis (page 540) and has a great tendency to chronicity, often lasting for weeks or months in varying intensity.

Treatment.—The limb should be fastened to a long splint extending from the foot to the axilla in such manner as to admit of local treatment without disturbance. The latter should consist of applications of the thermocautery and hot poultices. Later blisters may be applied over some of the more tender points, or anodyne liniments, such as chloroform or belladonna liniment, may be used. Free mercurial purgation is desirable, and in some cases phenacetin or antipyrin (gr. x) gives relief. At the onset it may be necessary to use morphin hypodermatically for a few days, but this should not be continued. Dana recommends bandaging the leg after applying sulphur ointment with menthol. Convalescence may be promoted by massage and the use of the galvanic current, one pole being held at the sciatic notch while the other is moved over the course of the nerve. Baking the leg in a hot-air box is another remedy suitable for subacute and chronic cases. The cases of occupational origin rarely require the extreme measures of acupuncture or nerve stretching.

OCCUPATIONAL NEUROSES IN GENERAL

Under this title are grouped an increasingly large number of neuromuscular affections arising from strain, repeated shock or constant overuse of the nerves and muscles induced by special occupations which may involve unskilled labor, but which, in the majority of cases, are connected with occupations demanding intelligence and skill. Dr. Charles L. Dana, in a clinical study of a series of 97 cases ("The Occupational Neuroses," *Med. Record,* March 9, 1912, p. 45), says that "with each new form of mechanical invention which calls for skilled manual labor some new occupational neurosis arises." Many cases, however, occur in time-honored occupations, such, for example, as the milker's cramp, etc.

A general classification of these neuroses includes: pains; neu-

ritis; muscular atrophy; cramps, symptomatic and professional; acroparesthesia. These disorders frequently exist in combination; thus pains are often a symptom of neuritis, and neuritis is often accompanied by atrophy and sensory disturbances.

In this group of 87 cases Dana found the symptoms distributed as follows:

Median nerve neuritis	10
Musculospiral neuritis	2
Circumflex neuritis	2
Peroneal neuritis	2
Atrophy of hand and arm	9
Brachialgia	20
Acroparesthesia of hand	8
Symptomatic cramps	6
Genuine occupation cramps	23
Sciatic nerve pains	3
Torticollis	2
Total	87

This group of cases was distributed among a long list of diverse occupations, as follows: pressers and ironers, tailors, carpenters, cigarmakers, jewelers, barbers, seamstresses, sewing machine operators, stone cutters, elevator boys, paper box makers, lithographers (stone polishers), miniature painters, lathers, machinists, bookkeepers, stenographers and typewriters, clerks, surgeons, laryngologists, dentists, violinists, milkers, pianists, flute players, auctioneers, pavers, housewives, bookbinders, modelers, drummers. To this list may be added cobblers, masons, laundresses, porters or others carrying heavy weights on the shoulders.

Among the occupational neuroses a large group comprises the skilled use of the hand in writing, and what may be called accessory occupations to writing (*See* page 557), such as those of stenographers, telegraphers and typewriters. A considerable group is constituted by musicians, such as pianists and violinists. Another large group is found among garment workers, such as tailors, seamstresses and

ironers or pressers. It may further roughly be estimated that fully 90 per cent. or more of the neuroses involve the nerves and muscles of the hand and arm. Other nerves occasionally affected as a result of carrying heavy weights on the shoulders are the musculospiral, circumflex and long thoracic. The cranial nerves may present occupational cramps or tics, as observed rarely in players on wind instruments, in which case there is overuse of the facial nerve branches. Dana reports a case of torticollis in a bookbinder, occasioned by rhythmical movements of the neck while at work.

The nerves of the legs are sometimes affected by neuroses, as when there is constant use of the leg in working a sewing machine pedal or other form of pedal. Motormen who stamp on a gong pedal may suffer in this manner. "Squatting" down upon the knees, as in the occupation of weeding flowers and vegetables, causes the biceps femoris tendon to compress the peroneal nerve against the head of the fibula, and in time pain, cramp, and possibly paralysis may ensue. Tailors who sit upon their crossed legs may have similar trouble.

Dr. David L. Edsall, writing of this topic in the *Journal* of the American Medical Association, quotes an experience of Dr. Latta, chief of the Pennsylvania Railroad Relief Association, who found that an exceptionally large number of locomotive engineers suffered from sciatica of the right leg, due to sitting on a bench sidewise, with the left leg hanging free and the weight of the body resting on the right hip while subjected to constant jolting. The ends of the benches were cut off to enable the men to sit squarely while facing forward, and further cases ceased to develop.

Motor bus drivers who are constantly pressing with the right foot to start the machine may suffer from sciatica and lumbago. The jarring of the machine may be a contributing element. Burroughs has described a case in which there was severe pain after each day's work in the right leg and lumbar region, intensified by motion and pressure. There was also hyperesthesia, so that the patient could not tolerate the weight of the bedclothing or lie on the right side.

Those whose work comprises the firm grasp of tools in the hand,

especially to make pressure or pound, frequently suffer from neuroses. Neuroses of the hand and arm usually begin with the symptom of increasing fatigue after prolonged use, which soon is accompanied by neuralgic pain. At first relieved by intervals of rest, the pain later becomes constant, or is excited by increasingly brief periods of use of the hand and arm, until the worker can endure the work no longer, and the symptoms may last for weeks or months after the work has been abandoned. The pains may be accompanied by points of tenderness on pressure along the nerve trunks and by subjective sensory disturbances such as numbness and formication. In some cases these symptoms are more complained of than pain, which is not necessarily excessive, or which is only evoked by use of the limb.

The ulnar and median nerve, according to Dana, are affected in like proportion singly, and rarely are simultaneously involved. An illustration of repeated monotonous muscular effort is given by W. C. Garrison, which was observed by him in a large industrial establishment in New Jersey. Here "the flooring of pine boards an inch and a half thick has to be renewed in front of certain machines once a year, because the operator's feet, from its being necessary to stand in one position constantly, wear their way completely through the boards, leaving, in their gradual descent, apertures the exact shape of his shoes and of a size not more than a couple of inches larger." He has also seen "steel and cast iron levers which actuated some of the machinery worn completely through by the constantly recurring grasp of the workman's hands." This author uses these illustrations rather to emphasize monotony of work than neuroses, but the latter readily develop under similar conditions.

Acroparesthesias arise from repeated or continued pressure upon the peripheral sensory and vasomotor nerves of the hand, as well as from exposure to moisture, heat and cold. The resulting sensory symptoms include burning, tingling and numbness, and the vasomotor disturbances comprise redness and swelling. In such cases pain and loss of muscular power are frequently wanting. Laundresses suffer sometimes from paresthesia of the hands, such as sensations of numbness, burning, tingling, etc., or from redness and swelling of the hands, induced by the trauma of hard scrubbing upon a board,

by continued moisture and alternating heat and cold. Sewing women who work perpetually on the same type of garment, repeating identical motions again and again, may acquire paresthesia of the fingers and thumb of the right hand (Margonnier), with stiffness of the right arm. From this cause Kron has described cases of ulnar neuritis with atrophy of the interossei supplied by the branches of this nerve (*See* also page 540).

The occupational cramps may be of central origin, like the various tic spasms, or of peripheral origin. Dana states that in his experience "the true types are all of central origin, but there are often symptomatic cramps occurring in the brachialgias, or aching arms, and often some symptomatic cramps are associated with neuritis."

The above described neuroses are many of them traumatic, in the sense that they are due to pressure, blows, vibrations, etc., in combination with oft-repeated muscular contractions. Others of them arise from the latter cause alone and without trauma of any significance. A third group of cases comprises those which are more definitely known as the "traumatic neuroses," and which are not necessarily occupational, or are so only in a modified sense. Such, for example, is the "railway-spine" condition which may follow a general jarring of the body received by a passenger in a railway collision. But in many industries, especially where cutting, grinding or stamping machinery is in use, the workman may receive an accidental surgical injury, as the partial loss of a limb, laceration of flesh, etc., which produces a severe general nerve shock that may beget tremors, cramp, atrophy and other nerve symptoms of more or less local character, or, as is very often the case, may produce a condition of serious neurasthenia or hysteria. The latter may be accompanied by inability, either fancied or real, to resume work which exerts a very depressing mental influence, amounting in extreme cases almost to melancholia. Where workmen, or especially working girls, are crowded together in large numbers calamities such as those of fire, explosion, a falling building, etc., may so alarm those who are in no wise physically injured that serious neuroses and neurasthenia result. There were many such cases among the

girl operatives who barely escaped with their lives from a recent calamitous fire in a shirtwaist factory in New York in which many others perished before their eyes. Several of these patients came to my clinic. An illustration of an extreme case, where a man met his ultimate death as a result, not of his own occupation, but of seeing another man die from an occupational hazard, is the following:

A man, 52 years of age, was brought to my service in the New York Hospital in 1889, unconscious, in an ambulance. When he came to his senses it transpired that the day before he had witnessed the horrible fatal roasting in midair of a lineman who fell across some electric light wires. Subsequently, while walking under a telegraph pole, another lineman cut a wire which fell near the patient, brushing off the latter's hat. The patient, thinking himself shocked to death, fell to the ground and became unconscious. Subsequently he became very weak, had partial paralysis of the right arm and leg, with pain and constant tremors. He had also hemianesthesia of the face and limbs and hemianopsia, sat brooding for hours at a time, became continuously weaker, refused nourishment, and finally, after several months, despite all treatment, both mental and physical, he died. It was proved beyond question in court that there was no current passing over the wire at the time it fell, and that in falling it did not even strike the man, but only knocked off his stiff hat. It often happens that after the shock of an escape from a burning building, or a steamboat or railway collision, or falling in an elevator, the victim may present no bruises or injuries immediately following, but after a period of days or weeks begins to manifest all the symptoms of profound nervous shock. It is as if, being originally well, the inertia of health carries him along a certain period of time and then he collapses, with muscular weakness, feeble circulation, failing nutrition, great mental depression, and often vague imaginings of internal injuries. Death such as that in the case above cited is unusual, but recovery almost always is exceedingly slow and taxes all the resources of physician and friends, for the treatment must be largely psychic.

The occupational neuroses may be accompanied by dyspepsia, a

slightly quickened pulse rate, vasomotor disturbances, diminution of sexual vigor, insomnia and irritability.

Prevention.—Most of the occupational neuroses are preventable by very simple precautions. Where pressure or repeated hammering blows are the cause, the use of properly adjusted pads or cushions, or occasional change in method of holding a tool or instrument, may be all that is necessary. In other cases frequent periods of rest with massage or douching of the hand and arm, with alternately applied hot and cold water, may avert both pains and cramps. The education of opposing groups of muscles is of service in some cases.

Dana urges the more frequent use of the left hand and arm by tailor's pressers and those engaged in similar occupations, in order to rest the right arm and thereby lessen the danger of atrophies, neuralgias and paralyses.

Treatment.—When pain is a serious feature, anodyne liniments may be useful, such as ℞ Chloral and menthol, āā ℥i, alcohol, aquæ camphoræ, āā ℥ii. Or the linimentum camphoræ, belladonnæ or saponis may be used. The gentle massage of rubbing in the liniment is useful. In some cases the Paquelin cautery is helpful. When muscular weakness or atrophy is present stimulating applications of mustard water and the galvanic battery may be employed with advantage to promote artificial exercise of the affected muscles and stimulate their circulation; 5 to 10 milliampères of current strength may be used for 10 to 15 minutes once or twice a day. The anode should be placed upon the spine over the origin of the affected nerves and the cathode moved along their periphery. The general health should be cared for and the patient should be encouraged in the belief that recovery is possible.

WRITER'S CRAMP

Writer's cramp, called also "scrivener's palsy," is neither a true cramp, being often non-painful, nor a true palsy, being usually unaccompanied by actual loss of power, but consists rather of a chronic spasmodic motor disturbance in the muscles used for writing. It is a neurosis resulting from fatigue, and the spasm is induced by

volition, i. e., resuming attempts at writing. It occurs often in persons who are perfectly well and not necessarily neurasthenic or neurotic, and is induced by long-continued writing, particularly where the same words are often repeated, as in signing a long series of documents of some kind or repeating columns of figures. Writer's cramp is favored by sitting in a confined position, with lack of freedom for arm and hand sweep, by using too hard or fine a pen which requires careful guidance and pressure. The pen should be held by those who write much with the easy position of an artist's brush, and never grasped with undue firmness. Attention should be given in writing to an easy position of all the fingers, not only those which support the pen directly. Its handle should not be allowed to slip down in the groove between thumb and forefinger, but kept well up toward the head of the first phalanx of the forefinger. When the old-time elastic quill was in general use this form of cramp was less prevalent than at present. Pencils also are less likely than hard steel pens to cause cramp. Writing under excessive strain or worry and when in ill health from any cause, if carried on for many hours each day, favors the development of cramp. The condition is more common among men than women, mainly because the latter, generally speaking, make less reliable clerks from the physical point of view, and hence there are fewer of them.

Pathology.—As there are no autopsy records of a functional condition of this sort, the pathology and morbid anatomy, if there be any, are unknown. C. L. Dana declares that "it is a neurosis having no appreciable anatomical basis." Different writers, in speculating upon the matter, claim for the pathology changes in the muscles, peripheral nerves, spinal cord and motor areas of the brain respectively. Overstimulation of the neuromuscular apparatus with fatigue phenomena appeals to J. H. Lloyd and others, but Dana argues that writing is such a complex "acquired automatic movement that it must have as its anatomical basis a certain established arrangement of the nerve-cell groups in the cervical part of the spinal cord," and "in writer's cramp the spinal group of cells are more or less used up or exhausted, and the motor impulse [from the cerebral cortex] which naturally would innervate them, strikes cells which respond

unequally, or it overflows to other cell groups, hence the spasmodic, irregular movements." In some cases, too, he believes the cerebral centers in the cortex or basal ganglia may become exhausted and functionate irregularly.

Symptoms.—The symptoms develop very slowly, often amounting to no more than a sense of undue fatigue after prolonged writing, or slight numbness of the fingers. From this indefinite onset, which may last for months if the occupation be persisted in, the case progresses to a condition in which the pen becomes entirely uncontrollable.

The symptoms vary in intensity and may not all be present simultaneously in the same case, at least not with equal prominence. There are tonic spasm and incoördination; anesthesia and vasomotor disturbance may be observed, but pain and paralysis, as stated above, are not present in all cases, and paralysis is not apt to occur, if at all, until the ailment has lasted a long time. Statements vary as to the number of cases in which the pronator and supinator muscles of the wrist are involved; probably, however, they are not in more than a tenth of all the cases. The non-painful spasm seizes the finger muscles at the moment of grasping the pen so that they stand apart rigid, and it cannot voluntarily be overcome. If the victim endeavors to hold the pen with other groups of muscles than those customarily employed, as between the first and second finger, for instance, he writes clumsily for a time, being unable to coördinate, and soon the muscles last used become involved with spasm. Other movements of fine coördination of the fingers such as threading a needle usually can be made, but movements like those made in pill rolling or cigarette rolling may be interrupted by spasm. A few patients can learn to write with the left hand. Some persons acquire a habit in ordinary writing of keeping other muscles than those of the hand tense, as in slight tension of the foot, muscles of the mouth, or more often the right arm. When they acquire writer's cramp, these other muscles may be affected slightly by spasm, sympathetically.

True tremor is rarely present in the writing muscles. When observed it is of the "intention" type, commencing when the patient

begins to write and having a more rapid and more restricted oscillation than that which characterizes multiple disseminated sclerosis. But the grosser irregular movements of incoördination, choreiform in type, are characteristic and on passively moving the fingers there is marked spasticity.

In the later stage of excessive spasm, some of the affected muscles may become paretic, but this condition is rare and usually belongs rather to hysteria, or some other form of disease like muscular atrophy, not originating in the fatigue neurosis of the typical writer's cramp.

Pain, formication or numbness may be felt at the onset of the symptoms, but these sensations may be absent throughout or develop only after the ailment is well advanced. Occasionally areas of cutaneous hyperesthesia are observed, but anesthesia is not often present except in hysterical patients.

Vasomotor disturbance is not uncommon and the fingers may become hyperemic or cyanosed and temporarily slightly swollen. Hyperemia of the skin of the face and of the neck on the affected side has been reported.

Electrical reactions are often intensified in the muscles involved, but the reaction of degeneration is wanting.

In some cases, more particularly in neurotic patients, who become worried over the interruption caused to their work, apprehensive hypochondriasis and emotional disturbances may be induced by the local phenomena.

Many neurologists are disposed to subdivide the cases of writer's cramp, according to their predominating features, into: (a) the spastic form, affecting mainly the flexors of the fingers, or sometimes of the thumb or one finger alone, with spasm and incoördination; (b) the neuralgic or neuritic form, in which to the preceding type are added: fatigue, pain and areas of tenderness extending up the forearm; (c) the tremor form in which this symptom predominates; (d) the paralytic form in which the pen cannot be held by the fingers at all. This type is more often a phenomenon of some other disease, such as hysteria.

Diagnosis.—Diagnosis is usually simple, based on the nature of

the occupation and peculiarly localized spasm unaccompanied by atrophy or reaction of degeneration. It should be observed that other forms of nerve disorder, such as occur in commencing general paresis, ataxia, progressive muscular atrophy, toxic neuritis due to alcohol, lead or arsenic, etc., chorea and other types of neuritis, when occurring in one whose chief occupation is writing, may evince an early preponderance of symptoms in the hand. In most of these instances some degree of bilateral involvement is apparent, and the progressive and more extensive evolution of the symptoms soon solves the diagnosis. In hysteria with localized spasm and incoordination the psychic symptoms usually predominate. Moreover in the hysterical cases the spasms are excited in other ways in addition to the action of writing.

Prognosis.—Improvement usually follows treatment, but many cases are very slow in manifesting it, and there is decided tendency to relapse with subsequent overuse of the muscles involved. Much depends upon undertaking treatment early and upon the patient's ability to take a long rest from the occupation. Complete cure is possible in the milder cases.

Prevention.—Prevention is best secured through a proper system of free-hand writing without shading and without resting the wrist or little finger in a fixed position on the desk. When a long series of copying names is necessary, as in signing thousands of bonds or certificates, it is well to rest the hand for a few minutes every half hour, and massage of the hand and arm combined with hot water douching aids in removing the products of waste of muscular activity and greatly lessens fatigue. Moreover, pains should be taken in all such cases to secure a soft pen and a fairly thick penholder with a cork or rubber tip, so that as much advantage as possible may be gained from elasticity. In some cases the substitution of a quill or soft gold pen for the hard steel pen is effective. Smooth paper is better than rough when much writing is done. Good light, an easy general posture at the desk, or changing from a standing to a sitting desk, or vice versa, cuffs which do not cramp free movements of the wrist, and placing the paper at an oblique angle rather than a right angle, are all minor matters which merit attention by those who

spend many hours daily in writing. As far as possible worry and "speeding up" are to be avoided.

Treatment.—As much rest as possible should be secured, even if it may consist only in five-minute interruptions of work. Pens and pen holders should be changed until the least fatiguing are secured. Obvious errors in position should be overcome. Some patients are aided by wearing rubber wrist bands attached by similar bands to the fingers. Finger splints and large, almost globular attachments to the penholder, to be held in the palm, aid some patients. Instruments have been devised to fasten the pen to the forefinger at the side, or above the fingers. Massage, douching, finger gymnastics, active and passive, the use of the Zander apparatus, are all procedures which have proved successful in some cases. The daily use of the galvanic current is also serviceable. The anode is placed at the back of the neck and the cathode moved over the fingers. Dana recommends a current of 5 to 10 milliampères for 10 to 15 minutes. For pain, rubbing with anodyne liniments and the thermocautery may be employed. Changing to the use of a typewriter exercises the fingers in a manner sometimes beneficial. Drug treatment is useless.

Influencing many of the occupational cramps, tics and spasms there is often a strong psychic factor. Thus a man with telegrapher's or writer's cramp may become convinced that he is unable to control his muscles to perform certain coördinate movements with the hand, while others, equally complex, are performed with ease. In these cases much benefit accrues from psychic treatment directed to reassure the patient that his trouble is not permanent or organic.

TELEGRAPHER'S CRAMP

This cramp originates in the same manner as writer's cramp from overuse and pressure made with the fingers upon the telegraph key, but is more liable to affect the extensors than the flexors as in the writer's neurosis. The key of the Morse instrument is held by the thumb, fore and middle finger, and the movements comprise alternating downward pressure and uplift of the key. The flexors of

the wrist are involved and sometimes the muscles of the forearm. It has been estimated by Fulton that a rapid operator may make 30,000 to 40,000 movements per hour, often working six or eight hours a day. Many operators have also to write a great deal and writer's cramp may be combined with telegrapher's. The neurosis of telegraphers is almost always markedly spasmodic in type and begins slowly, with difficulty and fatigue in making particular code letters. The extensor spasm finally draws the fingers from the key and wrist from the table (Lloyd). There are no atrophy, tremor, or anesthesia, and pain is not usually as prominent a feature as in writer's cramp.

Treatment.—Treatment is practically the same as that of writer's cramp described on page 557, and although the writer cannot change the form of instrument he often can adopt other positions of the fingers or learn to use the left hand.

SPASM OF EXCEPTIONAL ORIGIN

Localized spasm in single muscles or groups of muscles arises in many occupations as a fatigue neurosis. Such spasm is greatly influenced by mental states, being accentuated by emotion, embarrassment under observation, etc. It is of either chronic or tonic type, usually the former; the onset is slow. At first occurring only under the stimulus of use of the muscles or of excitement, it later becomes more constant and extends to neighboring muscles. The spasm may be accompanied by dull aching or sometimes sharp pain. A favorite single muscle to be thus involved is the sternocleidomastoid; the chin being turned to the opposite side and tilted slightly upward.

A few cases of occupational spasm have been recorded among cigarmakers who rolled cigar wrappers with the fingers; drivers who held taut reins; ballet dancers having gastrocnemius spasm, and spasm of the toes; smiths employed in stropping knives, sharpening swords, etc., and using heavy hammers for continuous pounding (hammer palsy), as in gold-beating, etc.; tailors, with spasm of the legs from sitting cross-legged; and seamstresses and shoemakers who may acquire spasm of the thumb and forefinger from sewing upon unyielding materials, like heavy cloth and leather.

Pianists who continuously overexercise certain fingers not rarely may suffer from fatigue neuroses, with aching pain, weakness and spasm, which may extend to the forearm. Violinists may acquire spasms of the fingers of the left hand from firmly pressing upon the strings. Such a case has been reported to me by Robert Abbe. Flutists have been known to acquire laryngeal spasm and players on wind instruments to acquire spasm of the tongue and laryngeal muscles.

Overuse of the voice in public speaking or singing, street-crying, etc., may give rise, exceptionally, to laryngeal spasm, tremor and paresis, with resulting aphonia. Sudden spasmodic closure of the glottis and incoördination of the vocal cords result.

Typewriters may acquire pain and spasm in the muscles of the fore and middle fingers of both hands. Arlidge refers to a pressure contracture of the little finger in engravers, and also backward subluxation of the thumb.

Auctioneers and conductors of orchestras may acquire spasm in the muscles of the right arm and shoulder from the continuous repetition of certain motions.

Spasm and cramp of the muscles of the foot have occurred in chauffeurs who constantly use pedals and in those who work machine stamps by tripping a pedal.

Boiler riveters formerly acquired spasm and paralysis of the hands sometimes, but this work is so largely done by machine hammers at the present time that such cases are rarely met with.

Spasm of the flexors of both hands and fingers occurs in milkers. According to Dana it is extremely rare, occurs in milkmaids only, not in men, but one of my cases of occupation neurosis was that of a man of thirty-five years who was in the habit daily of milking fifteen to eighteen cows before breakfast on cold winter mornings. He suffered from fatigue and pains in the hands and forearms with marked spasm on attempting to milk. He was obliged to abandon the work for a long period.

Dr. Thro brought to my attention the case of a woman who for twenty-five years had worked in a hat factory fastening bands inside of the hats. She acquired the habit of moving the head around to

follow rotation of the hats in fitting the bands. As she grew older and more subject to fatigue, she acquired painful spasm in the muscles employed in rotation of the head whenever she attempted work, finally became neurasthenic and in consequence of the severe cramp-like pain was obliged to abandon the work.

Annandale has reported a case of occupational spasm in a young girl weaver, whose work in following the movements of the machine caused frequent rotation of the head. When turning toward the left she developed clonic spasm and torticollis.

Treatment.—Treatment of these conditions involves the measures described for the treatment of the occupational neuroses in general described upon page 552.

GASTRIC AND INTESTINAL NEUROSES

Many forms of occupation give rise to gastric and intestinal neuroses, with alterations in the quantity and quality of the digestive secretions, alterations in mobility and pain, such as gastralgia or enteralgia. In some cases they are the outcome purely of fatigue which exhausts nerve energy and inhibits secretion and retards digestion. Sometimes they originate in irregularity in meal hours, or insufficient time for the noon meal. In still other cases they are the outcome of the strain and worry of "speeding up," etc. Such causes are very often operative among garment workers, laundresses, and workers in the textile mills.

In another group of cases they are the outcome of acute, or more often chronic, poisoning, particularly in the metal industry. The inhalation of toxic vapors and fumes may cause them, or they may be produced by toxic substances which are swallowed and act directly upon the gastric mucosa. Lead poisoning and arsenic poisoning afford familiar examples of the latter group of cases.

Treatment.—Treatment consists in remedying or removing the cause, as far as possible. Attention should be given to deliberate mastication and avoidance, if possible, of violent muscular effort directly after the noon meal. Excessive drinking of cold fluids by those whose work makes them perspire freely is to be avoided. Constipation

should be treated. Pyloric spasm and hypermobility may often be relieved by the tincture of belladonna. Hyperacidity should be treated with powders of magnesium carbonate, bismuth and soda, or the rhubarb and soda mixture of the pharmacopeia, and the opposite condition is best met by dilute hydrochloric acid with tincture of nux vomica with one of the simple bitters, such as tincture of gentian or cinchona, given with meals. Intestinal cramps may be relieved by an abdominal hot poultice or mustard paste, a hot high enema, a dose of castor oil and, if necessary, paregoric and tincture of belladonna.

VASOMOTOR DISORDERS

Dilatation of the peripheral vessels is produced by inhalation of many toxic vapors and fumes, in particular those of the nitrites. In the manufacture of nitroglycerin, nitrobenzol, anilin and many other similar toxic substances the results may be sudden and serious. With other groups of poisons there may be congestion of important viscera with serious functional disturbance. In many cases of neurasthenia vasomotor disorders play a prominent part. Headache, vertigo, faintness, palpitation and sometimes nausea and vomiting are the chief symptoms of these disturbances, in addition to either suffusion or pallor of the skin. The special vasomotor poisonings are described elsewhere under the appropriate headings. In emergency cases with serious faintness, headache, etc., such remedies as atropin, strychnin and diffusible cardiac stimulants like camphor and aromatic spirit of ammonia are the most useful remedies. For cerebral congestion with high blood pressure, the use of phenacetin, chloral, purges and hot mustard foot-baths is recommended.

EFFECTS OF PRESSURE, BLOWS, VIBRATIONS, ETC.

The local effects of rapidly intermittent pressure, blows and heavy jarring or vibrations are referred to in the sections upon the occupational neuroses (page 546) and neuritis (page 540). In addition, the general jarring of the entire body must be reckoned with. This

is experienced particularly by locomotive firemen and engineers and men who run heavily laden ill-working freight elevators. The spine, and in fact the entire peripheral nervous system, is jarred, and a condition of neurasthenia is sometimes developed (page 526). In extreme cases nervousness, insomnia and more or less gastro-intestinal disorder may result. There may be irregular neuralgic pains in the extremities with tremors and an uncertain gait. Such cases are not common, but in girls who tend looms or other machinery in textile factories where there is incessant jarring of poorly constructed floors by multiple machinery neurasthenia is by no means infrequent.

In the Government Printing Office in Washington six cases of cyst of the wrist tendons have been recorded among persons employed constantly in making firm pressure with the hands to fold heavy paper. Attention has lately been called to the constant jarring of the arm and even of the entire body by automatic hammers, such as are used in boiler riveting, riveting structural iron work and stone carving. Such jarring is capable, in time, of producing occupational neuroses or neuritis or even paresis of obstinate character.

III. THE EYES

EYE STRAIN

Eye strain, resulting in near-sightedness, is common among those employed in adjusting delicate mechanisms, such as watchmakers, or who focus the eyes constantly upon etching or engraving plates or delicate embroidery and lace making. Much visual strain also results among workmen in general who must constantly focus the eyes upon small objects near at hand under faulty conditions of illumination, by which the light is either too dim or too bright, or is made to fall at an injurious angle. An example of this is found in the asthenopia of gilders and polishers. The case is recorded of a United States Government plate printer who printed 900 sheets a night, looking at a bright electroplate, with the result that he acquired double retinitis and conjunctivitis.

Ellice M. Alger, in an article on Occupational Eye Diseases

(*Amer. Labor Legislation Rev.*, vol. ii, No. 2, June, 1912), states that there are thus three main causes of occupational eye strain: (1) asthenopia from fatigue incident to watching polished surfaces; (2) fatigue of the ocular muscles from overaccommodation in constantly focusing upon nearby fine objects, such as is experienced by embroiderers, stencilers and garment workers; (3) astigmatism and hyperopia, to which such workers are also very prone. Ciliary spasm also is common.

The various forms of eye strain thus induced beget a number of reflex disturbances such as headache, giddiness, nausea, and finally contribute to neurasthenia. The eye strains are accentuated in turn by long hours of fatiguing work, poor food, ill-lighted workrooms and many other unhygienic conditions. Watching rapidly revolving grinding wheels or other rotating nearby objects is a common additional cause of occupational fatigue. Proof-reading is another, and I have lately seen a serious case in a music teacher who stood for 8 hours a day behind her pupils, looking sidewise at the dots and bars of musical notation. Such illustrations might be multiplied indefinitely.

In the United States Navy Surgeon-General Stokes reports that gunners who point the big guns in turrets through telescopes, who begin with normal vision, soon fall to eight or ten below.

Treatment.—Relief of eye strain is obtained to some extent by frequently resting the eyes by looking at distant objects, bathing them in cold water, securing better illumination for the work, and by any measures which improve the general health.

TRAUMA AND THE DISEASES FOLLOWING IT

There are very many trades in which the eyes are at first injured by trauma and then become infected by contamination with septic germs. Notable among these trades are all forms of emery grinding, sandblasting, coal mining, metal filing, stonecutting and work like that of ashmen, coal-heavers, railway engineers, cement grinders, etc., in which much dust is forcibly blown about. In the *Report* of the Subcommittee on Hygiene of the Eyes of the American Medi-

cal Association, published in the *Journal* of the Association, July 1, 1911, it is stated:

"Many of these accidents occur in chipping, fettling or dressing rough edges of castings, ingots and even large armor plates. These chippings are very brittle and sharp and fly about, often bounding from objects which they strike. They are caused by one or two strikers hitting a chisel held against the offending part by another man. Not only particles are likely to fly from the metal struck, but from either end of the chisel or from the hammers of the strikers.

"Agriculturists often meet with eye accidents in threshing, chaff cutting, hedging, in distributing artificial fertilizers and by the entrance into the eye of spears of grains and grasses, twigs and leaves, also from insects and their stings. These injuries are usually produced by vegetable substances, straw, beards of wheat, etc., and are likely to become infected.

"Special forms of affection result in taking care of some plants, as ophthalmia among hop pickers, due to entrance of fine, thin, hair-like processes from the hop leaves."

Popping corks or the bursting of bottles being charged with gaseous fluids may bruise or lacerate the eyes and render them subject to infections, or subsequent corneal ulceration and opacity. In the Westphalian steel and iron industry, in 1905, nearly 8 per cent. of the laborers had injuries of the eye, principally traumatic, and in some smelting works the percentage was as high as 10 (Röpke). Some of the workmen exposed to the intense light from the furnaces and molten metal acquired opacity of the lens. The injured victim usually appeals to a fellow workman for relief, who attempts to rub out the sharp, often deeply imbedded, particles of dust with a corner of a dirty rag or a toothpick, etc., with the almost inevitable result of serious infection of the cornea or conjunctiva. F. W. Miller asserts that such traumatism is increasing with the extension of rapid transit, the number of new mechanical appliances and of industries giving rise to irritant dusts and fumes. Strong acids or alkaloids, lime, etc., when spattered into the eyes, give rise to ulceration with subsequent cicatrization and opacities of the cornea and

lens, which materially impair vision if they do not destroy it completely.

Through the infected wounds may follow iritis, ophthalmia, distortion of the pupil by adhesions, and other lesions which may result in partial or total blindness. So great is the danger from meddlesome attempts by workmen to remove foreign bodies from the eye that in some of the large steel plants and others, where the danger from flying particles of sharp dust is constant, the workmen are forbidden to render such aid, and the victim must go to a dispensary maintained by the company, where a skilled nurse is trained to render proper aid. The foreign bodies themselves may be sterilized by heat in foundries and machine shops, and the menace of infection usually lies in dirt subsequently introduced.

Prevention.—Prevention consists in warning workmen against the risk, posting of warning placards, the use of glass or mica shields and helmets (as in sandblasting) (Fig. 66, page 399), the use of protective goggles, the screening of grinding wheels and exposing as little of their surface as possible, and the placing of fixed glass shields on rapidly revolving machinery where they will screen the eyes of grinders (Fig. 11, page 93), the regulation of exhaust drafts to remove dust, and prevention of drafts from blowing toward the workman's face (Fig. 63, page 393). In chiseling or clipping iron or stone a canvas screen, appropriately placed, will often prevent rebound of sharp particles into the workman's eyes.

Treatment.—Sometimes skilled workmen are supplied with a flat platinum loop by which they may remove foreign bodies from the eye, after sterilizing it in a flame, but it is better not to permit them to meddle with them. Before removing the foreign body the eye should be well washed with a weak antiseptic solution or a saturated boric acid solution in sterile water, applied with an eye cup. Steel or iron particles may be removed with an electro-magnet when imbedded in the cornea, but magnesium, nickel, copper and brass dust will usually have to be removed by a scoop or snare under cocain anesthesia. Subsequently cold compresses should be applied and the eye should be rested by a pad or shield. Atropin may be required to quiet the ciliary muscle, and dionin may be used for

pain. If iritis is present mydriatics and saline catharsis are indicated. The prognosis depends more upon the promptness of removal than the size of the foreign body, although much depends upon the depth to which it has penetrated and the possibility of infection.

TOXIC GASES, VAPORS AND FUMES IN THE EYE

These substances are met with in very many industries, both as a constant menace to the eyes and casually. They are encountered notably in chemical acid and alkali manufacturing plants, "gassing" in textile industries, bleaching and dyeing, singeing in print works, in sulphur works, smelting works, etc. Some of them act only locally upon the eyes, like fumes of acids and alkalies, others, like wood alcohol (*See* page 337), act upon the eye indirectly so to speak, i. e., their effect follows absorption and general toxemia and is exerted upon the retina, optic nerve, etc., and not upon the outer structures of the eye. Others, like lead, may act in both ways, according to the mode of entrance into the body. Thus fumes of molten lead may irritate the eye locally, causing conjunctivitis, or some time after absorption may cause total blindness through neuroretinitis. Again they may cause temporary immediate effect through the circulation, producing double vision.

A large variety of poisons of this order give rise to transient affections of the eyesight, and some of them to permanent effects. These affections include: amblyopia, diplopia, retrobulbar neuritis, paralyses of the ocular muscles, neuroretinitis, iritis, conjunctivitis, corneal opacities, etc. The various poisons may give rise to any one or more of these conditions, depending upon the strength of the poison and duration of the exposure. Especially hazardous are the fumes of dinitrobenzol, which is much used in the manufacture of high explosives.

Other substances which formerly produced much eye trouble have been eliminated from modern processes of manufacture or the operatives are better protected by the wearing of respirators and glasses, as well as by the presence of exhaust fans. Such substances

are iodoform, volatile coal tar products used in dyeing, arsenic, formerly used in cosmetics and in the coloring of wall papers, artificial flowers, and paints; carbon-bisulphid, formerly employed in vulcanizing rubber.

Naphtha, if allowed to evaporate from uncovered containers, is very damaging to the eyes if inhaled in ill-ventilated rooms. It is used in clothes-cleaning and as a solvent for shoe cement and rubber, and in the manufacture of japanned or patent leather.

Treatment.—The eyes should at once be washed out with lukewarm sterile water, and in many cases it is desirable to put in a few drops of liquid vaselin, or olive or castor oil, which should be kept at hand in workshops where such risks are liable to be encountered. If iritis or conjunctivitis follow, atropin may be used to quiet the ciliary muscle and dionin may be used for mitigation of pain. The eyes should be rested and protected from light, if necessary, by bandaging.

IRRITANT FLUIDS IN THE EYE

In many industries the workman is obliged to lean over tanks, kettles or other receptacles containing irritant fluids, to stir them or dip various articles into them, and the fluids may easily be spattered into eyes unprotected by goggles. Serious burns occur from molten lead, solder, etc.

Burns of the eye from ammonia should be treated with copious lukewarm sterile water irrigation, and, when unslaked lime has been blown into the eye in order to prevent the tears from moistening it, liquid vaselin or olive or castor oil should be dropped into the eye, and a local anesthetic, such as a 2 per cent. cocain salve, should be used to relieve the pain. If the lime is already slaked and in solution, it is best to wash out the eye first with cold water and then with a 3 to 10 per cent. ammonium chlorid solution, which acts as a solvent for calcium, as recommended by Würdemann. H. Guillery recommends the treatment of subsequent opacities of the cornea with a mixture of 10 per cent. chlorate of ammonium in water with 0.1 per cent. tartaric acid. A warm 1 to 1,000 formalin aqueous solution may be employed as a disinfectant.

Acid solutions in the eye should be treated by weak alkalies, and alkalies with weak acid solutions, which should be kept near at hand where such misfortunes are liable to occur, as in acid factories, pottery glazing, and electroplating works. For acid burns of the eye H. Guillery (*Archiv für Augenheilkunde,* lxv, 139) recommends dropping into the eye a 0.5 per cent. solution of potassium hydrate.

IRRITANT DUSTS IN THE EYES

In general all dusts are irritant to the conjunctiva and sclera. Their effects may be purely mechanical or they may give rise to slight abrasions which become infected through germs borne into the eye with unclean dust particles. The force with which dust is blown into the eye, as well as its quantity, is an important factor in the effects produced. Cinders, ashes, sand, plaster, cement, coal and asphalt are familiar examples of inorganic dusts which thus irritate the eyes, and the various organic dusts from furs, skins, feathers, rags, leather, tobacco and many textile industries, especially those of jute, flax, cotton and wool, are all frequent agents in producing both acute and chronic conjunctivitis. The organic dusts are more liable than the inorganic to convey septic germs and hence give rise to purulent types of conjunctivitis. Hop-pickers may acquire acute conjunctivitis (E. M. Alger).

Dust in the eyes causes immediate pain, photophobia, redness and sometimes swelling of the lids. There may be congestion of the corneal and retinal vessels. The tears are increased, and, if there be infection, tenacious pus tends to glue the lids together.

Chronic conjunctivitis follows persistent irritation by dust. The eyelids are red and congested, the corneal vessels are congested, and there may be granulations of the lids which give rise to much discomfort and pain, or a feeling as if the eyes were "sanded."

Treatment.—Treatment of acute cases consists in washing the eyes frequently, at first every two hours, with solutions of boric acid (saturated) or boric acid with camphor water, and the frequent application of cold compresses.

DISEASES OF THE EYES DUE TO CIRCULATION IN THE BLOOD OF TOXIC MATERIALS

In some cases the effect is transient and immediate, causing double vision and vertigo, acting mainly through the cerebral visual centers. In other cases the effect accompanies symptoms of general systemic poisoning, and is of the nature of chronic inflammation of the retina and optic nerve, causing partial or complete blindness.

Some of the toxic metals afford striking examples of these symptoms. Thus double vision is commonly associated with "brass chills" among those working in brass foundries, brass polishing, etc. Bisulphid of carbon, nitrobenzol and anilin dyes may cause serious eye symptoms (E. M. Alger).

Lead causes serious central, as well as peripheral, eye diseases, such as retrobulbar neuritis and paralyses. It may be inhaled in fumes, or irritate the eyes directly, or enter the system through the mouth. Lead poisoning, which may be acquired in very many different trades, is particularly liable to injure the eyes of painters, file cutters, plumbers, electrotypers, typesetters and cleaners, pottery glazers and polishers, storage-battery makers, paint grinders, and makers of red, white, orange and yellow lead, makers of lead pipe, tinsmiths (solderers) and cutters of sheet lead or various lead articles of manufacture.

Many volatile substances when they reach the blood through absorption may seriously affect vision acting either directly upon the structures of the eye or affecting it through cerebral anemia. Of this group of volatile poisons wood alcohol forms the most striking example, as it produces almost instantaneous and frequently permanent blindness when inhaled (*See* page 337).

The effects of intense light upon the eyes are described upon page 514.

MINERS' NYSTAGMUS AND OTHER TYPES OF NYSTAGMUS

This symptom of rapid oscillation of the eyeballs is due to picking at overhead coal which requires strain of the eye muscles,

the eyes being constantly directed both upward and to one side. It is, therefore, limited to those who handle the pick exclusively. The symptom usually subsides in time after changing the form of work. It is at present a rare phenomenon, owing to two causes, first the increasing introduction of machine methods, and, secondly, the operation of the Gross Weight Law, whereby miners are paid for the gross tonnage of the coal mined, not on the basis of the size of the nuggets. When the latter system prevailed the miners sought to increase their earnings by carefully picking out large fragments of coal, which involved the ocular strain. In the *Report* of the Illinois State Commission on Occupational Diseases of January, 1911, the statement is made that, of 500 miners examined, none presented nystagmus, although two stated that they had formerly had it and recovered. In England, however, in 1908, 386 cases were reported.

Browne and Mackenzie state that the contributing factors in producing this symptom are: inadequate light, errors of refraction, straining of the extrinsic eye muscles, and a neurotic temperament. Ninety per cent. of their patients had errors of refraction. The symptom is often attended by severe pains in the head and eyes and by quivering of the eyelids. The miners find some relief from the affection by walking with the eyes directed downward. No special treatment, excepting rest, is of any avail, and after a prolonged period spontaneous recovery may take place, which may be partial if not always complete.

Nystagmus as an occupational symptom is not alone confined to miners, and may develop in those who are compelled to give close visual attention to constantly moving objects. For example, Dr. Collis, of the British Factory Inspection Service, found that 28 per cent. of 516 female sewing machine operatives had slight grades of nystagmus from fatigue of the eye muscles in following the work through the machine.

Exceptional cases have occurred among compositors who kept their copy above the eyes and threw the head backward to glance at it.

IV. THE EARS

EXTERNAL EAR

Dusty occupations lead to choking of the external auditory canal by accumulations of dust and cerumen. The obstruction may cause temporary deafness. This is common among jute workers, in rope or cordage industries, the fine jute fibers being particularly liable to pack the canal. It is also met with in those who handle much flour (bakers), cotton or wool millers, coal heavers, cement workers, and others. The inspissated cerumen, becoming hard, may give rise to eczema. Various dusty and volatile irritants, such as zinc, arsenic, turpentine, chrome pigments, etc., may cause eczema, sometimes of pustular type, of the external ear. These minor hazards are easily avoided by cleanliness or inserting plugs of cotton in the ears.

TYMPANUM

The tympanum may be ruptured by explosions of gunpowder, dynamite or gas, or deafness, usually of temporary nature, may result from such explosion without rupture of the tympanum. Hence those most liable to suffer from this injury are gunners, miners, quarrymen, and those who test high explosives, such as dynamite and allied products.

The tympanum may also be ruptured in divers, caisson men or tunnel workers under compressed air. This is not likely to occur below 45 lbs. of air pressure, and then rarely, usually as a result of too rapid increase of air compression, favored by catarrhal obstruction of the internal auditory meatus. It may occasionally occur also from very rapid decompression from high pressure. Hyperemia and hemorrhage may take place in the membrana tympani. This has occurred both in caisson men and divers, and in balloonists making rapid ascents into rarefied air.

Professional pugilists may acquire rupture of the tympanum from blows over the ear.

MIDDLE EAR

Affections of the middle ear are very common among those whose occupations lead them to acquire naso-pharyngeal catarrh from inhaling irritant dust and fumes or from exposure to constant excessive heat and moisture. Catarrhal or suppurative otitis media may in this manner be truly of occupational origin. It also may occur in those whose outdoor occupations lead them to endure long hours of fatigue, with exposure to cold and wet, as miners, drivers, sailors, postmen *et al.* Hemorrhage and air emboli may occur in the middle ear in caisson disease.

INTERNAL EAR

Labyrinthine disease, in so far as it is occupational, is mainly due to excessive noise. It may be temporary or chronic and may result in permanent deafness. Vertigo is a common symptom of it, with sometimes nausea and vomiting, with faintness. This group of symptoms may occur in compressed air illness from air emboli or hemorrhage into the scala or semicircular canals. In such cases deafness is bilateral and usually complete. It may lead to chronic inflammation of low grade, with atrophic change in the organ of Corti.

According to Röpke's special studies among iron workers, such as smelters, foundrymen *et al.,* the combination of exposure to frequent excessive temperature changes which induce nasopharyngeal catarrh, with irritation of the external auditory meatus by accumulated dust and dirt, may cause chronic catarrhal otitis media with labyrinthine inflammation and vertigo.

The effect of noise upon the delicate internal ear presents an interesting study. It has been found that the volume of sound, i. e., the loudness of the noise, has less influence than the quality in causing deafness. A reverberating noise, long continued in a confined space like the inside of a boiler which is being riveted, is particularly harmful, but damage also occurs to the labyrinth from

explosions, as when firing big guns, especially in the turrets of warships, testing high-grade explosives, mine explosions, etc. The deafness produced by constant noise of high pitch, but not necessarily extremely loud type, is common among loom-tenders, spinners and railway engineers, and may occur in telegraphers. A large proportion of railway engineers, fully 45 per cent., if they have been employed on engines for a number of years, have more or less labyrinthine deafness. This is especially true of those employed on oil-fed locomotives, which are more noisy than those which burn coal, on account of the roar of the boiler fires. To this must be added the noise of whistles, air-brakes, and the general pounding of the train on the rails. Frequently, immediately after leaving the engine after a long run, the hearing is more defective than after rest.

In many cases of occupational deafness the patient is annoyed, even when at rest, by buzzing or ringing auditory sensations. Occupational labyrinthine deafness is more pronounced for high than low notes, so that the patient may be able to hear low-pitched voice sounds while he is, perhaps, completely deaf to the high pitch of a shrill whistle.

The men who use automatic rivet hammers in the fastening of iron girders on bridges and buildings are subjected to as much noise as boiler makers, except that, not working in a confined space, there is less reverberation. "Boilermaker's deafness," as it is technically called, is usually of labyrinthine type, and in time the high-pitched notes damage the labyrinthine structures permanently. Experiments with animals have confirmed such changes as resulting from high rather than low-pitched noises. Unfortunately, there seems to be no remedy for this hazard, for not alone the ears, but the temporal and other cranial bones are set in acute vibration, and, if a man must work inside a boiler or gun turret, he has to accept the consequences.

In iron and steel foundries noise of trip-hammers induces both acute and chronic deafness from the excessive vibrations which affect the internal ear. Gas explosions in the foundries may give rise to rupture of the tympanum.

Among 75 smiths employed in manufacturing railroad equipment, Gottstein and Kayser found 30 with serious impairment of hearing. Barr found among 100 kettlesmiths that only about 9 per cent. had normal hearing, and, among 31 more, Habermann could discover none whose hearing was not impaired. Among 40 coppersmiths Holt found 36 with abnormalities of hearing. The deafness is bilateral, but the ear usually nearest the loud noises is found chiefly affected. Subjective noises are heard in about half the cases and vertigo is common.

Most of the authors referred to locate the difficulty in the internal ear. In an autopsy upon one of his patients Habermann found atrophy of the filaments of the auditory nerve. (*Arch. für Ohrenheilk,* Bd. xxx, S. 1.)

V. THE MOUTH

The mouth and adjacent structures are affected more or less seriously in a variety of ways by the occupational poisons. The teeth may be diseased, the lips, gums and entire mucosa of the mouth may be inflamed or ulcerated, the salivary secretion may be altered, and the bones of the jaw necrosed. These changes are brought about through direct contact with poisonous substances, through their inhalation in the mouth, and to some extent after absorption in the circulation and by resecretion in the saliva.

Among the poisons which most often and seriously injure the mouth and adjacent structures are mercury, phosphorus, lead, zinc, copper, chromium, arsenic, chlorin, and the fumes of the mineral acids. Sugar and meal dusts also contribute to caries of the teeth, particularly of the incisors. The diseases of the mouth tend to produce loss of appetite, decay and loss of the teeth interfere with thorough mastication, and altered saliva impairs digestion. Resulting from these conditions is chronic dyspepsia, with malnutrition, which, in turn, favors further decay of the teeth.

THE TEETH

The teeth in certain occupations may be injured by contact with hard metals, so that the incisors lose their enamel, soften and are

ground down. This occurs in workmen who hold nails in the mouth to facilitate rapid work, as do shoemakers and those engaged in nailing lath or shingles. Glassblowers hold iron blowpipes and turn them in the mouth, so that they are liable to grind the teeth. The teeth are also affected with necrosis and resulting pyorrhea from many toxic substances, and with lead, mercury and phosphorus poisoning they become necrotic and loosened. Chlorin and its products, as inhaled in lime and soda works, paper bleaching, etc., with the moisture of the mouth, form hydrochloric acid, which softens and loosens the teeth. (*See* Fig. 57, page 368.)

Caries of the teeth has also been observed in garment workers who held in the mouth threads colored by chrome and lead salts and other poisonous dyes (Adler).

In various dusty trades the mouth becomes affected by sharp, hard particles which grind off the enamel of the teeth and cause caries. Such substances are graphite, coarse meal dust (among millers), dust from grinding mother-of-pearl buttons, sandblasting, etc. The dust particles lodge between the teeth, irritate the gums and favor the development of acids which act upon the enamel. In sugar refineries the constant inhalation of sugar dust in the mouth gives rise to similar processes of decay of the teeth and irritation of the gums (Kunert).

Actinomycosis, which is rarely acquired as an occupational infection, may produce caries of the teeth.

Prevention.—The hygiene of the teeth is of the greatest importance in the occupations especially mentioned above. They should be brushed daily after work hours and before eating with an antiseptic paste, and the mouth should be well rinsed with a soda or boric acid solution. Lead workers often use weak solutions of sulphuric acid, but they do more harm to the teeth than good. In exposure to thick dust and irritating fumes workmen should refrain from talking, and, as much as possible, breathe only through the nose.

All carious teeth should be filled or removed. In the match-making industry this is of the utmost importance, and the workers should have frequent compulsory examination of their teeth.

THE GUMS

The gums are inflamed and swollen and acquire a tendency to recede from the teeth as a result of absorption of lead, copper and mercury. The gingivitis is often chronic and painful. They may become ulcerated and affected by abscesses. Lead, copper and exceptionally other of the heavy metals may be deposited in the gums, close to the teeth, in the case of lead causing the typical "blue line," and in that of copper a greenish discoloration. In addition to the general sources of lead poisoning by inhalation and swallowing described upon page 235, there are several occupations in which lead is directly placed in the mouth. Thus shoemakers sometimes hold tin-covered nails in the mouth. Cigarmakers sometimes roll tinfoil in the mouth in covering cigars. In these instances the tin alloy contains lead. Diamond cutters who imbed the stones in a leaden matrix often moisten it with the finger wet with saliva. The saliva is increased by mercurial poisoning and altered in composition.

Treatment.—Gingivitis and bleeding gums may be treated by painting occasionally with iodin or argyrol, and the same treatment may be applied to ulcers in the mouth. For the latter, also, astringent mouth washes may be employed, such as an alum solution. Mercurial stomatitis should be treated as described on page 297.

THE JAW BONES

The bones, especially the lower jaw, but occasionally also the upper jaw, become necrosed as a result of phosphorus poisoning to a most serious extent, as described on page 352. In most cases the poison acts primarily through teeth which are already necrotic from any cause, and which afford the vapor of the poison direct access to the bones, but the phosphorus necrosis may also result from absorption of the vapor by the blood and the ultimate formation of acid phosphorus salts which are readily soluble. (This topic is further discussed on page 353.)

Chronic mercurial poisoning may also give rise to necrosis of

the jaw, but of less serious character than that of phosphorus, and very limited necrotic areas may result from neglect of teeth which have become decayed from any toxic cause with pyorrhea.

Mother-of-pearl dust may give rise to a peculiar osteomyelitis of the jaw. Gussenbauer analyzed this substance and found, besides chlorid of lime, an organic material in the membranes covering the shell called "conchiolin." His hypothesis is that this substance has a specific action in causing the disease of the bone. Fortunately it is a rare condition.

VI. THE NOSE AND THROAT

The nose and throat are subject to many forms of occupational poisons which act both chemically and mechanically. For the greater part of their effect is local and direct, but in some few instances it is part of a general toxic condition resulting from absorption in the blood of various poisons. Naturally the nose suffers more than the larynx from the irritation caused by inhalation of sharp particles of dust, especially in grinding with emery stones, sandblasting, working with raw products of animal or vegetable origin, such as wool, hair, jute, hemp, etc. In fact all dusts are irritating and the matter is one of degree of irritation. Some of the animal and vegetable fibers used in textile manufactures, in addition to their primary substances, convey irritating oil from machinery, etc. Acute attacks of sneezing, coryza and rhinitis are the usual result of such irritation, to which, however, the workmen usually soon become immune, although, if they quit work for a time, on returning to it they are liable to fresh attacks. If dusty occupations are persisted in, the rhinitis becomes chronic, and the hypertrophic form, with much secretion, often purulent, may be succeeded by the atrophic form, with uncomfortable dryness. In like manner, but in lesser degree, the pharynx and larynx may present acute and chronic inflammation with hoarseness, cough and dry burning sensations with thirst.

Certain chemical dusts, notably chrome pigments and chromic acid, and some hard dusts like that of mother-of-pearl and cement,

cause ulceration of the nasal mucosa. The chrome ulcers, which often perforate the cartilaginous septum and attain considerable size and chronicity, are described on page 183. Similar perforating ulcers have been observed resulting from the irritation of mother-of-pearl (used in button grinding), cement, basic slag, and a number of other irritants.

Epistaxis occurs in the ulcerative cases and in chronic rhinitis. It also results from inhalation of fumes of the nitrites, which cause vasodilatation.

The chronic nasopharyngeal catarrh which results from exposure to cold and damp or suddenly alternating temperatures, as among dyers, paper makers, foundrymen, and in a host of other occupations, is very liable to cause catarrh of the middle ear.

The larynx is especially liable to irritation and inflammation from the inhalation of strong ammonia fumes, chlorin gas, and the fumes of mineral acids. Edema glottidis sometimes occurs in such cases.

Prevention.—Prevention of the different forms of nasal irritation is to be provided by proper ventilation, the wetting of dusts, where possible, the wearing of respirators, and, in the case of dusts which may be chemically irritating, by the greasing of the interior of the nose with vaselin or simple cerate.

Treatment.—Treatment of the rhinitis consists in cleansing the nostrils by spraying or irrigation with warm normal salt solution or saturated boric acid solution. Excessive secretion may be controlled by the use of atropin (gr. 1/200) twice a day and astringent sprays of persulphate of iron. The healing of ulcers may be promoted by touching them with nitrate of silver solution or using an ointment of ichthyol or resorcin.

Severe acute inflammation of the larynx may be relieved by steam inhalations, and a spray of iodoform in ether (gr. ii, fl. ℥i). An ice bag applied to the neck externally is useful, and, for edema of the glottis or vocal cords, nothing is so good as a 1 : 1,000 adrenalin chlorid spray. Rarely intubation may have to be resorted to temporarily.

VII. THE SKIN

GENERAL PATHOLOGY

The skin is naturally protected to a great extent against external irritation and vulnerability, both by its structure and physiological function. Thus under some forms of irritation there is epithelial proliferation, with protective hardening; in others there is desquamation, with stimulation to greater circulatory or secretory activity. Variations in the local blood supply and absorptive power are frequent under chemical, thermic and other forms of irritation. In addition it should be noted that there is a wide range of personal idiosyncrasy in response to external, especially chemical, cutaneous irritants, so that the popular notion of "thick skinned" and "thin skinned" types of persons, although applied to mental traits, has also a more literal foundation in regard to structure or resisting power. The latter, moreover, while partly racial and partly hereditary or "constitutional," is also subject to considerable variation in the same person at different periods of life and under different conditions of health.

Thus, as stated by Dr. John A. Fordyce: "The majority of irritants met with in the trades do not of themselves evoke an eruption, but rather act in conjunction with certain contributing factors. Those which come more prominently under consideration are a 'special susceptibility,' a delicate skin, or one presenting some congenital anomaly, as excessive dryness or ichthyosis; impaired gastro-intestinal, hepatic, or renal function; a depressed state of health, neglected hygiene of the skin, or a lowered resistance by a pre-existent eruption."

The latter factor of lowered resistance by previous irritation is highly important in the industrial diseases of the skin, for a man may handle a deleterious substance for a long time with immunity, but, once a skin lesion arises from it, it is liable to recur again and again. This is particularly true of the irritation caused by X-ray burns and certain dyestuffs. Moreover, repeated attacks of occupational skin lesions may result in chronic disease, very difficult to

cure completely, for, vulnerability of the skin being permanently increased by one form of irritant, other substances may act upon it which ordinarily would be without effect. All this has practical bearing upon injury to many classes of workmen and temporary or permanent incapacity among them.

Another important influence in favoring the production of occupational dermatoses exists in the prolonged maceration of the hands and arms when immersed in water, especially when cleansing soaps are used which remove the protective fat or oil of the surface. The macerated horny cells are also removed by friction in drying the skin. Under these conditions the skin is rendered much more vulnerable to all forms of irritation. This is particularly noticeable in the hands of washerwomen, dishwashers and those of surgeons and dentists whose frequent ablutions are followed by the use of such antiseptics as lime, corrosive sublimate, carbolic acid, potassium permanganate, etc.

Occupational dermatoses are very common, and John A. Fordyce states that they comprised two per cent. of the new cases treated in 1911 at his clinic in the University and Bellevue Hospital Medical College.

SPECIAL DERMATOSES: DERMATITIS AND ECZEMA; ECZEMATOID DERMATITIS

Dermatitis of occupational origin may be local or general, and is a common accompaniment of other dermatoses, especially eczema. In both conditions excessive heat and exposure to continued moisture are often as much responsible for the irritation as any specific properties in dust or dirt, as in the case of laundresses and sugar refiners.

The dermatitis, which is most often of eczematoid type, varies from a simple erythema and desquamative condition of the skin (Fig. 101) to a vesicular and bullous state. With prolongation of the exciting causes of an eczematoid dermatitis, the catarrhal inflammation assumes a chronic state, the skin becomes infiltrated, thickened and hardened, and desquamation is accompanied by fissures which are sore and painful, often bleed and are liable to purulent infection.

Many of the dermatitis or eczematous eruptions due to occupation give rise to intolerable pruritus, and the scratching which follows opens the fissures in chronic cases or makes new abrasions which are liable to infection and are made worse by continuance at



FIG. 101.—SEVERE DERMATITIS FOLLOWED BY COMPLETE EXFOLIATION IN A BARBER CAUSED BY USING HAIR DYE CONTAINING ANILIN. (Courtesy of Dr. John A. Fordyce.)

the original trade. Workmen often give their own names to such eruptions, such as "polisher's itch," "tar itch," "baker's itch," "cement itch," "grocer's itch," "sugar refiner's itch," etc.

An acute form of dermatitis derived from the volatile essential oils of certain plants, of which there are said to be more than 60 species, is known to affect the hands and face in florists. The most striking illustration is in a large variety of Dutch primrose. It is not necessary for contact with the plant to take place, as the emanation is so volatile that it will act at a distance of some inches. The eruption may be a simple erythema, or may closely resemble erysipelas, with vesicles, blebs and general subcutaneous edema. Only a few persons, however, are sensitive to this irritation. Other examples

exist in the eucalyptus and certain varieties of chrysanthemum. The familiar poison ivy (rhus toxicodendron), poison sumac and poison oak have a similar property. There is a tree of the genus Rhus from which lacquer gum is derived in India. Fordyce thus describes the cutaneous irritation caused in some persons by contact with the lacquer or by inhaling fumes derived from it: "The symp-



FIG. 102.—ECZEMA OF BOTH HANDS IN A FURRIER. (Courtesy of Dr. John A. Fordyce.)

toms appear in a few hours, and consist of fever and edema of the skin of the face, limbs and generative organs, nasal and conjunctival catarrh, and a papular eruption of the legs and forearms."

Some of the woods having resinous dust, on being sawed, may cause a widespread dermatitis, with fever, vomiting and cutaneous symptoms lasting several weeks.

Five cases of dermatitis among fur workers in New York City were reported in the early part of 1912 to the State Labor Bureau. Eczema also occurs in furriers. (Fig. 102.)

As a result of the intense heat and light irritation of electric

smelting the exposed skin of the face, neck and hands is affected by a burning sensation, redness, and sometimes blebs form. There is subsequent desquamation.

Herxheimer enumerates 74 trades which may give rise to eczematoid dermatitis. Bakers acquire dermatitis from the heat, moist dough, and saccharin materials to which they are exposed. Sugar refiners have a dermatitis of the hands, forearms and legs. They also acquire an infective lymphangitis, with boils, due, according to Gaillot, to infection of the scratched skin with the Staphylococcus pyogenes aureus, this common organism being found in molasses and the sugar cane residue.

Redness and roughness of the skin of the face become a chronic condition in certain types of workmen, especially those working in nitrous gases, caustic soda or potash, sulphuric and hydrochloric acids, etc. It is also common in those exposed constantly to rough weather, as drivers, seafaring men, engineers *et al.*

Eczema is by far the most common of the occupational cutaneous lesions, and naturally so, for these lesions are due mainly to external irritation and not to internal toxic action, and the hands are exposed so constantly to all forms of dirt, dust, oils and chemicals.

Among those most often developing this lesion on the hands or elsewhere on portions of the body exposed to the irritation are:

Masons and others who handle cement and lime;

Stonecutters exposed to various dusts;

Plasterers who handle lime, cement and sand;

Brickmakers, who are exposed to brick dust and the dust of glazed tiles which may contain lead—they may have a palmar dermatitis;

Bakers, who are exposed to heat and the dust of flour;

Bottle washers and barkeepers;

Sugar refiners, molasses stirrers and candy makers—the molasses residue contains much irritant dirt;

Cooks, who from constant exposure to heat are very prone to chronic eczema (Fig. 103);

Coal heavers;

Washerwomen especially when using alkaline or irritant soaps.

The element of trauma is also a factor in this occupation from pressure on the rough washboard. John A. Fordyce states that about one-third of the occupational dermatosis cases presenting at



FIG. 103.—CHRONIC ECZEMA OF THE HANDS AND FOREARMS PRODUCED BY LOCAL IRRITATION. The patient was a cook, 55 years old, who had suffered from repeated attacks of eczema for 7 years. (Courtesy of Dr. John A. Fordyce.)

his clinic were in work people who had their hands much of the time in water and soap, and sometimes cleansing alkalies. He states that "the excessive use of soap and water by extracting the fat and macerating the horny layers reduces the resistance of the skin";

Carders and spinners of jute, flax, cotton and wool, who are exposed to machine oil, fiber dust and dirt;

Woodworkers, cabinet makers, etc. Herxheimer mentions 12

kinds of exotic woods which contain irritant substances. At least one variety of wood contains a substance resembling chrysarobinic acid. Teakwood contains an essential oil which is not only specifically irritant to the skin, causing a universal and very intractable



FIG. 104.—CHRONIC ECZEMA OF HANDS AND FOREARMS. Common type following prolonged contact with irritants. In this case the irritant was wood-alcohol used in the preparation of varnish. (Courtesy of Dr. John A. Fordyce.)

eczematoid dermatitis, but sometimes systemic symptoms such as vomiting and other digestive disorders;

Polishers and cleaners who, from using benzene, impure turpentine and resins dissolved in wood alcohol, often suffer from eczema with marked pruritus (Fig. 104);

Surgeons and nurses, who may acquire chronic eczema of painful fissured type from the constant use for disinfection of the hands of such antiseptics as mercuric bichlorid, chlorid of lime, and carbolic acid;

Workers who, with arsenical and chrome pigments, may acquire eczema and other more serious dermatoses;

Dyers and users of anilin colors, especially the red, orange and black colors, who may acquire eczematoid dermatitis, as may those with sensitive skins who wear underclothing thus dyed. The eruption in exceptional cases becomes pustular;

The black, red and orange yellow pigments, according to Fordyce, are the most irritating;

Calico printers, who from the use of caustics and bleaching materials may have eczema and fissures of the hands;

Iron workers, who sometimes suffer from affections of the skin. Eczema of the hands, forearms and ears may be developed through exposure to great heat in smelting, combined with the irritation of dust. The dust of coke used in the process, mingled with sweat, chokes the orifices of the cutaneous glands, and small particles of steel or iron may lacerate the begrimed skin, which, on becoming superficially infected, presents furunculosis;

Metal workers, machinists, and printers, who acquire eczema and ulceration from the irritation of metal dust, machine oil and such substances as acids, benzene and turpentine which they use;

Electroplaters, who acquire eczema from lime dust, olive oil, and the acid beer used in "scratch brushing";

Miners and smelters, who, working in the production of mercury, may acquire a pustular eczema;

Chemists, who acquire eczema from a great variety of substances which they handle. Their hands may become hypersensitive, so that, as pointed out by Fordyce, inhalation of fumes, as, for example, of formalin, may call forth a fresh eruption without necessarily touching the substance. They develop anaphylaxis. Embalmers may acquire pustular dermatoses from formalin.

Workers in tar, creosote, and a variety of petroleum products, like paraffin, naphtha, benzene and gasolene, may develop eczema.

The handling of cinchona bark in the extraction of quinin, and the contact of vapor from the boiling solutions, may affect the hands and face of workmen with chronic eczema. Manufacturing drug-

gists may suffer from the same trouble acquired in handling large quantities of quinin.

A case of eczema of the hands is reported in *Sozial Technik,* 1912, vol. 4, No. 2, occurring in an Austrian modiste who dressed straw hats bleached with sulphur.

Another case, similarly reported, of eczema of the eyelids developed in a man employed in making cork-stone. The cork, mixed with pitch, is submitted to high temperature and pressure and much fine dust is liberated in the process.

ULCERS

Ulcers of the skin and nasal and buccal or pharyngeal mucosa are produced by a variety of agents.

Typical among these are chromic acid and the chrome pigments. Details of this ulcerative process, which causes "chrome holes" in the nasal septum and "chrome sores" of the hands, are described under Chromium, on page 185.

Hydrofluoric acid, used in glass manufacture and bleaching cane and making of fertilizers, gives rise also to nasal and buccal ulcers, and forms bullæ and ulcers of the skin.

Arsenic, as well as its compounds, which are much used as pigments, may cause serious ulceration, known as "arsenic pock," and superficial gangrene of the skin of the face, arms and hands. If transferred to the genitalia during micturition, the same lesions may develop there upon the sensitive skin. Arsenic causes eczema and ulceration in tanners and furriers, in both which trades it is used as a preservative. In the curing of furs it is mixed, as a sulphid, with lime, which makes it doubly irritant.

The oils used for lubricating machinery are often irritant, partly, no doubt, from the dust and dirt which they entangle and from the difficulty of thoroughly cleansing the hands from them. Thus spinners, carders and weavers of jute, hemp, flax, cotton and wool, in addition to the eczema above mentioned, may sometimes acquire ulcers of the hands. Belgian flax spinners are subject to ulcers of the palmar surfaces of the hands, with deep fissures. Follicular eruptions also occur on the face and arms in this industry.

Ulceration of the skin is reported from the use of acid solutions in tinning processes, the use of milk of lime in cleansing metal for galvanization, and from mixing acetic acid and sodium bicarbonate in making lemonade pastilles. (*Sozial Technik,* 1912, vol. iv, No. 2.)

Hatmakers acquire eczema and ulcers from use of sulphuric acid, and photographers from pyrogallic acid and mercury.

Miners and smelters using mercury may develop a pustular eczema of the hands and arms, with ulcers.

PEMPHIGUS

J. T. Brown reported a case of pemphigus in a butcher during an epizootic of foot-and-mouth disease, and suggests a relationship possibly existing between the two diseases.

SWEAT GLAND ERUPTIONS

Sweat gland eruptions, inflammatory, vesicular, cystic, etc., are observed in a number of trades involving constant exposure to heat, as shown in stokers, cooks, foundrymen and others. Fordyce says that palmar hyperidrosis is common in aniline workers, who use chlorid of lime to remove the staining from the hands. This is also observed in the lime and soda industries and among tar and paraffin workers. The two latter classes of workmen acquire hyperkeratosis, and the abundant secretion of the sebaceous glands results in formation of large dry crusts, matted with tar or paraffin. The dirt is conveyed by the hands or enters through the soiled clothing to the scrotum.

Intertrigo is common in stout working people who sweat profusely and work in hot, dusty atmospheres. Dust and grime collect in the folds of the skin, and inflammation, with swollen, macerated epithelium and sometimes superficial erosions, ensues. The skin should be washed with a saturated boric acid solution and treated with salicylic acid ointment, gr. x to the ounce of lanolin or cold cream.

Hydrocystoma is a cystic occlusion of the sweat glands occurring sometimes in the center of the face in those who, like laundresses, lean constantly over a warm, humid atmosphere, as that over a washtub.

IMPETIGO

Impetigo occurs in various forms, especially that of scabies. Among those subject to it are candy and sugar makers.

ACNE

Acne occurs particularly in workmen in industries involving inhalation of chlorin, as in chlorate of lime works.

Acne rosacea occurs in cooks and cabmen, but is probably alcoholic in origin rather than distinctly occupational.

CHLORACNE

Chlorin gas and the chlorids of calcium, sodium and potassium, when made by electrolysis, may give rise to an eruption of the face, chest and back resembling erysipelas, and caused by evolution of hypochlorites. The erythema and edema are followed by an eruption known as "chloracne," due to suppuration of the follicular glands. Fordyce reports that "with inflammation and suppuration of the follicular glands, nodules, pustules, boils and disfiguring scars are a not uncommon sequel." The pustular eruption may extend over the chest and back, leaving extensive cicatrices. (Fig. 105.)

FURUNCULOSIS

Furunculosis may occur by itself or accompany other lesions. It is liable to appear on various parts of the body and the infection may be transferred by the hands to the genitalia in performing micturition.

René Martial ("L'ouvrier, son hygiène," etc.) cautions workmen particularly in regard to the care of the nails, for torn nails or

"hang-nails" are a frequent port of entry for infection. Such lesions should be treated with a 10 per cent. bismuth salicylate solution or a one per cent. solution of glycerole of tannin, and further protected by collodion, and, when possible, by a rubber cot.

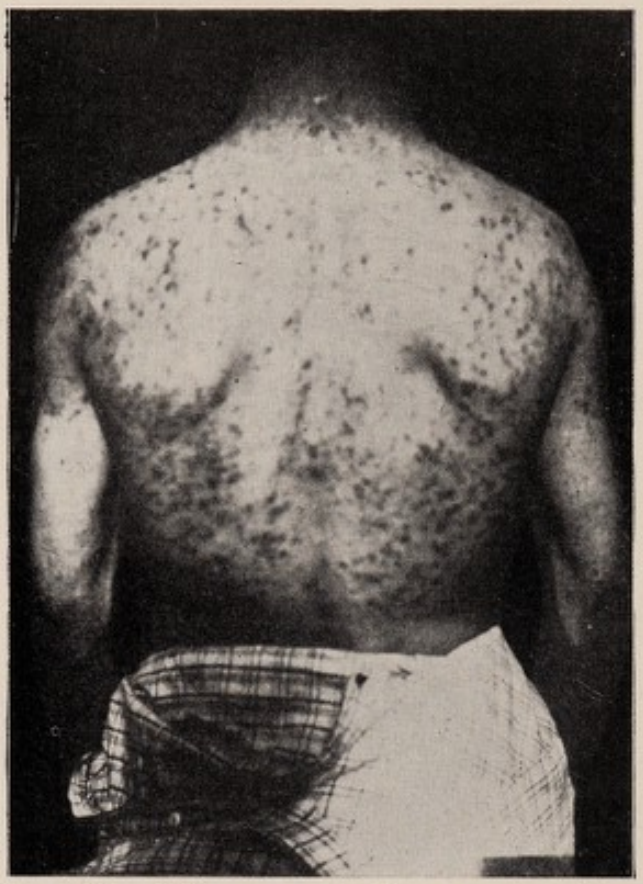


FIG. 105.—"CLORACNE." Scars produced by the universal pustular acne caused by continued exposure to chlorine gas. (From "Gefahren der Arbeit in der chemischen Industrie," Verband der Fabrikarbeiter Deutschlands, Hannover, 1911.)

Localized pustules and carbuncles often develop in those handling hides, hair and other animal industrial products. Such lesions should promptly be excised. Rag sorters are prone to similar infections, as are butchers, slaughter house workers, workers in bone-fertilizing plants, etc. They may also have impetigo contagiosa and cellulitis.

René Martial ("Hygiène individuelle du travailleur") cautions such workmen especially against picking the teeth or scratching the auditory canals with penknives, pins or other sharp instruments which are liable to cause abrasions and thus afford a site for infection.

ERYSIPELOID

Erysipeloid occurs through infection of the skin in those handling animal products, such as butchers, fish and cheese mongers, poultry dealers and cooks. Gilchrist reported 323 cases due to crab bites in fishermen. Of this disease Fordyce says, "It is believed by Rosenbach to be due to a micro-organism of the order Cladothrix.

It is characterized by one or more areas of slowly spreading inflammation, clearing up at the part originally affected and progressing slowly to new areas, the advancing border being festooned or scalloped. Burning, pricking or itching sensations accompany the affection, which involves chiefly the fingers and hands."

CHILBLAINS

Chilblains occur in those whose feet are constantly exposed to cold and dampness.

CALLOSITIES

Callosities and papillomata of the fingers and palms of the hands sometimes become very painful and annoying (Fig. 106). They are caused by repeated or continued pressure from handling many kinds of tools, and have been observed in flax spinners who stretch and pull upon the fine threads. In miners the use of the pick develops such callosities on the ball of the thumb and outer surface of the hand. They call the condition "beat hand." If the tissues become inflamed, suppuration may follow, which they call "the keens."



FIG. 106.—PAPILLOMA OF PALM OF THE HAND OF AN IRON-WORKER. Three years' duration. Lesion is due to friction from the tools of the trade. (Courtesy of Dr. John A. Fordyce.)

Callosities of the fingers are extremely common, and, in fact, are unavoidable in very many occupations in which constant pressure is made over limited areas, as, for example, in the fingers of girls who plait straw, in calico printers using stencils and brushes. Such callosities may appear from leaning against hard tables or hard benches, affecting the skin over bony prominences, such as the tuber ischii, etc.

Compositors acquire callous growths of the forefinger and thumb from constantly handling sharp-edged type (L. Devoto and L. Carozzi).

Warts or callosities may remain simple proliferations of the epidermis or form extensive granulomata and papillomata.

EPITHELIOMA

Epithelioma of the skin develops very slowly as a result of certain long-continued occupations in which irritant substances such as soot, benzene, creosote, tar and paraffin are ground into it. It usually arises from callosities, warts or other chronic lesions which may have preëxisted for years. Robert Abbe has recently shown that the occupational epitheliomata caused by X-ray burns may be removed successfully by radium.

Oliver reports the case of a man who had worked many years in coal oil and tar, acquiring extensive warts, ulcers and cicatrices. His son, doing the same work, had to have the forearm amputated for a malignant growth resulting from similar lesions. Metastases of the lymph nodes of the axilla and neck finally proved fatal.

In London, in the 17th and early part of the 18th century, when boys and small men were employed to clean out chimneys where soft coal had been burned, by climbing through them, the soot and dust was ground into the skin and epithelioma and chronic ulcers frequently resulted. Such occurrences are now fortunately very rare, and, owing to difference in method, have never prevailed in this country. Soot may lodge in the deep folds of the scrotal integument, so that scrotal epithelioma, as well as that of the thighs, hands and arms, was formerly recorded.

Gardeners who make use of soot to keep off slugs from plants are said to have developed epithelioma of the hands, but authenticated instances of such disease are difficult to find.

Workers in tar, coal oil, paraffin and other petroleum or coal tar products, however, are subject to an itching eruption of the hands which develops a keratosis and multiple warts. Hypersecretion of

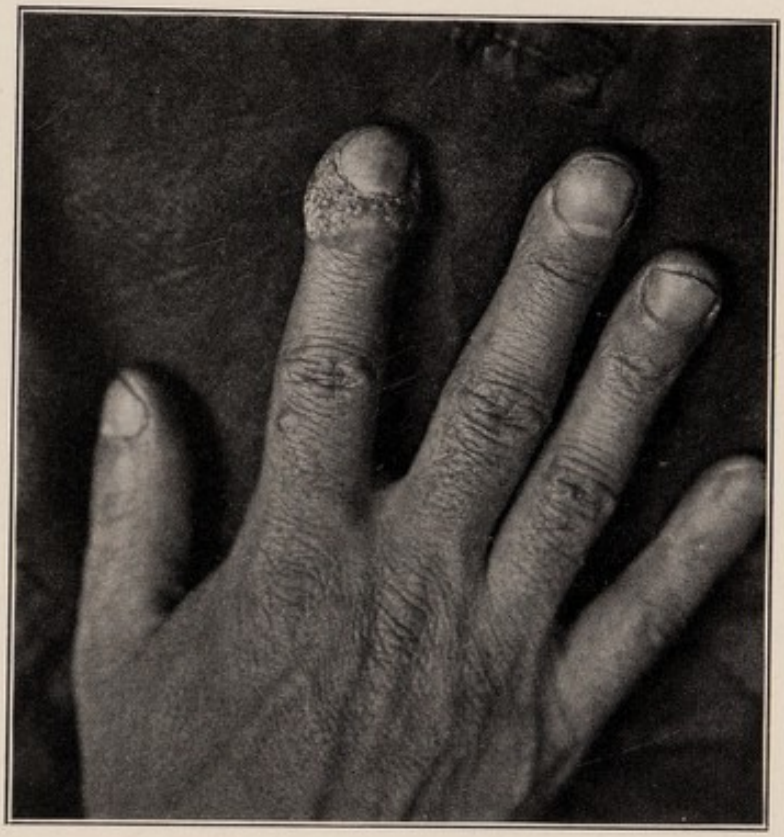


FIG. 107.—TUBERCULOSIS VERRUCOSA OF THE FINGER IN A BUTCHER. Warty form. (Courtesy of Dr. John A. Fordyce.)

the sweat glands results in extensive incrustation. The disease may be transferred in the act of micturition to the scrotum. Finally true epithelioma may appear through malignant change in the warts.

Unna has reported cases in sailors of papillomatous growths upon the face, head and hands which finally acquired an epitheliomatous character. They are attributed to the actinic rays of the sun acting upon those whose occupation has been one entailing constant exposure.

PARASITIC DISEASES

Parasitic diseases of the skin are sometimes occupational in etiology. Farmers who deal with animals infected with actinomycosis or millers who deal with grain which harbors the ray fungus have exceptionally become infected through some lesion in the mouth, such as that of a decayed tooth, or, still more rarely, through the skin.

Sporotrichosis infects stablemen and farmers rarely who have come in contact with horses or mules attacked by this mycotic fungus. Nodules develop beneath the skin which may ulcerate and produce sinuses. The disease invades the lymph channels and may be extensively distributed.

A grain mite, the Pediculoides ventricosus, which is found upon wheat straw, may infest farmers who thresh the straw, or millers who handle infected grain, producing fever resembling mild typhus and an urticarial rash and dermatitis which itch intolerably. It is rare in this country, but cases have been discovered by J. F. Schamberg in persons who slept upon straw-infected mattresses.

Anthrax is described upon page 452, and glanders upon page 458.

LOCALIZED TUBERCULOSIS

Localized tuberculosis, or verruca necrogenica, sometimes develops on the knuckles or forearms in butchers who have become inoculated through cuts received in handling tuberculous cattle. John A. Fordyce has described several such cases, two of which are shown in the accompanying illustrations (Figs. 107, 108).

FORMALIN ONYCHIA

This substance is used chiefly in disinfection, the preservation of organic compounds and making of coal tar dyes. It is used among other disinfection processes in curing horsehair for brushes. Among physicians who use formalin as a disinfectant, and museum "dieners" who use it for the preservation of anatomical and other specimens,

it causes a peculiar irritation of the distal phalanges of the fingers, with brittleness and splitting of the nails. By Fisher and Galewsky the condition has been described as "formalin onychia." It begins with brown discoloration of the nails, which then become serrated



FIG. 108.—TUBERCULOSIS VERRUCOSA IN A BUTCHER, WARTY FORM. (Courtesy of Dr. John A. Fordyce.)

and fissured. The neighboring integument becomes ulcerated. The affection is very painful, so much so as frequently to compel abandonment of the work which produced it.

PREVENTION AND TREATMENT OF CUTANEOUS LESIONS

Prevention.—Eczema of the hands may be avoided to some extent in occupations such as those of dyers, masons, plasterers, etc., by protecting the hands with simple cerate, oil, vaselin, cold cream, etc. Cleanliness is naturally of first importance, but frequent wetting and imperfect drying of the skin should be avoided.

Treatment.—The hands should be cleansed and wrapped in gauze moistened with calamin solution, liquor plumbi subacetatis dilutus, or a mild salve may be applied under a loose glove, composed of aluminum acetate solution, with lanolin or vaselin or a diluted zinc oxid ointment.

When the eczema proves chronic or rebellious to early treatment tar ointment or a weak resorcin salve, ichthyol ointment (40 per cent. in lanolin), or ichthyol collodion (40 per cent.) is useful. In still more intractable cases the hands should be bathed in tar and oil for half an hour, which is then rinsed off with green soap. Or chrysarobinic or pyrogallic acid ointments may be used. Aristol in powder or ointment is most useful in stimulating the healing of ulcers, and the old-time balsam of Peru is of service. Parasitic diseases may be treated with corrosive sublimate and carbolic acid lotions and sulphur ointment. Hyperidrosis of the soles of the feet or palms of the hands is often very annoying to workmen who wet the feet or hands constantly in solutions that denude the epithelium and overstimulate the sweat glands. The feet may be dressed with the following ointment:

℞ Tincturæ benzoini.....	4.	
Glycerini	8.	
Olei lini	15.	
Essence of lavender....	1.5	Misce.

Subsequently talcum powder should be applied. For the hands Guillebert-Dhercourt's lotion may be used:

℞ Terebinthinæ	12.	
Olei ricini	6.	
Collodion flexile.....	30.	Misce.

VIII. THE BONES AND JOINTS

ABNORMAL POSITIONS OF THE BODY

Constrained positions long maintained at certain kinds of labor give rise to various ailments and deformities, particularly through

anterior or unilateral compression of the thorax toward the abdomen. This results in impairment of movement of the diaphragm, free expansion of the ribs and sometimes visceroptosis. Those chiefly affected in this manner are shoemakers, tailors and weavers who use old-fashioned hand methods of work, carpenters or woodworkers who lean over and press against workbenches, engravers, lithographers, jewelers and watchmakers.

A man came to my clinic who had been employed as a shoemaker for 54 years, stooping over his work in a greatly cramped position. His thorax was bent upon the abdomen, his shoulders were rounded, and there was marked eversion of the free borders of the ribs and xiphoid cartilage. In addition to the pronounced thoracic postural deformity he had emphysema of advanced grade.

Curvature of the spine may thus be induced and become permanent. Dyspepsia, constipation and hemorrhoids become chronic complaints, and tuberculosis is quite common among such artisans whose indoor work and lack of varied exercise contribute to the hazard of their occupations.

Elevation of one shoulder much above the other is a very common deformity resulting either from carrying heavy weights, such as porters of various types are accustomed to carry, or from the long-continued use of heavy hammers, or pulling or pushing upon certain machines. One of my patients, a young man 25 years of age, for some years had carried heavy timbers upon the right shoulder, working as a carpenter's helper, with the result of acquiring permanent elevation of the right shoulder, lateral curvature of the spine in marked degree and compression of the left side of the thorax. I have met with a number of similar cases.

The unequal development or hypertrophy of particular groups of muscles from the constant use of machines, apparatus or heavy tools necessitating lifting, pressure, etc., is a matter of such common observation that a workman's occupation may often correctly be guessed from examination of his muscular or skeletal deformities.

Young children employed in carrying heavy baskets or trays, as in pottery works, very easily acquire lateral twists of the torso,

curvature of the spine, round shoulders, or compression of the sternum.

Varicose veins are common among motormen, those who tend machines, and others whose work necessitates standing long hours in a confined space.

Great muscular strain, besides inducing chronic deformities, may give rise to hernia and dilatation of the heart. Such conditions were formerly common among men like hod carriers and miners who had to climb long steep ladders in coming out of deep mines, but the almost universal use of lifts in connection with such work has greatly lessened these hazards.

Treatment.—Treatment of the various occupational deformities consists in correcting the attitude while at work, the training and exercise of opposing groups of muscles, and in children especially by the wearing of appropriate bandages or splints. Those whose occupation tends to produce round shoulders or a hollow chest should desist occasionally from work to practice deep breathing exercises and thoracic gymnastics.

AFFECTIONS OF THE JOINTS

Diseases of the joints are extremely common as a direct result of many industries. The greater number of ailments, by far, result from exposure to wet and cold, or to sudden alterations in temperature, with checking of perspiration, as are met with in laundresses, stokers, workers in potteries, blast furnaces, dyeing and paper making establishments, etc. Trauma is also a frequent cause of such ailments.

Persistent kneeling upon hard surfaces, as done by scrubbing women and men who lay floor mosaics or scrape and plane hardwood flooring, besides producing muscular cramps and sciatica, often leads to hypertrophy, with accumulation of fluid in the patella bursæ, commonly known as "housemaid's knee."

Automobile washers, who often work late at night in open, drafty garages exposed to wetting, are very subject to rheumatic pains, and many similar occupations could be cited which favor this condition.

There is a subacute inflammation of joints described by the patient as "rheumatism," with moderate swelling due to synovitis, more or less pain and tenderness, and especially stiffness.

Treatment.—The condition is best relieved by liniments, such as the linimentum saponis or capsici, the Scotch or alternating hot and cold douche, and the Paquelin cautery. If fluid be present, strapping the joint firmly with interlaced strips of adhesive plaster gives relief, or a bandage or knee cap may be fitted over the joint. The patient should be instructed to favor the joint as much as possible in working. In obstinate cases a capsicum blister drawing several drachms of serum often gives great relief within 24 hours.

Housemaid's knee requires substantially similar treatment with that above outlined, but a longer period of rest of the joint or change of work may be required to produce permanent relief.

In still other cases the joint symptoms are due to some general toxic agent, such as lead or mercury. In these cases there often are accompanying neuritis and muscular atrophy. Treatment should not be too vigorous. A mild liniment or soothing ointment may be applied and the joint wrapped in cotton and bandaged.

So many industrial workers come to my clinic with joint affections of one or other of the above varieties that the following circular prepared by my chief of clinic, Dr. W. H. Sheldon, is given to them:

MEDICAL CLINIC
CORNELL UNIVERSITY MEDICAL COLLEGE
OUT-PATIENT DEPARTMENT

Instructions for Patients with Chronic Joint Disease

Remember: Never consider your case hopeless. While the doctors may not always *cure,* they can do much to prevent your complaint from spreading. By following these instructions you can prevent the bad effects on the heart bloodvessels and kidneys.

To avoid catching cold

(1) Wear flannel underclothes all the year, warmer in winter.

(2) Keep the feet dry; wear warm socks or stockings; change them often if your feet perspire.

(3) Do not get wet or chilled.

(4) Keep in the open air and sunshine.

(5) Keep your rooms at an even temperature, not too hot.

(6) Avoid basement and ground floor apartments, as they are inclined to be damp.

Occupation

Avoid all out-door occupations in which you will be exposed to wet or cold, such as cabmen, drivers, conductors or motormen, sailors, etc. Indoor work, such as carpentering, operating machines, etc., is better for you.

Diet. Eat slowly; chew the food well.

Meat. Any red or white meat, boiled, broiled or roasted, once a day.

Dairy Products. Milk, cream, butter.

Cereals. Rice, hominy, Indian meal, barley, cracked wheat, oatmeal, cream of wheat, etc.

Bread. At least one day old. Whole wheat, rye, Graham, corn bread.

Eggs. Cooked in any way except *fried.*

Vegetables. Potatoes, beets, carrots, squash, lettuce, spinach, tomatoes, peas.

Fruit. All fresh fruits except strawberries.

Avoid all canned, salted, or fried meats, pastries, pickles, and all *fried* foods.

Drink plenty of water, at least two quarts daily. This carries away poisons from the kidneys. Drink *no* alcoholic liquors, including beer. They are poisonous for you and will shorten your life.

Habits. Sleep at least eight hours every night.

Be sure to have at least one good movement of the bowels every morning.

Keep the teeth clean. Have all cavities filled, as some joint conditions are caused by bad teeth.

Practice deep breathing in the open air.

Exercise. It is most necessary that you should take plenty of exercise, as this prevents your becoming crippled. Walk from two to four miles a day, and take light exercise with a cane or dumbbells, night and morning.

Local Treatment

Wrap towels, wrung out in hot water, about the joint for ten minutes night and morning. (The towels must be kept as hot as you can bear them). Then rub and knead the joint vigorously for ten minutes more. Try to move the joint a little more every day, as this prevents it getting stiff.

Caution

If a joint becomes red, swollen and painful, *go to bed,* and send for a doctor. Until he comes keep the part at rest wrapped in cotton, and take

no food except a glass of milk and some crackers. If you do this you may prevent the serious results upon the heart, bloodvessels and kidneys, and prolong your life. Remember that serious heart troubles come from neglecting to do this. [This refers to rheumatic endocarditis.]

FLAT-FOOT

The flattening of the arches of the feet, or "flat-foot," occurs frequently in occupations which demand continuous standing on hard flooring, especially in one position, as in tending certain machines. It is common among motormen who throw the body weight upon the left foot while sounding the gong of trolley cars with the right. It is met with in laundresses and is particularly common among hospital nurses, especially where the flooring is of tiles or hard wood. These women often are accustomed previously to wearing high-heeled, narrow-pointed shoes. To promote quiet in the wards, they are compelled to change the type of shoe, wearing low heels, or no heels and broad soles. I have tested the distance walked by nurses in my wards by having them wear pedometers, and found it to be from 5½ to 7½ miles per diem. Besides this, they do much standing, stooping and lifting, working from 10 to 12 hours per diem.

Mill hands who tend looms often remove their tight walking shoes and work in loose slippers, or sometimes bare feet, with the result of flattening the arches of the feet after a few weeks or months of work. The result is a constant aching in the soles of the feet, which extends up the calf of the leg, or sometimes causes pain in the knee and hip also on walking. The pain is constant while the limbs are in active use, and becomes so wearing as to interfere seriously with efficiency.

Treatment.—Treatment consists in adapting proper support to the plantar arches by orthopedic shoes, the use of massage night and morning with hot and cold douching of the feet, and by strapping the ankles and feet with adhesive plaster. In some cases cure can only be maintained through change of occupation. In tending machines while standing in a fixed spot, a soft mat of some kind is of service in preventing foot strain.

IX. THE BLADDER

Overdistention of the bladder as an occupational disorder is more common than is generally supposed and very little attention has been directed to it. It occurs most often among public carriers, such as engineers, drivers, chauffeurs, and especially motormen and conductors of trolley cars, who have long trips to make without opportunity to evacuate the bladder at the accustomed intervals. In time the bladder becomes more and more distended and its walls weakened, so that, in extreme cases, it cannot ever be completely evacuated and dribbling of urine results. The case presented in Figure 109 represents the extreme limit of this unfortunate condition. The patient was a trolley motorman, accustomed constitutionally to rather frequent micturition. He was employed for several years in making long trips on public thoroughfares where he could not respond to the calls of nature. As a result his bladder became enormously distended, reaching almost to the umbilicus, and he lost the sphincteric control and expulsive power so completely that he had constant dribbling of the overflow of urine. He was much worried by this, and, owing in part to worry and in part to irregularity

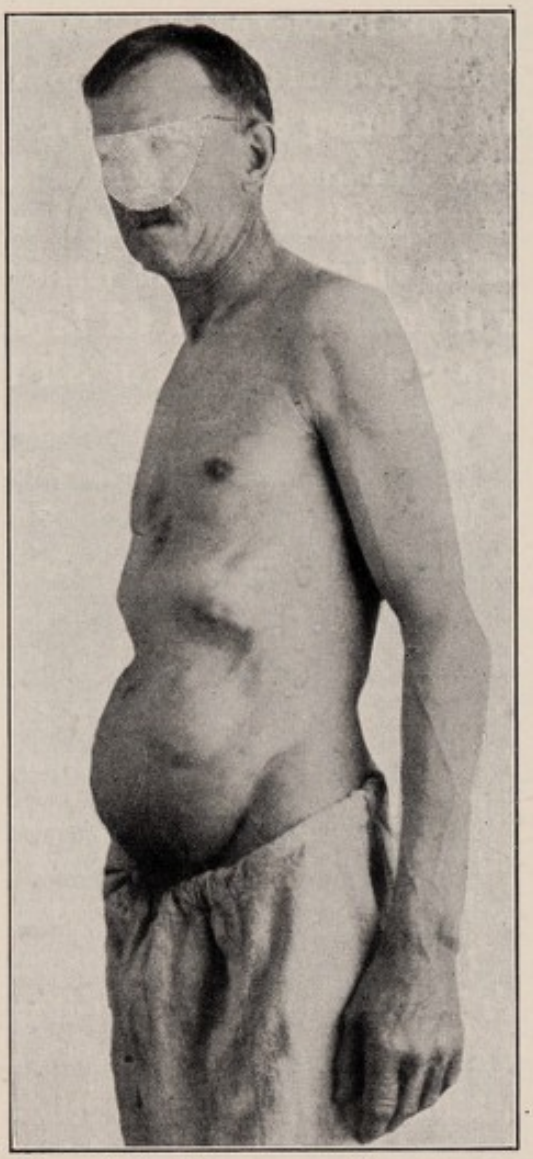


FIG. 109.—ENORMOUS DISTENTION OF THE BLADDER AND GASTROPTOSIS IN A MOTORMAN. The bladder is seen rising above the umbilicus, and the outline of the stomach, showing extreme gastroptosis, is seen lying above it in the left lower quadrant of the abdomen.

in meal hours, he grew thin and weak. His abdominal muscles became relaxed and he acquired a marked gastroptosis. He was treated by regular catheterization every six hours, the application of an abdominal binder and a dry diet with extreme restriction of fluids. Strychnin was also given. Under these measures he improved considerably, but was far from well when he left my hospital service. For some time previous he had been unfit to work.

PART VI

INFLUENCE OF SPECIAL CONDITIONS ON THE OCCUPATIONAL DISEASES

I. ALCOHOLISM

The relationship of chronic alcoholism to occupational diseases is a very important matter, and it is desirable to determine in the first instance whether any of the occupations predispose to drinking habits.

Those constantly exposed to excessive heat, such as glass-blowers, stokers, smelters and rubber workers, perspire very freely and become consequently thirsty. If they drink the malted liquors primarily to quench thirst, they soon drink too much, and in these classes of workmen drinking is rarely confined to the milder intoxicants. Beer brewers, mainly from easy access to the product, and especially beer wagon drivers, consume enormous quantities of malt liquor, often received as a perquisite in the saloons where they deliver their casks. I have seen many such men with much dilated stomachs, chronic nephritis and a tendency to obesity.

It is not to be supposed that the occupational poisons themselves develop any special craving for alcoholic beverages. Alcoholism in such cases is due rather to general lowering of vitality, often combined with gloomy surroundings, where the victim works in dark, damp or overheated rooms, as in smelting, stoking, etc., is covered with grime, has long hours of work, and depressing home surroundings, where he soon loses self-respect. Gas houses, foundries, fertilizer works, chemical works, refineries, breweries, etc., produce conditions which make nearby property undesirable for

residence, so that the workman's home and the saloon are often the only habitations within a long distance. Hence workers in such classes of industry are subjected to a dull, unvarying routine of life from which the saloon affords their only refuge. No doubt, also, the fatigue induced by heavy muscular effort in these grosser industries meets with temporary abatement by drink, but the effects of alcohol for this purpose are very transient, whereas its toxic properties are insidious and constant in their advance.

In a word the relationship of alcoholism to industrial diseases is a question of environment, and often a social one rather than a physiological one. For such reasons alcoholism is very prevalent among certain classes of workmen in addition to those above mentioned, such as painters, typesetters, bakers, ashmen, garbage men, etc. Hence any well-directed effort to ameliorate chronic alcoholism (for apparently it can rarely wholly be prevented) must deal with questions of wages, food supply and cooking, housing, wholesome diversions, cleanliness and personal hygiene, which are usually more potent than the influence of any particular trade apart from environment.

Chronic alcoholism is well known to lower the resisting power of the organism against microbic invasion, notably in such diseases as pneumonia and tuberculosis. Certain of the occupational diseases make much more rapid inroads upon the alcoholic constitution than upon the non-alcoholic. Very notable is this effect in lead poisoning. The typesetter or painter who keeps his system more or less under the influence of whiskey or gin most of the time is far more liable to serious plumbism by so doing, so that grave lesions of the nervous system are liable to supervene, such as paralysis, encephalopathy, etc.

Chronic alcoholism, in conjunction with chronic metal poisoning of any sort, is especially liable to establish arteriosclerosis, chronic interstitial nephritis and cirrhosis. Hence in many cases it is difficult to determine how much of the morbid conditions is due to the occupational poisoning and how much to alcohol. In this class of cases any acute illness, like pneumonia or rheumatism, is likely to be accompanied by an outbreak of delirium tremens.

II. SYPHILIS

The trio of syphilis, alcoholism and chronic metal poisoning make a combination of diseases which often act as synergists to each other, so that the more serious lesions of each may develop, but particularly in this class of cases are found advanced arteriosclerosis at a comparatively early age (often with aneurysm), and sclerosis of the brain and cord, locomotor ataxia and other permanent destructive lesions of the central nervous system. Cerebral hemorrhage may also take place at an early age. Plumbism in a syphilitic patient is apt to present symptoms of unusual gravity. As a matter, therefore, both of prognosis and treatment, the early recognition and vigorous treatment of syphilis are especially important in those whose work brings them into continual contact with the metal poisons.

III. ABUSE OF FOODS

There are several important dietetic matters to be considered in relation to occupation.

The normal appetite is often destroyed by toxic conditions, especially among those who deal with the toxic gases, vapors and fumes, and those who become anemic through chronic metal poisoning or from long hours of sedentary work in overcrowded, ill-ventilated rooms, such, especially, as are common in the textile and clothing industries. Often the hours of labor are such as to derange ordinary meal habits, as in night work, or rising so early on dark, cold winter mornings that little or no breakfast is eaten. Many foreign laborers, particularly Austrians and Hungarians, are accustomed before coming to this country to take no food on rising except perhaps a cup of coffee, and to adjourn work at ten o'clock or thereabout for breakfast. If compelled by American custom to work continuously until noon, they have to work many hours with an empty stomach, whereas for the laboring man breakfast should be a substantial meal, eaten early. In certain industries employing foreigners it has been found

an economic advantage to adapt the work hours to meet such habits.

Breakfast for the laboring man is often the most important meal of the day, for in some industries—especially those dealing with lead, phosphorus and other active poisons—a well-filled stomach is distinctly preventive of poisoning.

Another difficulty often met with is the brevity of the noon period for luncheon or dinner. If this meal be eaten hurriedly and hard muscular work performed directly after, digestion is retarded, dyspepsia, constipation and other disturbances result, all which tend to impair health and efficiency in marked degree. There may be no time or facilities for preparing hot food for either breakfast or luncheon, and, as a result, improper and often indigestible foods are eaten. The relationship of poor or unappetizing food and dyspepsia to acquisition of the drink habit is too well established to require detailed comment here.

The great importance of food cleanliness, particularly where contact with toxic metal dusts is possible, has repeatedly been pointed out in connection with the separate industries. Probably ninety per cent. of the cases of chronic lead poisoning might be traced to contact of dust of lead or its salts with food eaten in the workroom or without properly cleansing the hands.

In almost all large manufacturing establishments where the experiment has been tried the provision of separate lunch rooms has proved an economic success in lessening the days of illness of the employees. Well-lighted, cheerful, cleanly surroundings certainly promote both appetite and digestion. Many well-regulated industries like that of the American Telephone Company, go a step further in promoting hygiene of the employees by providing means for serving hot soups or coffee, etc., with the meals. Young girls particularly, without such rational facilities for proper dieting, are liable to try to stimulate their anorexia by confectionery, pickles, and a variety of innutritious substances which only serve to maintain chronic dyspepsia, anemia and malnutrition.

In my Out-Patient Clinic in the Cornell University Medical College we meet with such constant illustrations of the facts above mentioned that Dr. W. H. Sheldon, my chief of clinic, has devised

a circular of printed dietetic instructions which have been found exceedingly useful and practical to instruct what may be termed occupational dyspeptics. These instructions are given under the headings Food and Drink, on page 127, and Constipation on page 157.

IV. ABUSE OF NON-ALCOHOLIC STIMULANTS AND DRUGS

There are several stimulants of the nervous system which are sometimes employed in deleterious excess, as a result of modern conditions, in order to keep awake under long-continued strain (as in the 24-hour shifts formerly in vogue in foundries, chemical refineries, etc.), or to counteract depression. Coffee and, to a greater extent, tea, when used in unreasonable quantities, beget dyspepsia, gastritis, insomnia, palpitation, muscular tremors, and, in the case of the tea habit, I have seen painful multiple neuritis, affecting the nerves and muscles of the extremities.

The abuse of drugs is distinctly a disease habit of modern life, influenced by occupation in the same manner as the stimulant habits. The worst of all is the cocain habit, the most frequent the morphin or opium habit, and there are many other serious, though less common, drug addictions, such as the excessive use of chloral, heroin, the bromids, etc. These poisons are all depressants of the nervous system and heart action when taken in excess, although in the case of cocain, heroin and morphin there may be a preliminary phase of undue mental and nervous excitement. The moral sense becomes perverted so that the victim who begins by lying about the quantity of the drug he takes soon lies about everything, become suspicious of his friends, and filled with apprehension and hallucinations. He becomes bodily weak and mentally incapacitated, until, unless he can be rescued, which is seldom, he requires restraint in a sanitarium. Not a few of these drug addictions are originally acquired through ignorance of their danger, the drug being taken to relieve the pain of a toxic occupational neuritis, insomnia due to excessive fatigue, the strain of overuse of muscles, or as the pernicious and utterly fal-

lacious "nerve tonics." Young girls employed in the textile and clothing industries supply not a few of the victims.

V. ABUSE OF TOBACCO

Tobacco, used to excess in any form, gives rise to similar symptoms to the excessive use of tea and coffee, but with more marked effect upon the heart, for nicotin is a cumulative poison that in time tends to make the heart action rapid, irregular and feeble. Tobacco may also give rise to a form of temporary blindness.

Excessive smoking maintains constant pharyngitis and renders the nasal and bronchial mucosa vulnerable to catarrhal infections. Tobacco poisoning from excessive smoking is somewhat less common among the working classes than among the affluent, for the reasons, probably, that in many indoor occupations smoking is necessarily prohibited, and in outdoor occupations, accompanied by vigorous exercise, smoking is less harmful than in sedentary life in closed apartments. On the other hand, chewing is very prevalent among workmen, and I have met with many cases of tobacco poisoning from this habit. When chewed, more or less of the tobacco, besides being absorbed from the mouth, is swallowed with the saliva, and in time it develops gastritis, sometimes diarrhea, and always nervous symptoms, of which tachycardia and intermittent heart action are the most common, but there may be muscular tremors, insomnia and amblyopia.

A special danger from the use of chewing tobacco exists among workers in the toxic metals who put the "quid" in the mouth with dirty fingers or keep the tobacco plug in a dirty pocket; thus they easily convey metal dust to the mouth. (*See* Lead Poisoning, page 218.)

Although tobacco in any form is unnecessary, it is nevertheless a great solace to many a workman whose pleasures are few, and, used in proper moderation, it neither shortens life nor impairs health, as is often claimed for it, provided it is not used in boyhood or early youth.

Treatment.—Treatment of the "tobacco heart" consists in stopping its use and giving belladonna and sodium bromid. The gastritis is usually promptly relieved by ceasing to chew tobacco, and by giving such simple gastric sedatives as bismuth, cerium oxalate and bicarbonate of soda. Temporarily workmen may sometimes be induced to chew gum, as less injurious, or to chew on a fresh piece of rubber tubing which gives the exercise of the jaw muscles that has become a difficult habit to abandon, and without anything being swallowed or absorbed. In this manner the chewing habit sometimes may be reduced.

PART VII

MISCELLANEOUS OCCUPATIONAL DISEASES GROUPED BY INDUSTRIES NOT INCLUDED IN THE FOREGOING CLASSIFICATION

I. MINING

THE MINING INDUSTRY IN GENERAL

According to the United States Census Bureau, in 1912 there were about 800,000 coal miners in this country, and as many more work in the various ore-producing mines. Many of these mines, especially those in Colorado, are operated at great depth—1,000 feet or more—so that ventilation is a difficult problem. On account of the danger from "coal damp" or marsh gas, coal mines are usually artificially ventilated, but mineral mines are not, excepting as the compressed air introduced to operate mechanical drills supplies the deficiency. Such air should always be drawn from outdoors and not from the engine room, as it often is.

Miners are subject to a variety of deleterious conditions which may be classed under: (A) those common to mining in general, and (B) those due to the specific substances mined.

(A) Harmful Conditions Due to Mining in General.—With increasing depth of the mine the temperature rises at the rate of approximately 1° F. per 100 feet of depth. With increasing depth, also, the difficulty of adequate ventilation rapidly augments, the air is apt to accumulate moisture and the heavier natural gases, such as carbonic acid and marsh gas. The former may originally be present in the mine or is produced by the respiration of the men and any draught animals which may be employed. In addition, it

is derived from combustion of the lights used and from ignition of explosives.

The various gases of explosives, especially of nitroglycerin and dynamite, are irritating to the respiratory mucous membranes and may give rise to chronic nasal catarrh, and the nitrites may give rise to disturbance of the circulation. Most mines, particularly coal mines, contain much dust which is more or less irritating.

The detonation of explosives reverberating through the confined air spaces of the galleries and chambers causes repeated concussion of the tympanum, which, in conjunction with nasopharyngeal catarrh, produces tinnitus, vertigo and varying degrees of deafness. In some cases dust particles forcibly driven by explosives cause erosions of the nasal mucosa. In some such cases Röpke, of Solingen, has observed an atrophic rhinitis and purulent catarrh of the nasal sinuses.

After becoming overheated by working in damp, hot mines the workmen, on going out into the cold air in winter time, wearing perspiration-soaked clothing, sometimes suffer from bronchitis and rheumatism.

The fire damp, carbonic acid or other gases which do not support combustion extinguish the miner's candle and give prompt warning that the air is unfit to breathe; nevertheless, miners will often continue their work in such atmosphere, substituting carbid lamps, which are not so readily extinguished. The hazard from fire damp and carbon dioxid is greatest in coal mines, but fortunately these gases are heavy and accumulate near the ground. In mineral mines other gases, specifically poisonous, may also be present. Hotchkiss reported the death of a miner in Colorado from inhalation of powder smoke, and collected reports of 18 similar fatal cases occurring within a decade, and in the construction of the Gunnison Tunnel 9 out of 13 tunnel workers met death from the same cause.

The dust of mines naturally varies with the nature of the material mined, and of the methods of drilling, blasting, etc. Variations in the same mine are also dependent upon the degree of moisture present. Miners can rarely be induced to wear respirators or otherwise protect themselves from the risks of dust inhalation.

Where compressed air is used instead of a spray of water to cleanse the drill holes the dust hazard is great, especially when overhead drilling is employed, so that the dust is blown back into the face of the operator. (*See* Fig. 61, page 391.)

Filth infections occur among miners in unhygienic mines from their defecations. Typhoid fever may exceptionally be spread in this manner, as well as dysentery and the so-called Cochin China diarrhea. But the most common of the soil pollution infections of miners is the hookworm disease, uncinariasis or ankylostomiasis, which is described on page 449.

Miners often occupy temporary camps which are usually very unhygienic; the soil pollution diseases may originate in them, and the germs are conveyed into the mines by the feces of the workmen.

(B) Conditions Due to the Specific Substances Mined.—Conditions of this type which are deleterious concern mainly workers in lead, mercury, arsenic and sulphur. These hazards are described under the separate headings of these substances.

COAL MINING

Particles of coal dust, unlike metallic or mineral dusts, are not usually sharp-edged, but are nevertheless irritating and are inhaled and stored in the lungs, bronchial and mediastinal glands in great quantities. The special risk involved in long-continued inhalation of this dust is fibrosis of the lung, known as anthracosis. Coal miners are fairly healthy workmen, despite the large quantity of dust inhaled, and are found to be less susceptible to pulmonary diseases in general than many other classes of workmen, provided they do not drink heavily. In fact, in the coal miners of England and Wales, the mortality from these diseases is actually less by one-fifth than the general mortality among males of all other classes. The coal heavers, sifters and stokers are more exposed to inhalation of finely comminuted coal dust than are the pickmen in the mines, and hence far more cases of "miner's phthisis" are to be found among them. (*See* page 33.)

A patient who came to my clinic had worked as a coal miner in

dust and dampness for 19 years. For 11 years he had a chronic cough, with much expectoration and occasional attacks of rhinitis. When examined he had advanced pulmonary emphysema with anthracosis, and, although he had not been able to work for several years owing to amputation of an arm, his sputum still contained particles of carbon.

In mine blasting small particles of unconsumed nitroglycerin are sometimes blown into the coal along with detritus. According to Dr. O. V. Hoffman, of Dayton, during picking and shoveling some of this nitroglycerin may be inhaled, and a very small quantity will produce in the miner the symptoms of nausea, palpitation and headache. He has found men working on the tipple in the open suffering from the same symptoms when the loads are dumped.

Coal miners frequently exhibit bluish discoloration of the skin of the nose and face, due to tattooing with particles of coal or powder which have become embedded. (*See* Fig. 74, page 417.)

The substitution of water power for blasting powders in the mining industry is likely to mitigate many of the disease hazards to which miners are subject, especially the respiratory ailments due to inhaling powder fumes and foul air in general. Germany is gradually introducing this improvement in mining, and the mines of Alabama and West Virginia are already extensively worked by water power. It is also planned to introduce it in Indiana, Illinois and Oklahoma coal mines. Water is forced into the seams through drill holes, with the effect of cracking the coal so that it is easily broken with a pick.

Much of the handling of the finer grades of coal, as in shipping and in stoking large furnaces, is now done by machinery, so that the shoveler or stoker is exposed to less serious dust inhalation than formerly; still, much of this work must always be done by hand.

In Germany and Belgium the practice prevails for coal miners to take shower baths and change their clothing at the pit-head before going home, which is a great advance in promoting the cleanliness of the home, where washing facilities are often inadequate. In this country, on the other hand, it is the common custom for the miner on returning from work to enter public conveyances and his home

with clothes and body begrimed with dirt and sweat, a most uncomfortable, unhygienic and demoralizing method.

Stokers are subject to even more dust inhalation than miners, for they use the finely crushed coal, and, although not exposed to the hazards of smoke from blasting, they are exposed to great heat, and often work in very confined spaces, as in the holds of steamships, underground cellars, etc. Coming out into the cool air, they often drink large quantities of cold water to replace the water lost by perspiration. In this manner they chill the body surface, overtax the kidneys, and may develop gastritis and chronic nephritis. (*See* Fig. 73, page 416.)

MINERAL MINING

The mortality from respiratory diseases among metal or mineral miners in Cornwall is three-and-one-half times greater than among British coal miners, and S. C. Hotchkiss found it four times greater in the mineral mines of Colorado. This is no doubt due to the fact that the particles of mineral dusts are more angular and irritating than those of coal, and may be composed of poisonous substances which are more or less soluble, like lead, for example. The form of pulmonary fibrosis caused by the mineral dusts is known as silicosis. Poisonous gases, too, are common in certain mineral mines. Silicosis was found by Hotchkiss in 30 per cent. of the deaths among mineral miners in Colorado, and their total mortality showed 56 per cent. of respiratory diseases, certainly a very serious hazard. Silicosis is very prevalent also in the South African mineral mines and elsewhere. It has been disputed that lead poisoning is found among lead miners, but S. C. Hotchkiss, in an investigation for the United States Bureau of Mines, found records of 39 cases treated in St. Vincent's Hospital in Leadville within four years.

Prevention.—One of the most important of the recent advances in mining sanitation and hygiene is the establishment by the United States Bureau of mines of rescue stations placed adjacent to large mines. They are fitted with "first-aid" rescue appliances and are in charge of experts who give instruction to miners in rescuing their

comrades from poisoning by gases, fumes of powder, etc., and in the avoidance of these and other risks. The system of the Bureau also includes rescue cars which differ from the fixed stations mainly in being portable, conveying rescue equipment and supplies. (*See* Figs. 22 and 23, pages 145-6. General prophylactic measures for all mines should consist of adequate ventilation, the enforcement of rigid rules as to not working in air known to be seriously polluted, the prevention of spread of excrement, furnishing the workmen with proper facilities for washing and changing their clothing on leaving the mine, the dampening of dust by water sprays, and the compulsory periodic examination of the men by physicians.

II. MASONS AND PLASTERERS

Masons, plasterers and concrete mixers are subject to much exposure to dampness, cold, and, in new buildings, to drafts. They also inhale much dust of tile, brick, lime, plaster of Paris, gypsum, and cement. They are subject, from these combined conditions, to catarrhs of the respiratory passages, and such diseases as asthma, bronchitis, rhinitis, and atelectasis are frequently met with among them. They very often show rhinitis, and Röpke points out that by "picking" the nose with plaster or mortar-covered fingers they may produce superficial ulceration of the nasal mucosa. They sometimes suffer from catarrh of the middle ear and frequently from conjunctivitis.

Rheumatism is quite common among masons, as shown by a statistical table compiled in 1905 by the Berlin Masons' Association which gave 374 cases among 5,695 masons. In the same group the cases of various affections of the respiratory system numbered 452. Among the latter were 22 fatal cases. Sticker gives the average expectation of life among masons as only 55 years, but this includes the various industrial accidents, alcoholism, tuberculosis and other conditions not necessarily concerned with dust inhalation. Hirt gives the statistics of examination of 1,038 masons. Among them 34 per cent. sooner or later suffered from respiratory diseases; more

than one-third of this number had tuberculosis. These cases included the hazard of hammering stones and bricks, thereby breaking off fine particles of sharp, hard character. The mixers of mortar also deal with fine sand. These hazards, as in stone cutters, may give rise to "chalicosis" or pulmonary fibrosis, as the chronic interstitial connective tissue inflammation of the lung produced by the mechanical irritation of the stone or sand dust is called. (Page 33.)

I lately showed in my clinic a plasterer who for four months had suffered from fibrinous pleurisy, with atelectasis of the right lower and middle lobes of the lung. He had been employed in plastering for 20 years, and had always been well, excepting attacks of hay fever in August for several years, which possibly were induced by the plaster dust as an underlying source of Schneiderian irritation. In fact, he stoutly maintained that "plastering is an uncommon healthy trade." But I have heard house painters assert the same of their trade. Just prior to his attack of pleurisy and bronchiectasis, however, he began to use a great deal of plaster of Paris, mixed with water and lime into a paste, and added by means of a sifter. The fine dust proved extremely irritating to the lungs.

Ascher, of Berlin, found that among the masons who are much exposed to inclement weather and strain of frequent stooping, lumbago and sciatica are very common, being present at some time or another in fully half the workmen who were more than 45 years of age.

Masons and plasterers frequently suffer from cutaneous irritation. The coarse material which they handle clings to the hands and may cause blisters and infected pustules. Fissures form over the knuckles and between the fingers which are slow of healing, owing to constant irritation. Such lesions may appear in various folds or creases in the skin of the body, where dust has penetrated through the clothing. Chronic eczema is very common in the neighborhood of these lesions and may extend over a considerable surface. The skin of the palms becomes infiltrated and greatly thickened, more so, in fact, than in almost any other trade. Rarely, infection may occur through the cutaneous abrasions and give rise to localized

lymphangitis. The ears and eyelids frequently are affected by eczematous lesions. In handling cement the hands may be protected to some extent by greasing them with fat oil, simple cerate or vaselin. Treatment of the skin lesions is described on page 595.

Closely allied to the conditions above described are those which affect the so-called building "wreckers" who have to tear down masonry and plaster, and often inhale clouds of dust.

Prevention.—Prevention consists in shielding the workmen as much as possible from inclement weather and cold, damp indoor air in new buildings. Masons should stand upon lattice frames to keep the feet dry. Whenever possible building material, especially when being torn down, should be wetted with a hose, and workmen should be instructed to hold the breath when confronted with a sudden cloud of dust, as when a mass of plaster falls or a load of cement, bricks or sand is dumped. Masons, in hammering bricks or stone, should learn to stand so that dust is blown from and not toward them. Workmen sometimes put wet cotton in the nose as a filter, not realizing that in mouth breathing the hazard is greater. In some cases, as in tearing down old plaster in confined spaces, in tunnels, etc., where sprinkling cannot be resorted to, respirators may be worn temporarily.

III. ROOFERS

Those roofers who work constantly on sharply inclined surfaces may acquire peculiar weakness of the legs with tremors, amounting to a partial paralysis (Bruno Bosse). If employed in laying copper or tin roofs, they handle solder and are more or less exposed to lead poisoning. Tar is also considerably used in roofing (the risks of handling which are described on page 383). In summer metal roofs become greatly heated, and I have seen insolation among roofers employed on them.

IV. BRICK AND TILE MAKERS

In these industries the workmen are exposed to the hazards of constant wetting in the clay beds, overheating of the ovens, the in-

halation of clay and other dusts, besides those of lead used in glazing and various coloring materials, iron filings, etc. They may acquire chronic eczema of the hands. I saw a case of lead poisoning in a man employed in unloading from canal barges tiles which had been treated with a new form of lead glaze. The glazing of tiles with lead glaze is one of the industries in which women are employed about equally in number with men, but in pottery glazing, with kiln work, there are comparatively few women employed (Hamilton).

V. POTTERY MAKING, CHINA AND PORCELAIN

Nature of the Industry.—Pottery making is one of the oldest industries known to man, being of prehistoric origin. Apart from the pottery of the Cliff and Cave Dwellers, the first manufacture of it by civilized man in this country was conducted at a pottery opened by Dr. Coxe in 1685 in Burlington, New Jersey, and to this day that State, with Ohio, owing to local geological conditions of clay formation, comprise the centers of the American industry. In New York State, in 1908, there were 21 potteries, employing 751 men, 422 women and 59 boys and girls under 16 years of age.

In the making of pottery, tiles, sanitary and electric insulation ware, china and porcelain the processes employed are essentially alike, and consist of grinding and mixing the clay (or flint, in the case of china) with water to a consistency which enables it to retain a given shape on being molded. The articles thus formed receive a first firing in very hot kilns, being heated to 2,500° F., and subsequently are brushed and scoured. They then are dipped into various solutions to impart glaze and color, and the glaze, which often contains white lead among other substances, is fixed by successive firings. The glaze has further a protective action, being practically a fluid glass which prevents the pottery from being too much altered in further processes of firing, for, as Graham-Rogers says in his report on the Pottery Industry in New York State, made in 1909 for the Bureau of Factory Inspection, "with gradually increasing tempera-

ture the same mixture may successively assume the texture and character of sun-baked ware, terracotta, stoneware, porcelain and glass." The larger pottery wares are cast in molds made of plaster of Paris, into which they are pressed by machinery, the surplus clay being removed by scrapers on a revolving disc called a jigger, on which the molds are placed. All these processes involve considerable rehandling of the articles undergoing manufacture, for comparatively little of the work, excepting the mixing and grinding, can be done by machinery.

The finishing of the ware, when the process is carried beyond glazing, consists in painting with metallic paints and gilding, with subsequent refiring and perhaps polishing. This is sedentary work, involving no special danger except that of applying metallic paints. It is done by hand on the finer ware, but most of the work is accomplished by lithographic transfer. In this process the paint is stamped or otherwise placed on paper patterns which are laid on the pottery, so that the paint adheres when the paper is removed by a damp cloth. Subsequent refiring fixes the painted pattern permanently. The paint may be applied either before or after the glazing process.

The paints, which are usually chrome or cobalt compounds, are mixed with diluents. Commonly turpentine is used, but sometimes paraffin, petroleum, wood alcohol or essential oils are added. In the gilding of pottery and china turpentine and various oils are now used, but originally the gold was amalgamated with mercury and mixed with oil, and the mercury evaporated in the refiring of the ware. The gold is subsequently burnished to bring out its luster.

The fine mineral dust produced in pottery manufacture is composed of clay (a hydrated silicate of aluminum), feldspar and flint (a silicious variety of quartz), and the dust of glaze contains also borax, Cornish stone, carbonate of lime, kaolin, lead oxid and carbonate. "Fritted" lead, sometimes used for glaze, is a fused compound with borax and silica, in handling which there is less risk than from the ordinary glaze mixture, as it is less soluble.

Translucent china ware has added to the clay calcined bone or feldspar. The Limoges ware is derived from white Kaolin clay.

The glaze is a mixture of silica, silica borate and white lead, red lead or lead sulphid (galena). Cobalt is used to produce a jet-black glaze, and manganese a brown or purple color. Tiles are made from molded clay dust under heavy pressure.

In the making of porcelain tiles which are pressed in a die, each time the die descends in the press fine dust is blown out.

Hazards.—Dr. J. T. Arlidge states that "the pottery industry stands nearly at the head of the list of unhealthful occupations." The various menaces to health which exist in this industry arise from dust, lead poisoning and exposure to excessive heat and moisture.

Some years ago Dr. Lemaistre published an analysis of the dust in the air of the workrooms of the potteries of Limoges, France, which was found to be a mixture of kaolin, flint, granite, dried glaze, wood charcoal and soot. This dust was estimated to be present in the proportion of 640 million particles per cubic meter of air.

These several hazards have been mitigated greatly of late years by installation of mechanical clay mixers and other types of machinery. The chief dangers to health have always existed in the clay-mixing and molding rooms, and in the dipping rooms, where glaze containing lead is often applied. But there are other factors of ill health. In former years plumbism was so common among laborers in the slip or dipping rooms that the majority who pursued this line of work failed to live beyond their fortieth year. Much of the earlier high death rate from the pottery industry was doubtless chargeable in great part to excessive drinking, which was common among the low grade of foreign workmen at first employed. American workmen have now largely replaced them in American potteries and their drinking habits and social conditions are better.

In the clay-mixing and molding rooms clay and plaster of Paris, which are dropped upon the floor, dry and are pulverized by the workmen's feet, and raised into clouds of dust unless frequently removed by sweeping, which should be done only at night. The sweepers inhale considerable dust, but pass quickly through the rooms with open windows, which is quite different from sitting all day in a closed room, inhaling irritant dust. The finer clays used are in such a

high degree of pulverization that the dust they beget is exceedingly fine and penetrating. Unless properly conducted, however, the sweeping stirs up dust which settles upon sills, benches and rafters, and is set in motion by the blowers of hot air which is supplied for heating the rooms in winter. Wetting the dust before sweeping merely reduces it to adhesive clay again, and vacuum cleaners are beyond the means of most potteries, being expensive to install and operate.



FIG. 110.—DIPPING TABLE CHINA INTO LEAD GLAZE. A most unhygienic room, with glaze dripping or spattering all about. Note the glaze on the man's hand and the absence of gloves. Women are much employed in this industry.

Workmen in the mixing and molding rooms are exposed more or less constantly to wet and often to excessive atmospheric humidity and suffer frequently from sciatica, lumbago and chronic or subacute rheumatism.

In the British potteries the ware is dipped by the workman's hands directly into the glaze (Fig. 110), but the French workmen use tongs for the purpose. In either case there is danger from spat-

tering the fluid, which subsequently dries and gives rise to much dust.

"Ground-laying" is another highly dangerous process. The ware, already partly glazed, is covered with an adhesive oil and powdered dry lead enamel color is dusted on with a cotton pad. This process has quite recently been largely replaced by the less hazardous method of blowing on the powder by means of a compressed air jet.

The kilnmen or firers are subject to several hazards. Such are: exposure to excessive heat, inhalation of coal dust and of coal gas from the ovens, and dust on removing the biscuited and glazed ware. As the kiln chambers are large, the kilnmen have to enter them to bring out the ware after firing, and are thus exposed to great extremes of temperature whenever a kiln is "drawn" and they have to go in and out repeatedly. They perspire very freely, and W. C. Garrison writes (in a *Report on Health Conditions of the Pottery Industry in New Jersey in 1905*): "Draughts are quite frequent where this work is performed, and a not inconsiderable amount of illness of at least a temporary character is caused thereby." The workmen often expose themselves to the outdoor air, seeking prompt relief from the heat. Such exposure chills the body surface, raises blood pressure and tends to overtax the kidneys and heart. It is also a source of more or less bronchial irritation and asthma; the so-called "potter's asthma" is very prevalent among these workmen, as it is among those who work in the more dusty rooms.

After the first baking or "biscuiting" the ware is brushed and scoured to cleanse it from roughness and from adherent materials of various sorts (Fig. 111). In Limoges, France, and other places where high-grade porcelain table ware is made the plates, cups, saucers, etc., before firing, are placed on trays called "saggers," and separated from each other by a hard flint earth or sand. This prevents them from sticking together, but in the subsequent brushing or "scouring" process much flint dust is added to that of the china, a dust which is so fine, hard and sharp that it is very liable to cause pneumonoconiosis. In the United States much of the brushing of

pottery is done by women, whose hair and clothing become saturated with very fine dust.

China and semi-porcelain are mainly manufactured from kaolin, calcined flint and calcined bone ash, pulverized and treated by great heat. The brushing or scouring of the biscuited ware is most irri-



FIG. 111.—WARE-CLEANING ROOM. (Taylor, Tunnicliffe and Co., Hanley, England.) "Women workers sit around the room at convenient distances, each one before a large photographic dish, shaped in front so as to fit to the body of the worker. This dish contains water, and all the larger particles of glaze fall into it and are retained. Immediately behind and above the dish is an opening into a large fan duct, so that the fine dust is also carried away; and the room is always kept in a condition of great cleanliness." (From the Shaw Lecture by William Burton, F. C. S., on "Hygiene of the Pottery Trade," Royal Society of Arts, London, Feb. 7, 1908.)

tating to the eyes and respiratory system. This branch of the work, as well as all the others in which dust is excessive, is liable to produce bronchitis, bronchial asthma, and pneumonoconiosis. The tendency to tuberculosis among potters in England was formerly so great that the disease was called "potter's rot." In the Limoges works formerly one-half of the deaths among potters were due to tuberculosis.

The disease may develop upon a pulmonary fibrosis caused by mineral dust inhalation, or attack those weakened by constant exposure to extremes of temperature and moisture, with alternate excessive perspiration and sudden cooling of the body. It is also much favored by the chronic bronchitis due to dust inhalation and by the undermining of the workman's constitution due to chronic plumbism.

Arlidge found from statistics gathered prior to 1892, or more than 20 years ago, that the general mortality from respiratory diseases among workmen, exclusive of potters, was 7.86 per cent., whereas among potters it was 12.29 per cent., and, the general mortality from consumption being 9.27 per cent., that among potters rose to 12.90 per cent. In estimating such results the type of workmen engaged in the industry should be reckoned with. Ignorant workmen of low social grade who are more likely to spend their wages for drink than food, and take no precautions against the possible dangers of health to which they may be exposed, quite naturally tend to augment the death rate of any trade. Certainly no such excessive mortality exists among potters in the United States to-day, for among the 3,751 potters whose condition was investigated by W. C. Garrison in New Jersey, the death rate for 1905 was only 2.3 per cent.

Arlidge also reported plumbism among 8 per cent. of male potters and 5.06 per cent. among female pottery workers. Ten years later Sir Thomas Oliver found these conditions in England considerably improved, and doubtless the better understanding of general hygiene and of tuberculosis brought about in the past decade explains the marked lowering of mortality in the pottery industry, combined, as it is, with employment of a much higher grade of workmen.

In 1908, in a lecture before the Royal Society of Arts, Mr. William Burton stated that whereas there were 73,000 pottery employees in England, only 26,000 were exposed to any form of dust, of whom 19,000 may be exposed to flint or clay dust and the remainder to lead dust. For the five years from 1901 to 1906 there were an average of 92 cases per annum of serious lead poisoning

among some 6,700 workmen and women exposed to the risk. In 1909 the number fell to 58. This is a great improvement, certainly, over earlier conditions, but it is the common experience that, where cases of plumbism are serious enough to be reported by laymen, physicians can detect many additional cases of more insidious type. (*See* Lead Poisoning, page 242.) Among these 485 cases reported by Burton in the five years' record, 205 were among men and 280 among women.

Men employed in handling the pottery to arrange it upon "saggers" or fire-clay boxes, are known as "biscuit placers" and "glost placers." The former handle the ware in relation to its first firing and are exposed only to inhalation of mineral dust, but the latter handle the ware after it has been glazed, and often while the glaze is still moist upon it; hence they become liable to lead poisoning. In the dipping process the arms of the workmen are sometimes entirely immersed in the lead solution, which in this country has usually a strength of 10 per cent., but as the absorption of lead by the skin is a negligible factor, there is more risk from spattering the solution into the mouth or allowing it to dry and become pulverized upon unclean floors. Ware cleaning is much more dangerous than dipping.

W. C. Garrison, in a study of 3,751 pottery workers in New Jersey in 1905, 18 per cent. of whom were women or girls, writes of pottery and china painting: "Enamel painting, if done with ordinary care and attention, is rarely productive of injury, even where the colors contain lead; but in ornamenting very common ware the colors are mixed with gum water, and, being put on rather thickly and carelessly, the worker's hands are coated with the mixture, and in some instances lead poisoning follows."

When certain lead colors are diluted with water and applied thickly over the surface of the ware the water evaporates and lead dust is liberated, often in dangerous quantity. Sometimes the application is made by a spraying or atomizing apparatus worked with compressed air (aerographing), which gives rise to much less dust that may be blown backward toward the operator.

In the process of gilding the vapors of turpentine and oils vitiate

the air of ill-ventilated rooms, and novices at the work suffer from headache and indigestion.

In the burnishing process gum water is provided to moisten the gilt surface, but Garrison says that employees usually prefer to use their saliva instead, with the result of impairing the digestion of amylaceous foods.

In Hungary much pottery is still manufactured in the homes of the workmen who use the family stove and kitchen in the process with most disastrous results to the women and children. Here, Dr. Oliver says, in *Bulletin No. 95* of the United States Bureau of Labor, 1911: "I found a child 6 years of age who had suffered from saturnine encephalopathy, which had left him with cramped limbs, legs flexed upon abdomen, head retracted, eyeballs paralyzed, loss of control of the sphincters, and with defective mental development. Saturnine meningitis in children usually proves fatal within two or three days, or there is an incomplete recovery with such sequelæ as I have mentioned.

"Dr. Chyzer found in the blouse of the son of a potter, aged 5 years, and on whose gums there was a well-marked blue line, lead to the extent of 0.243 gram, and in his cap 0.0144 gram of lead.

"I have never seen such widespread suffering from lead poisoning, nor have I witnessed such harrowing sights as those I saw among the Hungarian potters who make their trade a home industry. Young men paralyzed in hands, face and feet, helpless, and unable to dress and feed themselves; women paralyzed; children imbecile and blind, paralyzed in their legs, or suffering from colic, and all of them with a well-marked blue line on their gums."

He continues: "The domestic animals, too, do not escape. A potter cannot keep in his house a singing bird nor can he rear fowls in the courtyard, for the dried splashed lead glaze rapidly kills them. Cats are extremely susceptible to lead. They suffer from colic, and in their agony they roll upon the ground, bending their limbs toward their body, or they strike their abdomen against the floor, mewing as if in pain. In some of these animals symptoms akin to madness arise. Losing control of themselves, they run wildly about, heedless

TABLE I—SHOWING QUANTITIES OF DUST IN THE AIR AT DIFFERENT POINTS OF POTTERY WORKROOMS (Ditman)

Process	Dust Present in 10 Cubic Meters of Air (mgms.)				Remarks
	At the Breathing Point of Worker	Two Feet above Breathing Point of Worker	Center of Room at Breathing Level	Kind of Dust	
Pressing clay in potters' shops	93	48	90	Mixed clay	China
	79	36	....	"	China
	101	24	36	"	China
	72	22	....	"	Earthenware
Fettling clay ware	293	125	....	"	Clay quite dry No exhaust
	60	....	78	"	Clay quite dry Exhaust applied
	24	18	....	"	Clay quite damp No exhaust
Towing of earthenware	627	....	....	"	Exhaust stopped
	36	26	42	"	Exhaust running
Tile pressing	209	96	....	"	No exhaust
	294	173	....	"	No exhaust
	394	....	....	"	No exhaust
Tile fettling	388	....	....	"	No exhaust
Placing china biscuit	442	215	90	Ground flint	Flint cool. No exhaust
	301	165	....	"	"
	172	208	....	"	Flint warm. No exhaust
Placing earthenware biscuit	197	....	60	Sand, ground flint	No exhaust
Emptying china biscuit	802	600	394	Ground flint	Emptying from saggers at bench. No exhaust
	....	421	385	"	"
	709	702	....	"	"
Emptying earthenware	36	48	22	Sand, ground flint	Sand warm. Emptying done at mouth of oven. No exhaust
Knocking flat	79	265	179	Flint	Good exhaust. Inlets for air near exhaust and low down

TABLE II—SHOWING THE QUANTITY OF LEAD IN THE AIR AT DIFFERENT POINTS OF POTTERY WORKROOMS (Ditman)

Process	Lead Present in 10 Cubic Meters of Air (mgms).				Remarks
	At the Breathing Point of Worker	Two Feet above Breathing Point of Worker	Center of Room at Breathing Level	Kind of Dust	
Dipping	3.32	3.32	2.36	Glaze	Earthenware dipping. No exhaust
	3.87	2.21	2.13	"	"
	2.49	1.66	1.84	"	China dipping. No exhaust
Ware cleaning after dipping	1.81	2.36	2.36	"	Exhaust applied
	0.95	0.47	0.71	"	Exhaust applied
	3.32	....	....	"	Exhaust applied
Gathering	2.21	3.32	2.36	"	Ware warm. Air inlet close to hot drying machine and low down.
Glost placing	2.61	2.13	2.13	"	No exhaust

of obstacles, or they throw themselves into water and are drowned. In one instance a cat in its agony leaped into the fire."

I once lost a valuable Angora cat with precisely these symptoms, which became accidentally poisoned by licking fresh lead paint off its paws.

The preceding dust determinations in the pottery industry are quoted by Ditman in the *Journal of Industrial Safety* (vol. ii, No. 3, March, 1912). (Tables I and II.)

Prevention.—Cleaning the floors, workbenches and tables by night only and installation of exhaust fans to remove dust, turpentine and other vapors will abolish the evils of the molding, brushing and finishing rooms to a great extent. The excessive moisture attending the mixing and the excessive dry heat to which the kilnmen and "placers" are subjected is a necessary incident to the labor which it is practically impossible to relieve. The "dippers" who place the ware in the enameling solutions and the glost placers who carry it should

be protected from lead dust and moist lead enamel by daily bathing after work, thorough cleansing of the hands before eating, and frequent exchanging of soiled for clean overalls. (Details of the prevention of lead poisoning are given on page 271.)

Brushing and scouring of pottery and china should be done by machinery or, if by hand, the ware should be held in boxes with small openings, and provided with strong suction ducts to screen and draw off the dust.

The Worcester Royal Porcelain Company employ a sandblast for this purpose. The ware to be cleaned is held by the operator inside a cabinet by passing his hands through an opening in a small cloth screen. (*See* Fig. 62, page 392.) The cabinet is connected with a strong suction fan and the operator looks in through a glass window. For further protection he also wears a respirator. Another method of securing complete dust protection for women employed in sandblast scouring consists in placing the ware upon traveling wooden racks which convey it in and out of the scouring cabinet, while the operator does not even have to place the hands inside. By such means risks of pulmonary cirrhosis and tuberculosis are being practically completely eliminated from this class of workers in what formerly was one of the most dangerous of all the industries. Still further improvement has been made by Mr. Fainford, of Staffordshire, who invented a process to do away with sandblasting. The china is placed in a revolving drum or rumbler (Fig. 112) and fragments of broken china are added which rub all the adhering flint off the ware. An exhaust duct removes the dust, so that the ware comes out clean and smooth.

Respirators may be worn in the more dusty places, especially where flint and lead dust are in suspension in the air.

Owing to the insidious development of fibroid phthisis, as well as many of the symptoms of lead poisoning, all potters should undergo a thorough physical examination by a competent physician at least four times a year, and oftener should symptoms of any kind arise between the regular examination periods, particularly such as colic or muscular weakness.

In certain types of pottery other materials may be substituted

for lead in glazing, as in making salt-glazed stoneware, but nothing has yet been found which will wholly replace lead for the finer sorts. One process consists in "fritting" the glaze with silicious material, so as to make the lead insoluble in weak acids, like that of the gastric juice. It is not practicable, however, to reduce the soluble lead to less than 5 per cent., and even that does not produce the best results in glazing.

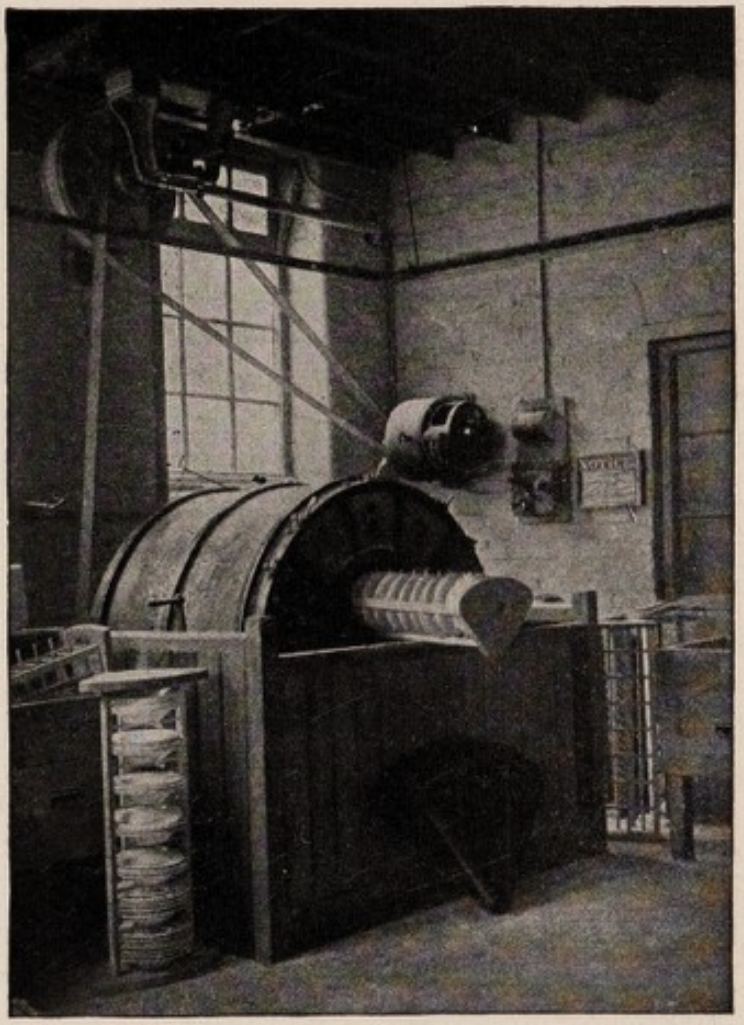


FIG. 112.—CHINA SCOURING BY "RUMBLER." (Doulton and Co., Burslem, England.) The plates or dishes after glazing and re-baking are placed in racks which are set inside the large drum where they are rotated with fragments of china or other scouring material. All escape of lead and other dust is thus prevented. (From Shaw Lecture by William Burton, F. C. S., on "Hygiene of the Pottery Trade," Royal Society of Arts, London, Feb. 7, 1908.)

Improvements in the British pottery industry, largely due to the efforts of Sir Thomas Oliver, have reduced the number of cases of plumbism arising from this work from 457 cases and 17 deaths in 1898 to 58 cases and 5 deaths in 1909.

That pottery molding, when dust is reduced to a minimum and lead glaze is not used, is not necessarily unhealthful is shown by the fact that in the Arequipa Sanatorium in California for tuberculous women, this occupation was introduced with much benefit by Dr. P. K. Brown. The work is conducted outdoors and the pottery is kept as free from dust as possible. The

work interests the patients, who are permitted to sell their products, and has proved in every way beneficial.

VI. CHEMICAL WORKERS

Workers in the various chemical industries employed in the derivation or production of all manner of chemical materials are subject to very many serious diseases. They may acquire eye and skin lesions, respiratory, circulatory and nervous diseases, besides acute gastro-intestinal ailments. These are described under the subheadings of the particular industries in which the hazards occur. In Germany, in 1905, it was computed that among 185,820 chemical workers there were 163,522 cases of occupational disease, or 88 per cent of men employed were affected in one way or another, with an average incapacity for work of 8 days per man. There were 122 deaths, or 1.11 per cent. Such figures afford an idea of the exceptional disease hazards of these trades, in addition to the trade accidents which may arise in the employment.

VII. FERTILIZERS

The making of both bone and mineral fertilizers exposes the workmen to much dust and to the inhalation of acid fumes of various kinds. In handling the carboys of acid the hands may be burned, or the acid may spatter into the face and injure the eyes. There is also a stench which to those unaccustomed to it is intolerable, but it is not necessarily injurious to the health of the workmen. One of the processes used in making bone meal fertilizer employs benzene for extraction of fat, which adds considerably to the offensiveness of the odors.

Mineral superphosphates are prepared by pouring bags of powdered phosphate into a mixer into which sulphuric acid is drawn from a tank. The mass is then emptied into a pit, where it hardens and is dug out with pickaxes and ground. This process exposes the workmen both to dust and acid fumes. If sodium nitrate be added,

nitric acid may be liberated. According to C. F. W. Doehring (*Bulletin* of the U. S. Bureau of Labor, No. 44, 1903), the workmen in artificial fertilizer factories often suffer from gastro-intestinal catarrh, and sometimes from hemoptysis, as a result of inhaling acid fumes. When nitrate of potassium is added in a fertilizer mixture with acid superphosphate, both nitrous and nitric acids are developed from which he says "direct cases of poisoning have been observed." In some of the mixtures hydrochloric, hydrofluoric and sulphurous acid fumes may also be liberated, and the hydrofluoric acid vapor is especially irritating to the respiratory passages and very poisonous.

According to Doehring, the dust arising from grinding basic slag is very harmful, and he reports 13 cases of severe pulmonary diseases occurring in a short time in one factory where the slag dust contained iron oxid, magnesia, lime phosphate, quicksilver, silica and aluminum. The slag, which is a waste product from the manufacture of steel, has to be ground extremely fine. It contains on an average as much as 17 per cent. of phosphoric pentoxid, hence its value as a source of phosphates for the soil when properly prepared.

Symptoms.—The various dusts may produce bronchitis, fibroid phthisis and asthma. The acid fumes may give rise to bronchial irritation, hemoptysis, anemia and cardiac weakness. Another special hazard is found among the men who skin the carcasses of dead animals, such as horses, preparatory to boiling them and reducing the bones. It is the danger of septicemia from abrasions of the hands which become infected with putrid animal matter. General as well as localized sepsis may thus occur.

Prevention.—Prevention demands ventilation, removal of dust and fumes by forced suction drafts, protection of the eyes with goggles against the spattering of acids, and special care in handling the carboys of acid. No one with abrasions of the hands should be allowed to handle the animal carcasses. The stench may be mitigated by spraying the air exhausted from the workrooms with live steam or forcing it through a furnace.

VIII. DYERS

Dyers make use of a great variety of toxic substances as coloring, bleaching and fixing agents or mordants. Among the most important of them are ammonia, the mineral acids, naphtha, gasolene, chlorid of lime and other bleaching agents, salts of such metals as copper, arsenic, iron and chromium, anilins, wood alcohol, and a variety of pigments derived from foreign woods, some of which are toxic. The more important of these several poisons are described under their individual headings.

Hazards.—The hazards of the occupation comprise irritation of the respiratory system from inhalation of hot vapors and fumes, often strongly acid or alkaline, or, as in the case of chlorin, specifically poisonous. The workroom is often hot and filled with steam. The bare hands and arms may suffer from skin irritations such as are described on page 580, or the dyestuffs may spatter into the face and injure the eyes. The workmen are in some cases almost constantly wet from their own perspiration, from spattering the clothing, or absorption by the clothing of the moisture from the kettles where hot processes are used. Anemia and digestive disorders, too, are observed. (Fig. 113.)

As an example of some of the hazards of dyers, dermatitis is caused by potassium bichromate solution, much used in dyeing, in the usual strength of ¾ lb. to 100 gallons of water, in which the goods to be dyed are boiled for an hour. R. P. White has reported in the *Lancet* of January 29, 1910, two such cases in dyers. The eruption involved the backs of the hands, forearms, face and exposed part of the chest, and was of the nature of an areola in which was a scaly papule. This form of chrome pigment does not usually affect the unbroken skin, but dyers, whose hands are constantly wet with hot fluids or steam, perspire freely and the skin of the hands tends to become thickened and encrusted, and to show deep fissures through which irritant substances may act. Accumulation of sweat and dirt on the exposed skin adds to the trouble.

One of the patients, a man 52 years of age, who was shown at

my clinic in 1908, had been for many years a dyer of ostrich feathers, in which process he had handled with bare hands arsenic and oxalic and hydrochloric acid solutions. He had also inhaled much dust laden with starch, oxalic acid and arsenic. He presented no neu-

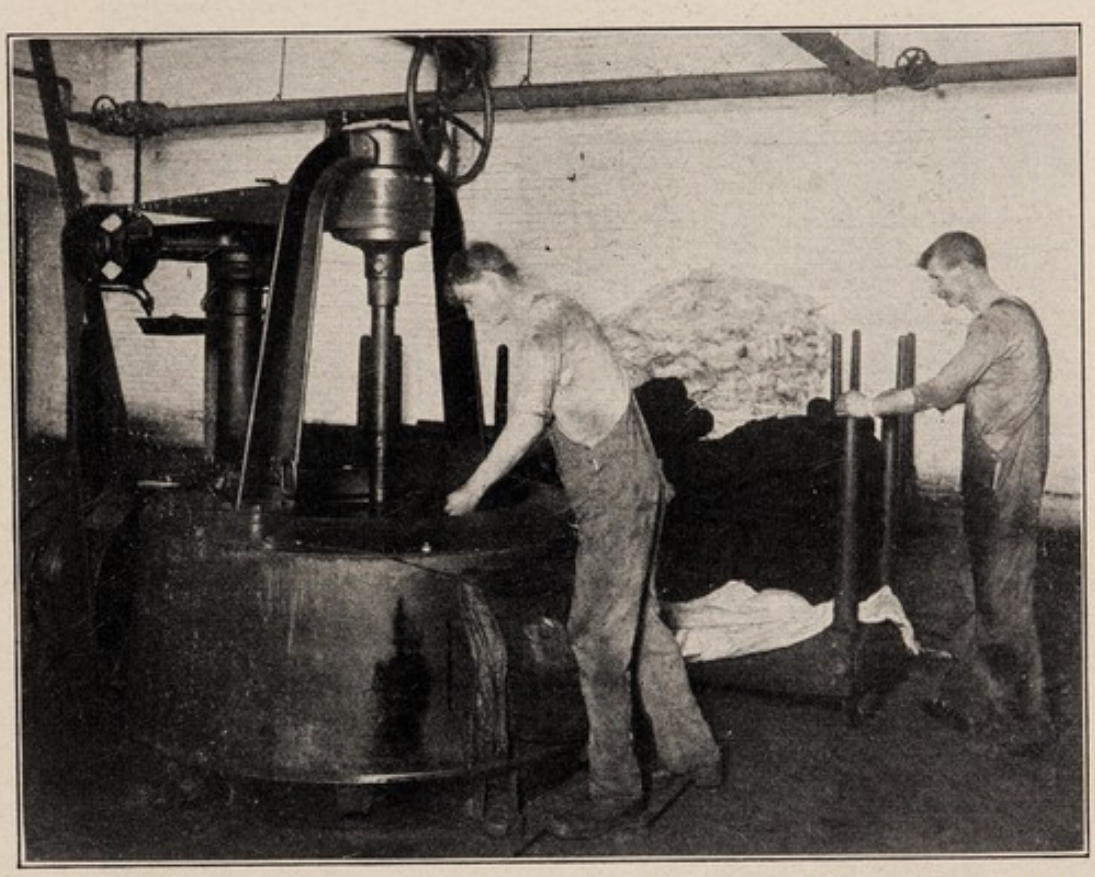


FIG. 113.—SQUEEZING DYE FROM YARN BY HAND. Hazards: eczema, chrome sores, lead poisoning, and wetting.

ritis, but had a chronic bronchitis. He had had bronchial hemorrhage, and an attack of right-sided hemiplegia, which would imply arterial degeneration. He also had well-marked diabetes with 1.3 per cent. of sugar by polariscope. This latter disease, however, may have been incidental or not of occupational origin. The sputum showed numerous tubercle bacilli.

Another of my patients who was a dyer was in the habit of washing his hands in a lime and soda solution, but had escaped any deleterious consequences of his occupation which he had followed for 9 years.

Treatment.—To protect the hands in temporary work rubber

gloves may be used, but they cause sweating and are hot, uncomfortable and clumsy. It is better, therefore, to keep the hands well greased, if possible, and R. P. White suggests that the instruments

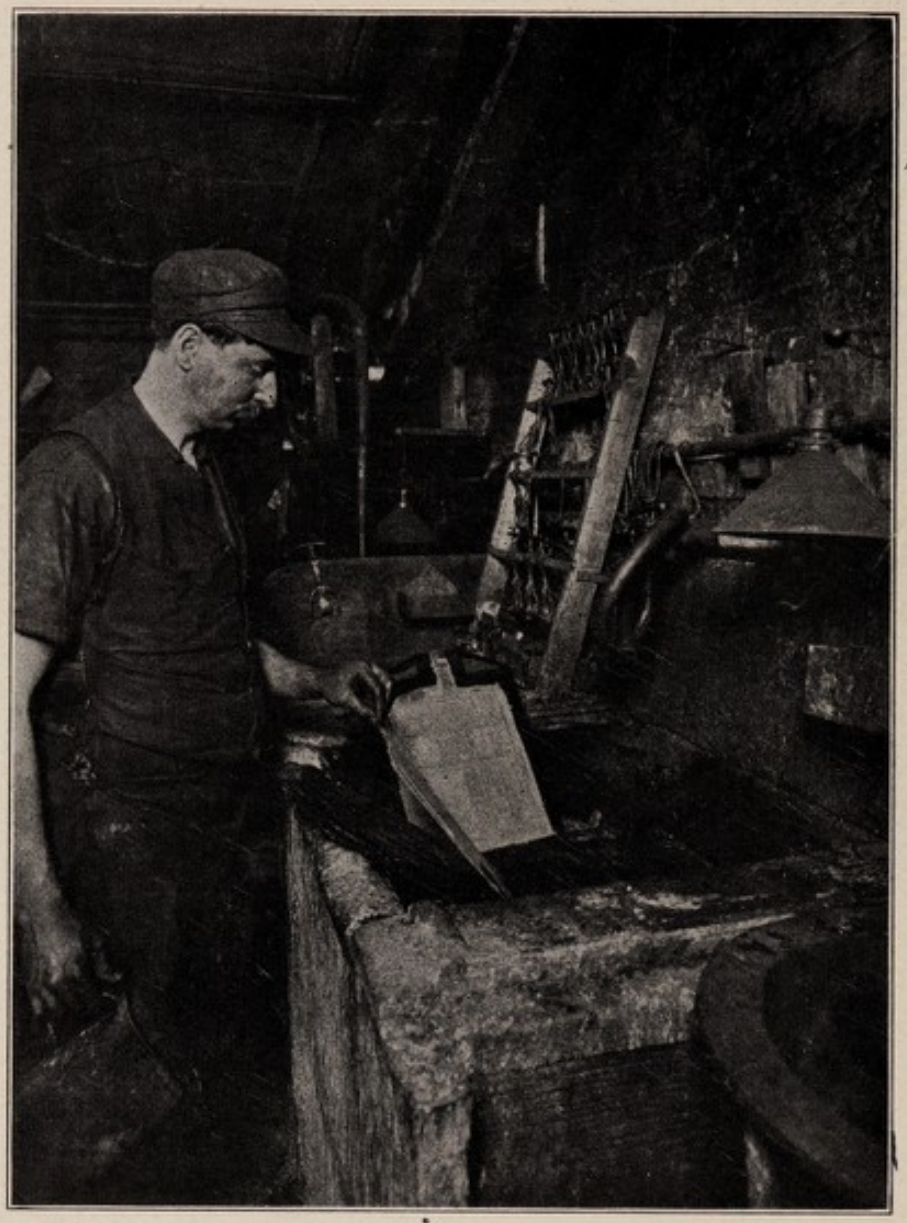


FIG. 114.—ELECTROPLATING. Hazards: lead poisoning and dermatoses.

employed to lift yarn, cloth, etc., out of the dyeing solutions be protected by shields like a sword guard, to prevent the solutions from running up the hands and arms.

At best dyeing is dirty work, and it is difficult to avoid saturating the clothing. Rubber aprons and rubber boots may be worn, and

the feet should be protected further from wet floors by standing upon raised slats or grills. Clothing should be changed before going home, and ample washing facilities are most important, as described on page 91.

IX. ELECTROPLATING

The chief risk in this employment, which is most serious, is from poisoning by red lead, and it is described in detail under that heading (page 209). But the process has other minor hazards. (Fig. 114.) Powdered lime in oil is used in finishing and sour beer in "scratch brushing," and these substances cause considerable irritation of the skin, resulting in dermatosis of the forearms and hands. (Fordyce.)

X. LITHOGRAPHERS AND ENGRAVERS, LITHOTRANSFER

Lithographers and engravers suffer from myopia. Also, from sedentary work and close application, they may acquire dyspepsia and anemia. They make use of a variety of acids and may acquire eczema and other cutaneous lesions, described under Diseases of the Skin, page 580. They have a somewhat high mortality from tuberculosis.

Lithotransfer work involves serious hazard from lead poisoning, and is described upon page 232.

XI. JEWELRY INDUSTRY

The metals used most extensively in jewelry manufacture are gold, silver and platinum. Brass is much employed in making the cheapest articles of personal adornment, such as collar and shirt buttons and studs. Lead solder is also used to some extent.

Although the various metals employed are ground into dust to some extent in the operations of filing, polishing, etc., the quantity thus liberated is so small as compared with many other industries

that their irritant effects are negligible. Neither are the soluble silver and lead solder liable to prove toxic. The danger to the eyes and respiratory system from these dusts has been much reduced by the almost universal introduction in jewelry factories of strong exhaust fans with separate ducts leading to each source of dust production, for they have the economic advantage that the dust is drawn off into iron reservoirs, where it is wetted and valuable particles of metal are recovered.

The hazards of the jewelry industry, therefore, arise chiefly in other ways, as from inhalation of fumes of the strong inorganic acids used in "coloring" and gilding processes, as well as from acids used in refining the gold and silver. Some operatives suffer from eye strain, from the nearness with which bright metallic objects are held to the eyes in polishing, and also from sitting in cramped positions at their work. William Stainsby, who has made a special study of 2,721 jewelry workers in Newark, states: "The jewelers' work in all its branches is particularly trying to the eyes, and it not infrequently happens that defective sight compels men to abandon the trade who are in every other respect capable and competent to follow it for years to come."

The danger of inhaling acid fumes does not differ in this industry from the effects of this hazard in general, and is described under the titles of the several corrosive acids. (Page 367.)

XII. TANNING AND LEATHER DRESSING

The leather industry ranks as the third greatest manufacturing industry in the United States, the steel industry standing first and that of drygoods second. About 250,000 employees are found in the entire leather industry of the United States, some 50,000 of whom are in the tanning and leather dressing industry, the remainder being mainly shoemakers and harness makers.

Nature of the Tanning and Leather Dressing Industry.—This process is complicated and prolonged, and involves much laborious hand work. The hides or skins are washed and salted, which prevents

decomposition. After a fortnight the hides are washed for another week in water, then soaked in lime for a few days to loosen the hair. The hair is next scraped off in what is termed the "beam house," again soaked in lime for four or five days. After this "fleshing" is



FIG. 115.—TANNING ALLIGATOR SKINS. Hazards: acids, lime, heat and moisture.

performed, i. e., any still adherent particles of fat or fascia are removed and then the hide is placed in the first tanning tank, where it is soaked for several weeks in tanning extracts. The hide is next taken out and split by machinery into the desired thickness. A second immersion in the tanning fluid follows, after which the hide is scoured, stretched on frames and dried in the sun and air or otherwise. For further treatment the hide must be softened and then japanned, glazed and grained. Dyeing, polishing and enameling are additional processes in the industry.

Hazards.—Most of these processes demand care and skill. The workmen are obliged to be wet much of the time, from lifting hides

into and out of the vats and in handling bundles of large heavy hides considerable strength is required.

The dangers to health in this industry are due to the constant exposure to wet and excessive atmospheric humidity and frequent changes of temperature, the handling of lime and occasional exposure to special substances used in dressing or currying processes, such as fumes of naphtha and turpentine, employed in the japanning process, the extreme heat of the drying room, and various substances used in dyeing (Fig. 115). As a further hazard serious explosions have occurred from setting fire to the buffing dust of chrome-tanned leather.

The disagreeable odors connected with tanneries are due to a mixture of smells from the oil and fat of the skins with lime and tanbark or tanning extract.

Symptoms.—Hirt found as a result of examining 54 tanners that more than a third were subject to frequent colds, and a number had had bronchitis, emphysema and pneumonia. Rheumatism is also common among this class of workmen and they may suffer from varicose veins. Quite a large percentage, nearly ten, develop tuberculosis sooner or later. In Swedish and British tanneries cases of gastric fever have been observed quite often.

All the maceration and tanning processes tend to fill the air with foul-smelling and more or less irritating fumes, which are largely responsible for the cases of gastric catarrh which are noted among many of the workmen.

In some cases muscular and skeletal deformities have resulted from constant irregular use of certain groups of muscles or faulty positions while at work. The hands are often macerated in the lime or bark solutions, and the fingers, hands and arms may become the seat of eczema, blebs, ulcers and pustules. Ecchymoses are observed, which may become excoriated and painful, and on the sides of the fingers typical so-called "pigeon spots" may develop, which are small areas of erosion with pale, whitish margins of macerated epidermis, looking as if they had been cut out with a punch. The perforations bleed readily and may be somewhat painful. The finger nails are stained brown. (Hannover and Shann.)

Anthrax is a disease to which tanners who handle imported hides are liable, and the disease is described in detail on page 452. In England between 1899 and 1904 there were 86 cases among those who handled raw skins and hides, of which 21 proved fatal. In half the cases the site of the carbuncle was in the neck, which is perhaps attributable to the habit of carrying the hides upon the shoulder, where they easily irritate and infect the skin of the unprotected neck. Lindemann collected records of 68 cases occurring in Germany in 12 years, with a mortality of over 22 per cent. Non-malignant pustules and lymphangitis from infected wounds of the hands are also observed in tanners and leather workers.

In parts of the leather-dressing industry the workmen are subject to the fumes of naphtha, amyl acetate and wood alcohol. In dressing, trimming, polishing and carving leather much dust is set free which is moderately irritating, and may be specifically so, as in the following case:

A man, 45 years of age, presented himself at my clinic who for 25 years had worked as a finisher of leather, which he scraped, rubbed and polished. The leather had been treated previously with an arsenical preservative solution, and much dust was given off in the work. Ventilation of the workroom and washing facilities were poor and lunch was eaten on a worktable or bench. As a result of these poor hygienic conditions the man, who was originally of robust physique, acquired a multiple arsenical peripheral neuritis of both arms and legs. He had considerable pain and tenderness along the course of the peripheral nerves, accompanied by partial loss of muscular power.

Nine cases of poisoning of various sorts in the leather industry were reported in 1912 to the New York State Labor Bureau, six of which were in connection with tanning processes, such as dermatitis and ulcers from handling lime and hydrochloric acid, and septicemia from contact with "fleshings," or the flesh and fat removed from skins. In one case the acid got inside the workman's rubber gloves and gave rise to severe dermatitis. To the ulcers, which are deep and obstinate in healing, the workmen give the name of "chrome holes" (*See* page 185).

Amyl acetate is used in preparation of patent-leather. Under some conditions its vapor is explosive, and a building was recently wrecked in Passaic by explosion of a 60-gallon tank of this substance.

Notwithstanding the apparent insalubrity of these various processes they rarely produce any serious permanent disability, and a tendency to attacks of rheumatism and to "take cold" represents almost the only hazard in the better regulated tanneries. The workmen, on the other hand, are often remarkably strong and vigorous. An investigation of the "Health Conditions of the Leather Industry" was made by the New Jersey State Bureau of Statistics in 1906. In this State the leather industry is a prominent one, amounting to an annual output valued at about $21,000,000. The health of nearly 3,000 employees was inquired into, and found exceptionally good, better, in fact, than in most occupations involving as much hard labor. Only 69 of these men were too ill to work at some time during the year, a morbidity rate of only 2.3 per cent., and most of their illness was independent of the occupation. The death rate was extremely low. Most of the workmen, moreover, repudiated the suggestion that there was any hazard in their work beyond the tendency to "rheumatism" above referred to, and occasional affection of the bowels from turpentine and naphtha inhalation. Hard drinking is incompatible with intelligent labor and is discouraged by dismissal, which is no doubt responsible for much of the good health record of the men.

Prevention.—Care should be taken to protect the workmen from wet by suitable aprons, rubber or wooden shoes, and wooden slats on which to stand above wet floors. The precautions against poisoning by turpentine and naphtha consist merely in adequate ventilation, and precautions against poisoning by dyestuffs are described under that separate topic.

Abrasions of the skin should be promptly disinfected, and the neck should be protected when carrying raw hides, and hides suspected of infection should be disinfected with formalin with steam under pressure.

XIII. FACTORY AND HAND SHOEMAKING

FACTORY SHOEMAKING

There are in the United States about 200,000 boot and shoemakers, about half of whom work in factories. This industry is greatly subdivided, much of it being conducted by machinery. Many of the factories, although very large, are much overcrowded. The various processes involve handling of leather (which is scraped, cut and polished), lasting, pegging, sewing by machines, etc. Many females are employed.

Hazards.—The risks to health of this industry are not very acute, but they are numerous and some of them are incapacitating.

In a report of the Massachusetts State Board of Health for 1907 it is stated that, in 85 of a number of boot and shoe factories examined, "a considerable proportion of the operatives were noticeably pale and unhealthy in appearance." (William C. Hanson.)

The cutting, scraping, trimming and polishing of leather begets much organic dust (Fig. 116), which, moreover, is sometimes impregnated with dyestuffs and preservatives used in tanning. As a result, this dust, combined with frequent poor ventilation conditions, leads to irritation of the pharynx and bronchi. Sitting for long hours in cramped positions while operating the sewing machines leads to anemia and sometimes disorders of the bladder, especially in women, who also acquire dysmenorrhea. The "lasters" make constant pressure over the epigastrium, which leads to various gastro-intestinal disorders, including visceroptosis.

Much of the work requires strong light, and the operatives sit facing the glare from large windows. William Stainsby, who made an investigation of the health of 1,000 employees of shoe factories in New Jersey, states that many of the operatives show evidence of eye-strain in conjunctival congestion, narrowed pupils, and semi-closing of the lids, with pain which becomes quite acute toward the close of the day's work and prevents them from reading or sewing in the evenings at home. His tabulated list of prevalent diseases shows that, among the 1,000 operatives reported upon, 34 suffered from

gastro-intestinal disorders, 23 from pulmonary diseases, 12 from irritation of the throat, and 6 from vesical disturbance. The mortality appears to have been high, amounting to 6.6 per cent.



FIG. 116.—EDGE TRIMMING OF THE SOLE OF A SHOE. "The process gives rise to varying amounts of dust, the finest of which in well-equipped factories is sucked at once into the pipe. The work requires good light, accurate eyesight, considerable skill and close attention. Note the dust on the outside of the pipe, showing in this instance that the suction power was inadequate. In this industry fine leather dust is irritating to the respiratory tract, and naphtha fumes cause various forms of intoxication, especially in women." (Reproduced with permission of Dr. William C. Hanson, Massachusetts State Board of Health.)

In some of the machine shoemaking processes mercury is used as a lubricant, and in the finishing work the sole is smoothed over

emery, sand or glass paper wheels which generate dust of leather, emery, glass or sand. Brass filings from rivets constitute another source of dust.

All these dusts are unwholesome, and J. Beatty, of Northampton, England, found the tuberculosis death rate per 1,000 among shoemakers to be 2.59, as compared with the general average of 2.08.

HAND SHOEMAKING

Hand shoemaking, or the ordinary cobbler's work, leads to marked deformity of the thorax, although the cramped position acquired by sitting on a low stool and leaning forward is offset, to some extent, by the movements of stretching the arms in drawing the threads, which tend to expand the chest.

A patient shown in my clinic who had been a cobbler for thirty years was round-shouldered and flat-chested, with forward curvature of the clavicles and depression of the lower half of the sternum, due to constant pressure over the last. He acquired chronic bronchitis, asthma and emphysema.

Cases of tetany ("shoemaker's cramp") among shoemakers are described by Frankel-Hochwart. There are bilateral tonic cramps of the muscles, chiefly of the hands and wrists, with increased response to electrical and mechanical excitation. Among 399 cases of tetany in Vienna he found 179 were shoemakers.

There is often found in cobblers a fibrous swelling above the right knee, due to frequent hammering. Formerly tin-covered iron nails were used to fasten the leather "uppers" to the last, and, as tin contains lead, when the nails were held between the lips or in the mouth there was danger of lead poisoning. Injuries to the fingers causing abrasions or punctures may become infected and cellulitis result. In Vienna, in 1904, there were 357 such cases among 5,920 shoemakers who reported ailments to their unions. I saw an Italian shoemaker in New York who was obliged to have the forefinger of the right hand amputated from this cause.

XIV. GLOVEMAKING

This occupation is much subdivided and machinery now replaces many processes formerly conducted by hand. The hazards are neither serious nor constant, but from time to time various poisonings and injuries are reported in the literature. Dr. Alfred Mode, in his "Health Book of Glove Manufacture," refers to chlorosis and tuberculosis as among the disease hazards of the industry due mainly to the dust, heat and poor ventilation of the workrooms.

In the preparation of the kid or other skins part of the work comprises maceration, and various dyestuffs are used. Thus cases of chrome poisoning with perforating ulcers of the hand have occurred (*See* page 185) and for cheap grades of white gloves lead white or Kremsen white, which is applied to the skins, may cause plumbism. Alum, talcum powder, pumice powder and anilin are among other injurious substances sometimes handled in considerable quantity. The hands of the workmen may be macerated from handling skins which have been freshly wet in various solutions. Many cases are reported of muscle and joint strains from standing in constrained positions at workbenches or tending machines while constantly doing the same kind of circumscribed work.

Julien, of Lyon, has reported several cases of traumatic orchitis among workmen who pressed constantly against a workbench. Practically all such hazards are easily avoidable and need rarely occur in any but the poorest regulated manufactories.

XV. BUTTON MAKING

The grinding of the various materials, horn, hoofs, bone, ivory, vegetable ivory, tortoise shell, celluloid, shell, etc., of which buttons frequently are made distributes clouds of dust which are scattered by the emery grinding wheels used for turning and polishing the buttons.

In 1905 there were approximately 10,000 button makers in the

United States, about half of whom were employed in making fresh-water mussel "pearl" buttons.

For the manufacture of the so-called pearl buttons, clam and mussel shells derived from the beds at the mouth of the Mississippi River are used to a great extent. Round discs are sawed or punched out of the shells, and the enveloping skin, consisting of nearly 6 per cent. of organic matter, is ground off on emery wheels. The dust from these shells consists of 93.5 per cent. of calcium carbonate. The buttons are then drilled, polished with chemicals and buffing wheels.

Another substance much used is "vegetable ivory," which is the seed of the fruit of the *Phytelephas macrocarpa*, or "ivory nut" palm, growing in Colombia. This nut is close-grained, hard and albuminous, and is readily sawed, colored and polished. The "composition" buttons are made of fossil and vegetable gums, lime carbonate, mica, feldspar, amber, etc., in various mixtures. Celluloid, wood, casein, dried blood and potatoes are all substances which, with various treatment, are made to furnish material for buttons.

Efforts have been made to reduce the dust menace in the pearl button industry, for the dust sometimes spreads far beyond the limits of the factory building, but for certain technical reasons this has proved difficult.

Other buttons ground from bone also give rise to much organic dust which is somewhat less irritating than the mineral clam shell dust. The disgusting odors associated with bone button manufacture are mainly objectionable from an esthetic point of view. In a town in Eastern New York they were so disagreeable as to lead to the expulsion of a large button factory from the town.

In the manufacture of other types of buttons much silica dust, which is highly irritating, is distributed in the atmosphere.

Symptoms.—Button workers acquire rhinitis, chronic bronchitis and conjunctivitis, and may develop fibroid phthisis. The tuberculosis mortality among bone button makers is extremely high. Ludwig Teleky, of Vienna, examined 150 button makers using mother-of-pearl and found that only 93, or less than two-thirds, possessed normal lungs.

The chronic bronchitis may be of purulent type and bronchial hemorrhage may occur. There is also much asthma among button makers, and they acquire chronic conjunctivitis and blepharitis. Frequently the hands become fissured. Among pearl button workers thirty-one cases of a peculiar form of osteitis have been collected (Teleky). The disease begins usually in the diaphyses of the long bones, with pain, soreness, periosteal inflammation, thickening and fever. The bone presents the changes of subacute osteomyelitis. The disease begins in some one bone and gradually extends to others. It affects particularly the radius, ulnar and femur, but the humerus, lower jaw, metatarsal bones, clavicle and scapula have all been involved (Gussenbauer). It affects youths from 14 to 16 years of age whose bones are still developing. Remissions and exacerbations of the local pain and swelling occur. The disease may subside completely after weeks or months, or leave some degree of permanent thickening. Pus formation does not appear.

The etiology of this condition is very obscure. Gussenbauer attributes it to conchiolin, an organic substance derived from the mussel shells from which buttons are sometimes made, which may develop embolic processes in the bones. His hypothesis is that this dust enters the pulmonary lymphatics and is finally decomposed by the carbonic acid of the venous blood, which dissolves the lime and liberates the organic matter. In the small vessels of the epiphyses the conchiolin is chiefly deposited. Diagnosis is based upon the localization of the lesion at the end of the bone, with fusiform tapering of the swelling toward the center, and the favorable outcome of a condition which seems very serious at the onset (Teleky).

The rotating wheels used in the button machinery frequently are controlled by a foot pedal, the workman standing upon the opposite foot, which often results in flat-foot. As the workman bends over his machine he is liable to acquire deformities, one shoulder becoming higher than the other and the thoracic spine bent toward the depressed shoulder.

Prevention.—Prevention of the hazards of button grinding consists in the use of strong exhaust ducts applied close to the grinding

wheels to carry off the dust (Fig. 117). Moistening the materials used is not very practicable, for the dust is thrown off in such quantities and so rapidly from the freshly ground surfaces that large



FIG. 117.—FACING, GRINDING, POLISHING, AND DOMING PEARL SHELL BUTTONS. "There is an exhaust-blower system which is, to a certain extent, effective. The girls, however, are exposed to much dust which is not carried away." (Dr. William C. Hanson, *Bulletin* of the Massachusetts State Board of Health, Aug., 1910.)

quantities of water would have to be used, which would interfere with the work.

Treatment.—Treatment of the periostitis and osteitis consists in local applications of mercurial ointment or icthyol ointment (40 per cent.), and internal use of potassium iodid.

XVI. CALICO PRINTING

Calico was early made in Calicut, India, and hence the name. This industry occupies a number of men, women and children. In New York State alone over 1,600 were employed in 1908 in the three establishments of the State.

Nature of the Industry.—The process of calico printing involves the expert use of many chemicals and exposes the workers to much dust, moisture, excessive heat and steam. Among the chemicals used in considerable quantity are arsenic, antimony, chromates, copper, lead, quicklime, chlorin, cyanids, fuchsin, logwood, anilins, and hydrochloric, sulphuric, acetic, formic, citric and tannic acids. All these chemicals have special uses, in part as coloring agents, in part as fixing agents or mordants, and in part as bleachers.

The industry has been made the subject of an excellent special report in 1909 by Dr. C. T. Graham-Rogers, Medical Inspector of Factories of New York State, from which the following brief account of the complex processes is mainly derived. The report does not deal with cases of occupational disease in the industry, but opportunities for their origin certainly exist where factories are not carefully constructed and the work well supervised as to hygienic control. The industry comprises printing on long strips of cotton cloth, dyeing, bleaching and finishing. The printing machines consist of large metal drums protected by a blanket cloth, against which revolves a set of copper cylinders with patterns engraved upon them. In the working of the machines the cloth is drawn between the drum and the revolving cylinders, which dip into a color paste, and the pattern is thus laid upon the cloth. The color paste may be applied simultaneously with a fixing agent or the mordant may be first applied by dyeing the cloth, then printing over the mordant and bleaching out the areas not covered by the pattern.

To prepare the rather coarse yellow cotton cloth for calico printing it is smoothed between shearing knives and brushes and then singed over iron tables heated by coke ovens beneath. This part of the process, designed to remove all loose threads and fibers, naturally

is extremely dusty, and, if the ovens are not well cared for, there may be opportunity for chronic carbon monoxid poisoning, as there often is where coke is used. Several washings follow, alternating with bleaching in vats with first potash, then chlorin solutions or lime, and finally dilute sulphuric acid. After drying in a hot chamber the cloth is ready for printing.

Among the great variety of materials used for printing colors the anilins are most employed. They are mixed with acetic acid and ammonium acetate, to which arsenious acid in glycerin is added. Exposure to steaming liberates the acetic acid and ammonium arsenate unites with the anilin. In another process which Dr. Rogers describes a tannate of antimony is formed instead of the arsenate. The blue colors are made with copper and sulphuric acid, sometimes with addition of anilin and potassium bichromate. The red colors are made from beta-naphthol with paranitranilin, and brown and gray shades with logwood.

After dyeing, printing and bleaching out, with lime or acids, all unnecessary mordant or color-fixing agents, the goods are "finished" by filling with boiled starch, often stiffened with sulphate of calcium or barium ("barytes") and tinged with bluing.

The calico is finally dried over steam heaters or revolving cylinders, smoothed, folded and packed. Rogers also refers to a process known as "napping," by which rollers bearing fine teeth roughen the surface of the calico after dyeing and printing. The dust evolved by thus roughening the cotton fibers is impregnated with whatever toxic substances have previously been applied.

Hazards.—The hazards of this industry are numerous. The dyeing and steaming parts of the work expose the workmen to considerable heat and much humidity, conditions which predispose to rheumatism, bronchitis and anemia.

The many metals used may give rise to specific poisonings derived through inhaling dust after the printing process or from careless handling of solutions. Arsenical poisoning has been reported a number of times in this industry, and both Rogers and Legge, of England, have seen "chrome holes" (*See* page 185) on the hands of dyers using the chromic acid salts. Anilin poisoning

acquired in similar manner is relatively common. It gives rise to gastro-intestinal and nervous symptoms, and produces an hemolysis which in acute cases may be fatal. (*See* Anilin Poisoning, page 307.)

The chlorin, ammonia and various acid fumes pervade certain of the workrooms and may cause conjunctivitis, coryza, rhinitis and bronchitis, besides gastro-intestinal disorders. The irritation of the hands and arms caused by the lime, anilins and various acids gives rise to dermatitis, eczema with fissures, etc. (*See* Diseases of the Skin, page 580.)

XVII. SILK MANUFACTURE

In silk manufacture many strong chemicals are often made use of, first to dissolve the gum and other impurities of the raw silk, then for dyeing, and sometimes the silk is dipped in a strong solution of tin or other substance to restore the weight lost through removal of the impurities. The workmen may thus acquire various cutaneous lesions or other forms of poisoning from handling the chemicals.

XVIII. LACE-DRESSING

It has been asserted that this industry, owing to the variations in temperature and moisture, is an unhealthful occupation, but an investigation by Philip Boobbyer, Medical Officer of Health for Nottingham, England, in 1907, of 1,002 women employed in lace-dressing and dipping shows conclusively that the work entails no risk to health whatever when conducted in properly ventilated rooms. Many women "are upset at the outset by the high temperature of the lace-dressing rooms and subsequently abandon the work altogether in consequence," but, on the other hand, those who remain soon become acclimated, so to speak, and, beyond the ordinary common colds, suffer no inconvenience and develop no special predisposition to tuberculosis. The lace, after bleaching, and sometimes dyeing, is dipped in starch solution and stretched on frames to dry

in rooms heated by steam or hot water pipes from 75° to 100° F. In Lyons some of the silk lace-dressing rooms are heated to 140° F. The dryest air in the Nottingham works held only 27 per cent. of relative humidity, and the most moist air 83 per cent.

XIX. GARMENT WORKERS

Under the general name of "operators" are grouped a large number of industrial workers employed in operating machines for the sewing of garments, in cutting from patterns, pressing, etc. Cloak makers, skirt makers, and makers of men's clothing are all exposed to certain disease hazards affecting the respiratory and digestive systems, and frequently also the nervous system.

Nature of the Hazards.—Apart from the foul air, poor light and overcrowding which have received so much attention of late as notoriously connected with these occupations, there is exposure to dust, such as that of fine cotton and wool fibers, to illuminating gas which leaks from the pressing irons or charcoal ovens used for heating them, or to leaky gas stoves used for heating the rooms. There are also to be reckoned with, as affecting the muscular and nervous systems, the effects of faulty positions of the body in leaning over work, the strain of the constant use of machines when operated by hand or foot, and the general mental strain of working under unusual hurry, or "speeding up" in the rush seasons of the year. As in many other industries, moreover, the work is so subdivided as to increase monotony and multiply the number of certain movements without variety, thus the cutting, basting, sewing and pressing and finishing processes all have their potential hazards.

The cutter piles a number of layers of cloth, one on the other, and places a pattern on top. The layers are then cut through simultaneously with sharp rotary knives or shears, operated either by hand or machine. The operator, in carefully following the pattern, leans closely over the cloth and necessarily inhales considerable light dust. In sewing the thread and cloth both evolve more or

less dust. Investigations of the New York Labor Bureau show that in some clothing manufactories the dust accumulation is as high as in the pearl button industry. The cotton fiber dust is found to be worse than the woolen.

During the assembling of the garment, if it be part of a suit, for example, it is sent to the presser, who employs either a hand gas iron or "goose," or sometimes a heavy gas iron worked both by hand and foot. In heating these irons Bunsen burners are usually used, which often have leaky connecting tubing or attachments, and which always, besides consuming much oxygen, fill the air with products of incomplete combustion, and especially carbon monoxid. Hence the pressers especially are liable to chronic illuminating gas poisoning, which gives rise to headache, anemia, nausea, constipation, and muscular debility. Moisture also is evolved from the damp pressing cloths. The finishing machines are frequently run by small gasolene engines in the workroom, which add to the general vitiation of the atmosphere.

As a result of these unsanitary conditions, the operators, who are often also ill-fed and ill-housed at home, acquire an impaired condition of health in which constipation, dyspepsia, anemia and neurasthenia are the predominating symptoms, together with a strong predisposition to acquisition of pneumonia and tuberculosis.

In the New York Health Department Tuberculosis Clinics nearly two per cent. of all occupations represented among the patients are those of garment cutters.

Of 456 garment workers treated in the Milan Clinic, 1910-1911, 128 presented diseases of the respiratory system (65 being tuberculous), 15 had pleurisy, 16 diseases of the circulatory system, 6 diseases of the muscles, 73 disorders of digestion, 22 diseases of the nervous system and 6 had nephritis.

Dr. George M. Price, Director of the New York State Factory Investigating Commission, is authority for the statement that in New York City, "Within the last year (1911) an investigation of 1,800 shops in the cloak and suit industry, made under my direction, has disclosed the fact that but 3.83 per cent. of the shops had any special means of ventilation."

Women and girls who work pedal machines sometimes acquire dysmenorrhea.

Prevention.—Prevention consists primarily in securing good ventilation and preventing overcrowding. Food should not be permitted to be sold or eaten in the workshops, but suitable luncheon rooms should be provided and adequate time should be allowed for eating and a midday rest.

Treatment.—Treatment of the neurasthenia and digestive disorders is described under those headings (pages 531, 155).

XX. LAUNDRESSES

In the steam laundry business women and girls chiefly are employed, although men are required as firemen, engineers, carriers and to manage some of the machinery. The old-fashioned wooden tub washing which involved stooping, wetting and much exercise is now relegated to the small hand laundries and to private families. The mechanically washed clothes are placed in assorted groups in nets and enclosed in rotating closed drums, where they are subjected to steam and hot soap suds, often under slight increase of pressure. The mangles and most of the ironing and starching processes are conducted by machinery which merely requires "feeding" or tending without much expenditure of muscular energy. Finer work, as on lace and thin fabrics, must be done by hand throughout. Shirts, which are washed, mangled and starched by machines, have to be ironed by hand, owing to their shape.

Hazards.—The risks to health in steam and hand laundry work are the following, as the industry is at present conducted: fatigue from long hours of work and much standing; wetting of the feet and body and prolonged maceration of the hands and arms, in the case of hand tub washing; fatigue from tending certain machines, as cuff ironers; exposure to extreme heat and humidity. Where gas stoves or gas irons are used the air is very often polluted by leakage of gas. Among 32 girls thus employed Röpke found 13 who complained of headache, vertigo and malaise. Chlorosis is common among the younger workers in steam laundries. Chronic rheumatism

and tendency to acquire "colds," bronchitis and rhinitis are common, also gastralgia and chronic constipation are among the most frequent disorders. Flat-foot is often observed, and varicose veins and ulcers of the leg occur in the older women. Women who use the right arm for continual hard scrubbing may acquire sinovitis of the shoulder, wrist or elbow joints. Enteroptosis may take place from long standing, combined with frequent bending of the body.

As the "nets" of clothing often contain colored articles which might have their color dissolved and stain other clothing, very hot or strong soap suds cannot be used with them. Moreover, the clothing from several families is customarily packed in one net, hence there arises some liability to the spread of such contagious or infectious diseases as typhoid fever, variola and scarlatina. This danger, however, is often considerably exaggerated, although any such process of promiscuous washing is emphatically to be condemned.

Jane Seymour Klink, in a report on health conditions in laundresses in Brooklyn (*Proceedings, Acad. Political Science,* New York, Jan., 1912, vol. ii, No. 2), states that among a yearly average of 165 women under observation for 3 years there were 1,876 complaints at various times of illness, a high average for any harmful employment. Among these cases were 436 of gastric disorder, 328 of dysmenorrhea, 124 common "colds," 55 cases of "sore throat," 36 of neuralgia and 31 of rheumatism. As these were layman's diagnoses they are not very accurate, but show at least a preponderance of diseases arising from exposure to heat and dampness, with long hours of standing at hard work.

XXI. SLAUGHTERING

Workers in slaughter houses and packing houses have to stand for long hours in cold rooms. They must often lift heavy weights (sides of beef, etc.), and in consequence may suffer from lumbago and flat-foot. They are exposed to dampness as well as cold in winter and are prone to bronchial catarrh. The handling of sharp knives in rapid work often results in cuts of the hands which may

become infected, giving rise to cellulitis. In Germany, where women are employed to a considerable extent in packing houses, sausage works, etc. (as they are not in this country), they are liable to become anemic and nervous, so much so that, according to Leiser, of Berlin, their appearance gives rise to the local descriptive term of "Slaughter-mamsell."

XXII. CANNING

This work comprises such processes as washing, skinning and peeling fruits and vegetables, lifting heavy crates, and working in a

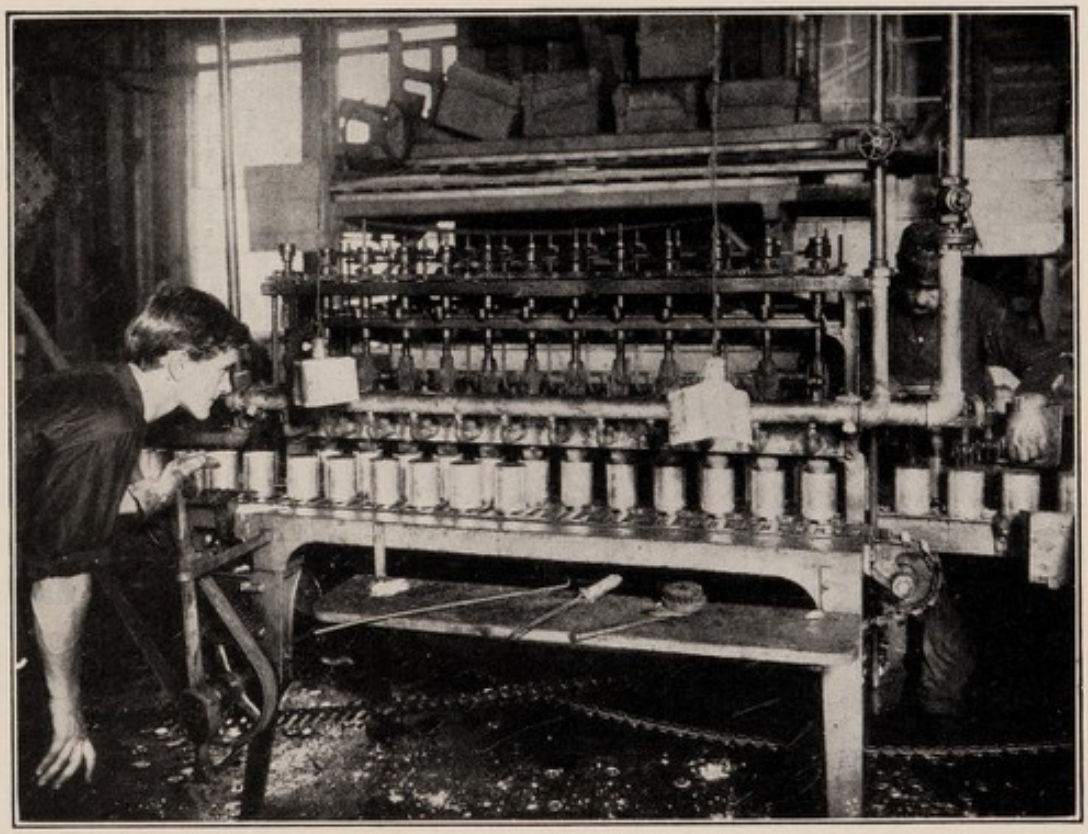


FIG. 118.—SOLDERING CANS OF PRESERVED FRUIT, 12 AT ONE TIME.

steam-laden atmosphere where the heat and temperature are often extreme. In some of the rooms the workmen stand on slats or wear rubber shoes for protection from the wet and the moist skins and pulp which are allowed to accumulate in dirty canneries.

Hazards.—Although the industry is not especially hazardous, it is by no means always free from risks. The work is of irregular

type, dependent upon season, the hours are long, and the employees, who are largely women and children, often work under considerable tension. The women employed in the washing rooms often stand for hours in wet skirts and their hands constantly are immersed in cold water. The crates which they lift have a standard size of 40 lbs. The fingers of the peelers are often cut and become quite sore and sometimes infected. At the end of a canning season many of the employees find themselves unfit for other work for a considerable period. In soldering the cans there is risk of lead poisoning. The cans, on a traveler, pass in front of the workman, who solders twelve at a time. (Fig. 118.)

XXIII. BAKERS

Hirt has furnished some German statistics of mortality among bakers and grain millers, both classes working in very dusty rooms. Although the dust is soft and not particularly irritating, it is very abundant, light and easily inhaled.

These statistics show that more than 42 per cent. of the deaths among such employees arise from respiratory diseases, 20 per cent. being caused by pneumonia. Emphysema, chronic bronchitis and asthma are common, and in the United States Census returns the mortality from tuberculosis among bakers occupies a midway position among 27 industries selected for comparison. Bakers, however, often work by night in cellars where the ovens are placed, and, being below the street level, are exposed to outside dust, poor light and other unhygienic conditions which are really apart from their occupation *per se*. They sometimes sleep on empty, dusty flour sacks. They are exposed to high temperatures on entering large ovens and to inhalation of carbon dioxid developed in the course of the fermentation of the flour by yeast. The ovens, often cheaply constructed, may emit carbon monoxid fumes from the ill-consumed fuel.

XXIV. MISCELLANEOUS FOODSTUFFS

The preparation or handling of a considerable variety of foodstuffs may cause irritation of the eyes, nose and throat, although

cases of serious poisoning from these sources rarely if ever occur. The effects of sugar and flour manufacture have been considered under those headings.

MUSTARD AND PEPPER

The grinding of mustard and pepper exposes workmen to irritating dusts which cause sneezing, nasal catarrh and conjunctivitis.

STARCH

The manufacture of starch from potatoes, corn and other products gives rise to much dust, which is not particularly irritating, but if any of the starch undergoes fermentation the acetic, butyric and lactic acids which develop may give off fumes and carbonic acid, and sulphuretted hydrogen gases may also be evolved in sufficient quantity to cause slight toxemia. In making starch-sugar diluted sulphuric acid is used, which contributes fumes to the general unhealthfulness of the occupation. In making alcohol from starch considerable carbonic acid gas is evolved.

VINEGAR

In the manufacture of vinegar, especially in the bottling process, workmen are exposed to the slightly irritating fumes of acetic acid, which cause nasal catarrh.

XXV. TEA TESTING

One of the methods of testing the quality of tea is to sit at a revolving table upon which are cups of tea of different qualities. From these the tasters sample each variety by sipping a mouthful and subsequently expectorating it. Despite the expectoration, much strong tea is absorbed through the mouth or swallowed, with result of producing sometimes chronic thein intoxication.

Symptoms.—The symptoms are insomnia, restlessness and general "nervousness," gastric catarrh, constipation, and sometimes neuritis.

XXVI. CHOCOLATE MAKING

The chocolate industry necessitates frequent tasting of the products to determine their quality. One of my patients was a man of 42 years who had acquired the "chocolate habit" through tasting the products of his manufacture. He was unduly stout, dyspeptic, and had a pronounced functional glycosuria, which yielded promptly to dietetic treatment.

XXVII. TELEPHONE OPERATORS

Much study has been given to the subject of the possibility of disorders of hearing resulting from the strained attention and buzzing of the apparatus experienced by telephone operators, and Tommasi described diminution of acuteness of hearing, vertigo and disease of the middle and internal ear among them. Such cases, however, are rare, and probably are due to a general neurasthenic state rather than to sound irritation. In fact, many aurists have failed to confirm such observations. The only serious inconvenience suffered by the operators is a tendency to hysteria and neurasthenia, especially in young girls in whom long hours of sedentary work, fixed attention and nervous dread of committing errors may, in time, give rise to considerable nervous strain and weakness, especially during menstrual periods. The resulting nervous phenomena are in no wise different from the effects of similar strain experienced in other ways and are described under the headings Hysteria (page 533) and Neurasthenia (page 528). In a few operators cases of nervous palpitation and vasomotor disturbances have been observed. (Hoche.)

Thebault has reported several such cases occurring in Paris, and Wernicke in Berlin and Tommasi in Rome have commented on the

great frequency of hysteria and neurasthenia in young telephone girls who have worked continuously for several years.

In the United States the largest telephone company is justly proud of the health record of its operatives, and claims that among its many thousand operatives no serious cases of illness were attributable to the specific nature of the occupation. Many of the larger "exchanges" of this company afford models of good hygiene. The windows must necessarily be kept closed on account of the serious injury possible to the delicate apparatus from outside dust, but good artificial ventilation is installed. Matrons supervise the health of the girls and anemic and neurotic girls are excluded from the work, as well as those having digestive or menstrual disorders. Constipation is very common among girls and women in all sedentary occupations, and the treatment is described on page 156.

The American Telephone and Telegraph Company has found it an economic advantage to take excellent care of its operatives in order to lessen the possibility of neuroses and neurasthenia among them. In the larger "exchanges" rest rooms are provided, and in some of them there are roof gardens and calisthenic exercises are encouraged for relaxation. Lounges are supplied where girls may lie down and rest during their off-duty periods, if necessary. Much attention also is given to providing means for personal cleanliness, adequate wash-rooms, lockers, etc., and hot food and tea or coffee may be purchased in the separate lunch rooms for cost price. In the larger exchanges an emergency hospital ward is maintained for use by any girl who may become suddenly ill from any cause. In some of the rest rooms pianos, pianolas and games are supplied for diversion. All these things, rightly used, tend to counteract the fatigue and strain resulting from long hours of close mental application. The report of the company states that "untiring vigilance is given to the problem of keeping the load of work so adjusted that it shall result in neither the monotony of idleness nor the strain of over-exertion."

More than 50,000 young women are employed throughout the Bell telephone system in this country.

XXVIII. BARBERS

It is hardly to be expected that barbers should suffer from any occupational troubles other than occasional cuts of the fingers, but they sometimes have flat-foot from standing long hours on tiles or other hard flooring. They also exceptionally have eczema of the hands from frequent rubbing with hair dyes, oils and other applications. Cases of barber's eczema are described upon page 581.

XXIX. GARDENERS

The hazards of the occupation of gardening are several, but not very serious, and are to a great extent offset by the advantages of life in the open, excepting for those who work constantly in hothouses. Gardeners are subject, however, to working in wet clothing after rainfall and heavy dew, and may thus acquire catarrhal affections of the upper air passages, and those who work in winter in damp hothouses are much exposed to chilling the body on going out into the cold air. Influenza, rhinitis, chronic bronchitis and rheumatism are among their chief ailments. The dust of seeds and of fine earths used in potting plants is moderately irritating to the Schneiderian membrane, and nose colds or other forms of "hay-fever" are sometimes met with. There is a variety of large primrose (Primula obconica) grown under glass in Holland, and sometimes imported to this country, which possesses as definite toxic properties as the common poison ivy. It causes intense acute rhinitis and, if handled, develops a violent urticaria which may involve the hands, face, and parts of the body. Some gardeners are so sensitive to this and similar plants, such as Primula sinensis and P. Sieboldii, that they cannot work with them at all. Dr. W. B. James told me of a patient who purchased several of these primroses and took them home in her carriage. Being very fond of them, she buried her face in them for a few moments and shortly after developed a dermatitis of face and hands which caused redness, swelling and intolerable itching of several days' duration.

Garden vegetables require much weeding, and as the plants grow low and in long rows the gardener must do much of the planting, weeding, berry-picking, etc., upon the knees. Patellar bursitis may develop as a result of such occupation, as well as lumbago and sciatica. Richard Loth, of Erfurt, refers to the occasional occurrence among gardeners of tetanus, the germ of which (Bacillus mallei) may enter the foot from the soil by means of accidental puncture with a rusty nail or otherwise. Soils in certain localities are well known to be extensively infected with this germ.

Septic infection of the hands may result occasionally. Exceptionally cases of arsenic poisoning have occurred among gardeners who use arsenical preparations, either in powder or fluid form (Paris green, Bordeaux mixture, etc.), as insecticides, against the potato bug and other insects.

XXX. BLACKSMITHS AND HORSESHOERS

Blacksmiths and horseshoers usually work in open shops and, despite the deleterious gases of their furnaces which they lean over, do not appear to suffer from gas poisoning, as a rule, but I have referred under Brass Poisoning, page 175, to a case of lead palsy acquired in this manner. From the frequent changes in temperature to which they are subjected in winter, being overheated at the forge and cooling off suddenly outdoors, they are liable to frequent attacks of bronchitis and rheumatism, and are predisposed to nephritis. They have conjunctivitis from smoke and dust in the eyes, and they acquire a physiological hypertrophy of the muscles of the arms and thorax. Horseshoers rarely may be exposed to glanders.

XXXI. DRIVERS

Drivers of street drays, public hacks, etc., have always been rated in England as belonging to one of the most unhealthful occupations, their tuberculosis mortality, according to Arlidge, rating

359, as compared with 220 in other occupations. They also have gout and rheumatism, being exposed to cold and damp, and especially to the hazards of the corner grog saloon. They often work in foul stables and besides are exposed to much street dust. In this country there are (or were before taxicabs and motor trucks came into such general use) about a half-million drivers of this class, but the occupation is not rated as especially hazardous. Its evils, after all, are largely offset by an open-air life. Conditions vary so much among these men, being largely influenced by personal habits, the degree of sedentary work, etc., that it is difficult to generalize about them.

XXXII. FIREMEN

Firemen are exposed to the hazards of extreme heat, and also, in winter, to cold, and at all times to wetting, and irregular hours for sleeping and eating. Their chief hazard, however, is from asphyxia caused by inhalation of hot smoke, coal gas, illuminating gas, or the fumes of burning oil, turpentine, sulphur, naphtha, camphor, ammonia and a variety of similar highly poisonous substances which may have been stored in burning buildings. They are subject from these causes not only to immediate asphyxia and pulmonary edema, but to conjunctivitis, acute and chronic bronchitis and pneumonia. The condition of asphyxia is described on page 144, of pulmonary edema on page 154, and various types of rescue and preventive apparatus are described on pages 145 and 147.

APPENDIX I

TABULATED LIST OF THE PRINCIPAL HARMFUL SUBSTANCES AND THEIR EFFECTS

A. METALS

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Antimony: Antimony colors, antimony oxid, and chlorid, cinnabar, Naples yellow, antimony alloys and other compounds.	Preparation of type and white metal, Britannia metal, fireworks, paints, anilin dyes, pottery glaze, red rubber, tartar emetic, as a mordant, extraction of antimony from native trisulphid, tinning, enameling, hardening lead for ammunition, burnishing rifle barrels, paint making.	As a vapor (oxid), as a skin irritant (antimonic acid and sulphid), as a dust (metal).	Coryza, dyspepsia, intestinal colic, anemia, nephritis, skin eruptions, depression of heart, vertigo and fainting.
Arsenic: As a metal; arsenic trioxid, arsenic acid, arsenious acid, Schweinfurth's green; Scheele's green, cochineal, realgar, orpiment.	Mines, foundries, chemical works, manufacture of shot, glass, anilin and other dyes, wall paper, oilcloth, artificial flowers, colored chalks; dyeing, preservation of taxidermist's specimens, tanning, etching brass, fur curing, felt hat making, pottery	As a vapor and dust through respiratory mucosa and skin.	(a) *Acute poisoning:* Constriction of throat, gastric pain, vomiting, diarrhea, jaundice, hematuria, muscular weakness, cramps in legs, depression of heart action, vertigo, fainting, delirium, convulsions, collapse. (b) *Chronic poisoning:* Malnu-

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
	glazing, extracting oil from raw wool, bronze colors, zinc smelters, making artificial stones, paints, insecticides, smelting of copper ores, tinning, enameling.		trition, melanosis, bleeding gums, loss of hair and nails, dryness of skin, skin eruptions (as eczema), conjunctivitis, inflammation of the respiratory passages. Nervous symptoms: peripheral multiple neuritis, anesthesia, diminished reflexes, paralysis, insomnia, melancholia. Arsenic may be present in the urine.
Brass: Pure yellow brass consists of equal parts of copper and zinc. Ordinary brass consists of copper, tin, lead and zinc in varying proportion.	Brass filing, cutting and polishing, casting.	As a dust, irritating the respiratory system and entering the alimentary canal.	Chills, perspiration, headache, neuralgia, dyspnea, vomiting, deposit of green tartar on the teeth (due to copper), gastrointestinal catarrh, colic, metallic taste in mouth, anemia, fibroid phthisis, chronic bronchitis.
Bronze: Substances used for bronzing consist of various alloys of copper	Bronzing work with bronze powder or liquor.	As a powder and in fumes, irritating the respiratory system.	The symptoms are those of the several poisonous metals which predominate in the bronzing

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
and zinc, copper and tin and other metals. Antimony chlorid is used for bronzing gun barrels. Nitromuriate of platinum and manganese are also used in combination.			mixture. They are mainly headache, rhinitis, conjunctivitis, a metallic taste in the mouth, anorexia and anemia.
Chromium: As chromic acid, lead chromate, chrome carmin, orange, red and yellow, cinnabar.	Manufacture of chrome steel, mineral tanning, bleaching, wax and palm oil, pyroligneous acid, denatured spirits, anilin colors, photolithography, manufacture of hektographs, mordants and dyes, Swedish matches, galvanic batteries, colored glass, acetylene, artificial flowers.	As dust, irritating respiratory passages and skin.	Chromic acid irritates the respiratory passages and may cause necrosis of the superior maxilla, chronic bronchitis, bronchopneumonia, chronic otitis media, chronic conjunctivitis, chronic gastritis, anemia, chronic nephritis. Lead chromate causes eczema, deep ulcers of the skin and mucous membranes, ulceration and perforation of the nasal septum.
Copper: Copper sulphate.	Copper ore is associated with lead and arsenic which cause	As a dust from filings irritating the respiratory	Chronic bronchitis, vomiting, gastritis.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
	more serious poisoning than the copper itself in smelting. Miners, bronzers, coppersmiths, filers, founders, watchmakers.	passages, and, when swallowed, as a poison through the alimentary canal.	
Gold.	Jewelry manufacture, plating, gilding, gold beating. Bronze gilt powders, enameling.	Non-poisonous except through associated acids, potassium cyanid, mercury, benzene used for cleansing, etc.	Symptoms are those of the substances used in manufacturing articles of gold or gilt.
Iron and Steel.	Foundries, rolling mills, cutlery works, and all industrials in which iron dust and steel filings are present; steel construction works; tube works; sandblasting and emery grinding of iron castings; cutlery; making of needles, nails, wire, etc.	As a dust by inhalation; and by mechanical injury to the eyes. Potassium cyanid may be used in the process of hardening steel.	Pneumonoconiosis ("knife grinders' phthisis"), bronchial irritation; corneal injury, ulceration, etc.; injury to the eyes by excessive light and to the eyes and skin by excessive heat in foundries, rolling mills, etc.
Lead: Lead alloys, lead sulphid, lead sulphate and lead chrome pigments. (*See* chromic	Lead mines; manufacture of lead sheets, pipes, wire, pots, pails, bottles, taps, pumps, retorts. Use of alloys: type metal, shot,	As a vapor, from superheated lead; as a dust, by inspiration or conveyance to the mouth by un-	Chronic lead poisoning affects many different organs, notably the arteries, nerves, and kidneys; slow absorption of lead

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
acid.) Lead oxids, Pb.O (litharge), Pb_3O_4, Pb_4O_5 (red lead).	lead tin (calin), type foundries, typesetting (linotyping), metal caps for bottles, file making, diamond polishing. Preparation of lead pigments as litharge, white lead, red lead, Naples yellow, antimoniate of lead oxid, Cassel's yellow, lead chromates; in pottery glazing, painting and varnishing. Other lead compounds, such as preparation and use of sugar of lead, lead subacetate, borate, chlorid, etc.; mining of zinc and copper and manufactures derived from these metals; solder used by tinsmiths, roofers, jewelers, coppersmiths and many other trades. Brush making, enameling, workers in glass, gold and silver, gilders, patent leather, lead platers in sulphite and cellulose factories, storage batteries, brick glazers, white rub-	clean hands; as a fluid, in solutions of lead salts which irritate the skin.	gives rise to arteriosclerosis, chronic neuritis and chronic interstitial nephritis, with deposit of a lead line on gums and the presence of lead in urine. These symptoms are associated with chronic anemia, chronic gastritis, constipation, loosening of teeth, pains in the joints, anesthesia, paralysis, abdominal cramps and colic. Temporary blindness or loss of hearing, smell and taste may occur. Lead encephalitis gives rise to vertigo, insomnia and mental deterioration.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
	ber making, painting, sandpapering old paint, putty powder, cigar wrappers, white gloves and shoes, matches, linoleum, batteries, cable splicing.		
Manganese: As oxid.	In chlorin industry; preparation of oxygen, bleaching powder, potassium permanganate, manganese glass pigments, enamels; glazing, dyeing, marbling of soap; manufacture of lacquer, varnish, oil paints, galvanic battery cells; in a sulphurous compound used as a drier in linoleum.	As a dust by inhalation.	Dyspepsia, paresthesia, tremors, vertigo, derangement of voice and articulation, mental depression, paralysis of limbs, emaciation, anasarca, loosening of the teeth, muscular pains, incoördination, hysteria.
Mercury: Cinnabar, mercury alloys; amalgams with gold, silver, zinc, tin, lead and copper; mercury compounds as corrosive sublimate, mer-	Mining in mercury and gold mines, smelting, extraction of gold and silver, gilding, silvering and bronzing; making of mirrors, thermometers, barometers, manometers, glow lamps,	As a vapor through the respiratory system and as a solid through the skin or by conveyance to the mouth by the fingers.	Chronic inflammation of the gums and mucous membranes of the mouth, loss of teeth, necrosis of the jaw, ulcers in the mouth and pharynx, chronic gastritis, enteritis, anemia, emaciation, fur-

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
curic oxid, nitrate, sulphate, fulminate.	Sprengel air pumps, caps and explosives, felt hats; dyeing of hair, calico printing, photography, etching on steel. Makers of foil, taxidermists, dyers of artificial flowers, fireworks, antiseptics, bleaching cane chairs, goldsmithing, antiseptics, rubber industry, shoemaking machines, electric meters.		unculosis, anesthesia, mental depression and hallucinations, increased reflexes, palpitation, tremors of the hands and muscles of the face, atrophy of muscles.
Platinum: Platinic chlorid.	Photographic printing.	Irritant to mucous membranes and, in solution, to skin.	Rhinitis, sneezing, coughing, asthma, bronchitis, eczema, with fissures and ulcers of skin.
Silver: Silver nitrate.	Photographers, glass makers, making silver leaf, electroplating.	As dust and through alimentary canal by absorption and action on skin and mucous membranes.	Bluish-brown discoloration of skin and mucous membranes.
Vanadium.	Photography, cloth printing, steel casting.	As a vapor, trioxid, through the lungs.	Pulmonary congestion, spasmodic cough and pulmonary hemorrhage. Acute hemorrhagic ne-

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
			phritis, gastro-enteritis, conjunctivitis, rhinitis, bronchitis. May be fatal.
Zinc.	Zinc white or zinc oxid paint, brass founders, zinc plate makers and engravers, dry-cell battery makers.	As a dust and as a vapor through the respiratory system.	(Same as *Brass.*)
B. GASES. VAPORS. FUMES			
Acetaldehyd; Ethylaldehyd: A colorless, volatile, pungent fluid.	Vinegar making, silvering of mirrors.	As a vapor, through the respiratory passages.	Rhinitis, laryngitis, bronchitis, conjunctivitis, night sweats and tachycardia.
Acrolein: A colorless, volatile, pungent fluid with fiery, nauseous, intensely disagreeable taste. It is the aldehyd of the allyl series made by distillation of glycerin with strong phosphoric acid or potassium sulphate. Also derived from distillation of fats.	Trying out fat for bone fertilizers, etc., oilcloth and linoleum making, varnish boiling, tallow rendering, soap and stearic acid making.	As a vapor, through the respiratory passages.	Lacrimation, conjunctivitis, itching or burning in throat, thirst, rhinitis, pharyngitis, acute bronchitis.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Ammonia.	Gas works, numerous chemical works, manufacture of sal ammoniac and ammonium carbonate, refrigerating plants, varnish and dye works, calico printing, bleaching, tanning, by-product from coal gas manufacture, tin platers, sugar refiners, tobacco workers, cesspool cleaners.	As a highly irritant gas, by inhalation.	Inflammation of eyes and bronchial mucosa, sneezing, lacrimation, constriction of larynx, edema of epiglottis, increased salivation, violent cough, blood-stained sputum, dyspnea, vomiting, anuria.
Ammonium Chlorid: Sal-ammoniac.	Galvanizing zinc.	As fumes, when heated, irritating the eyes and respiratory passages.	(Same as *Ammonia.*)
Amyl Acetate: An ingredient of "Zapone," which is a solution of celluloid in acetone and amyl acetate.	Lacquering metal ware and jewelry; making oilcloth and metal wire for incandescent lamps.	As a vapor, by absorption through the respiratory passages.	Nervous and circulatory symptoms, such as fullness and pain in the head, vertigo, palpitation, anesthesia. Also nausea and vomiting.
Amyl Alcohol: Chief component of fusel oil.	Preparation of fruit essences, anilin dyes, amyl nitrite.	As a vapor, through respiratory passages.	Headache, vertigo, tinnitus aurium, dyspnea, lowering of ar-

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
			terial blood pressure, faintness, nausea and vomiting.
Anilin and Anilin Oils.	Anilin colors; fuchsin and other anilin works; dyers.	As a vapor, through inhalation and by absorption through the skin by saturation of the clothing.	(a) *Acute poisoning:* Muscular weakness, vertigo, pallor, frequent micturition, cyanosis of the lips, slow pulse, contraction of pupils, fainting, strangury, collapse, possible death in coma, or convulsions. (b) *Chronic poisoning:* Chiefly nervous symptoms, disturbances of sensibility and equilibrium, tinnitus aurium, nausea, vomiting, diarrhea, eczema and furunculosis.
Arseniuretted Hydrogen Gas.	Developed in the production of hydrogen or carburetted hydrogen in the arts and in the manufacture of hydrochloric and sulphuric acids, developed from ferrosilicon when water has access to it.	As a gas, irritating the respiratory system.	Chills, vomiting, hematemesis, pains in back, vertigo, fainting, dyspnea, hematuria, jaundice, congestion of liver and spleen, delirium, possible fatal asthenia.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Benzene (C_6H_6) (Commercial).	Anilin works, automobile cleaning, "dry cleaning" of clothing, gloves, etc., cloth finishing, linoleum.	As a vapor, through the respiratory system.	Nausea, vomiting, headache, vertigo, mental confusion, fainting, coma, polyneuritis, acne, tremors, paralysis, subnormal temperature, anesthesia, amblyopia, incoördination, "steppage" gait, hematuria, delirium, convulsions, coma. In rare cases, carcinoma of the bladder.
Benzol (Pure benzene).	Manufacture of India rubber, resin, dyeing, associated with production of iodin, phosphorus, sulphur and fats.	As a vapor, irritating respiratory passages.	(a) *Acute poisoning:* Vertigo, tinnitus aurium, insomnia, cough, vomiting, irregular pulse, cyanosis, tremors, dryness of skin, perspiration, pruritus, anesthesia, delirium, coma, convulsions. (b) *Chronic poisoning:* Petechia, purpura hemorrhages from nose and bronchi, fatty degeneration of liver, kidneys and heart. Anemia and phenomenal leucopenia (down to 500 leukocytes).

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Bromin.	In chemical and pharmaceutical industries.	As a vapor, through respiratory system.	Same as *Chlorin.*
Carbon Bisulphid: A colorless, volatile, nauseous fluid.	Extraction of fats and oils, of sulphur from gas-washing materials; vulcanization of rubber, purification of tallow, paraffin wax; preparation of chlorin compounds; dissolving of fats in treating rags, bones and raw wool; oil factories.	As a vapor, by inhalation; as a fluid injuring skin.	(a) *Acute poisoning* presents paralysis of central nervous system, destruction of red blood corpuscles, somnolence, fatal coma. (b) *Chronic poisoning* causes vertigo, general bodily pains, pruritus, cough, rapid pulse, mental exhaustion, mental excitation followed by deterioration. Special nervous symptoms are: chills, absence of reflexes, anesthesia, tremors, fibrillation, cramps, tetany, paralysis, muscular atrophy. Disorders of vision, taste, smell and hearing. Acute mania or dementia. Serious general symptoms arise from absorption by contact with the hands.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Carbon Dioxid.	Met with in sewer gas, wells, tan pits, brewers' vats, yeast factories, bakers' ovens and coal mines, blast furnaces, caissons and tunnels, divers, glue and paper mills, sugar refineries, cleaning sewers and vaults, wells.	As a gas, causing anesthesia and coma when inhaled.	Large quantities cause death by immediate suffocation; smaller quantities inhaled cause vertigo, tinnitus aurium, dyspnea, anesthesia, somnolence, muscular weakness and coma.
Carbon Monoxid: Coal damp, or coal gas, illuminating and water gas, etc.	Manufacture of illuminating gas, coke; smelting furnaces, metal foundries, lime and brick kilns, coal mines, hydrogen gas works, cooks, ironers, worsted spinners, users of gas stoves, pressers.	As a gas, through respiratory system.	(a) *Acute poisoning:* Slow pulse, elevation of blood pressure, cardiac paralysis, vertigo, tinnitus aurium, nausea, redness and suffusion of skin, dyspnea, fever, marked leukocytosis, sometimes convulsions, anesthesia, incontinence of urine and feces, coma. (b) *Chronic poisoning* causes nausea, vomiting, anemia, palpitation, insomnia, failure of memory and other psychic functions, localized neuritis.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Carburetted Hydrogen.	In coal mines, seldom met with unmixed with other gases.	As a gas, through respiratory system.	Asphyxia, hemolysis, fatal syncope.
Chlorin.	Bleaching of linen and paper, manufacture of chlorid of lime, tinning works, disinfection, electrolytic processes.	As a gas, through respiratory system.	(a) *Acute poisoning:* Large quantities cause cardiac paralysis; smaller quantities cause burning and stinging of the skin with formation of blisters, papules, cough, dyspnea, bronchitis, spasm of the glottis, perspiration, feeble pulse. (b) *Chronic poisoning* causes gastritis, anemia, nasal and bronchial catarrh, furunculosis.
Chlorid of Lime.	Bleaching establishments, disinfection, manufacture of chloroform, chlorin and oxygen, dyes and calico printing.	As a gas, through inhalation; as vapor and as dust of chlorid of lime, irritating eyes, lungs and skin.	Bronchitis, dyspnea, asthma, conjunctivitis, pruritus, eczema, ulcers of the skin.
Diazomethane: A volatile yellow gas.	Methylizing processes.	As a gas, through the respiratory system: cutaneous irritant.	Headache, weakness, ulcerative bronchitis, conjunctivitis. Other symptoms like dimethyl sulphate.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Dimethyl Sulphate: A colorless oily fluid.	Manufacture of perfumes and methyl ethers, ethers and amins.	As a gas, through the respiration; as a fluid, irritates the skin.	Burns of skin and mucous membranes. Pains in neck and thorax, lacrimation, conjunctivitis, photophobia, edema of cornea, ulcers of bronchial mucosa with aspiration pneumonia, convulsions, paralysis, coma, death.
Dinitrobenzol.	Explosives, such as roburite and securite; anilin works.	As a vapor, through the respiratory system.	Vertigo, insomnia, headache, nausea, gastritis, feeble pulse, gray-blue discoloration of the skin and mucous membranes, neuralgic pains, diminished reflexes, paralysis, dark brown urine.
Essences and Extracts (Volatile essential oils).	Perfumery and flavoring extracts.	As vapors, through the respiratory passages.	Headache, vertigo, tinnitus, conjunctivitis, erythema, dyspepsia.
Ether.	Photographers.	As a vapor, by inhalation.	Nausea, vertigo.
Ether, methylated.	Making incandescent mantles.	As a vapor, by inhalation.	Headache, nausea, lassitude and insomnia.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Ethyl Nitrite.	Fulminate for percussion caps.	As a vapor, by inhalation.	Acute dyspnea and cyanosis, but rarely fatal.
Ferrosilicon (Phosphoretted hydrogen).	Used in steel works to remove bubbles from molten castings. Contains calcium phosphid and arsenic as impurities.	In the presence of water vapors of phosphoretted and arseniuretted hydrogen are evolved and may be inhaled. Also disintegrates spontaneously.	Abdominal cramps, vomiting, prostration, coma, and death within 24 hours.
Formaldehyd.	Disinfection, manufacture of dyes, preserving anatomical specimens.	As a vapor, through respiratory organs.	Painful prickling in nose and eyelids, lacrimation, bronchitis, necrosis of mucous membranes, dermatitis, eczema, loss of finger nails.
Hydrocyanic or Prussic Acid and the Cyanids: Potassium and sodium cyanids, rhodan compounds.	Preparation of cyanogen, extraction of gold, photography, dyeing cloth, printing, coal gas manufacture, electroplating, manufacture of oxalic acid, Berlin blue, iron, vitriol and phosphoric acid from bones;	As a gas, through the respiratory system; in liquid or solid form through the skin. The cyanids as dust or in solution, through the respiratory system.	(a) *Acute poisoning:* Indigestion, vertigo, dyspnea, strangulation, palpitation, nausea and vomiting, convulsions, frequent micturition, coma, bluish color of skin and mucous membranes, dilated pupils, death in syncope.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
	fulminate of mercury, steel manufacture, welding iron.		(b) *Chronic poisoning:* Vertigo, hesitating gait, gastro-intestinal disorders, slow pulse, albuminuria.
Iodin.	In chemical and pharmaceutical industries.	As a vapor, through respiratory system.	(Same as *Chlorin.*)
Lydol (fluid) and *Triton* (powder).	Two high explosives used for blasting, etc.	The vapor of lydol and powder of triton enter the circulation through inhalation.	Weakness, headache, pains in back, cyanosis and yellow pallor, methemoglobin, crenation and vacuolation of erythrocytes. Sometimes fever.
Methyl Alcohol: Wood spirit or wood alcohol. "Denatured" alcohol contains 10% wood alcohol and sometimes benzene and pyridin.	Manufacture of varnish, polish, denaturation of spirits, anilin dye stuffs; lacquerers, gilders, makers of silk materials, felt hats, patent leather.	As a vapor, by inhalation.	Irritation of eyes and respiratory passages, vomiting, vertigo, dyspnea, general inflammation of entire respiratory mucosa. Polishers of furniture, etc., acquire inflammation of the skin of hands and arms. Fatal paralysis of the heart, restlessness, chills, thirst, dilated immobile pupils, amblyopia, optic neuri-

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
			tis, blindness, abdominal cramps, paralyses, delirium, coma.
Methyl Bromid (a colorless gas) and *Methyl Iodid* (a colorless fluid).	Used in anilin dye making.	As a gas, through the respiratory passages.	Headache, vertigo, diplopia, rigid eyeballs and fixed expression, pale skin, slow pulse, constipation, prolonged coma.
Naphtha and *Gasolene.*	Rubber and patent leather, dyeing and cleaning, waterproof cloth, fat rendering, rubber shoes, patent leather, disinfection of clothing, metal polish.	As a vapor, through the respiratory system.	Headache, vertigo, nausea, vomiting, dyspnea, palpitation, insomnia, hysteria, mental confusion; hemorrhage from the lungs may be fatal.
Nitrobenzol.	Manufacture of dyes from tar and anilins, perfumes.	As a vapor, through the respiratory system; as a fluid, through cutaneous absorption.	Burning sensation in mouth, nausea, vertigo, cyanosis of lips and face, anesthesia, tinnitus aurium, incoördination, visual disturbances, pupils at first small, later enlarged, dyspnea, delirium, convulsions, subnormal temperature; odor of bitter almonds in breath, urine and vomitus. Formication in the legs

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
			and feet, stammering speech, paralyses, viscid brown blood with a methemoglobin spectrum and irregular red cells.
Nitrous Gases: Low degrees of oxidation of nitrogen, such as NO, NO_2, N_2O_3, HNO_2.	Nitrification in chemical works, celluloid works, preparation of sulphuric acid, picric acid, anilin, nitroglycerin, and gun cotton, etching of metals, electrometallurgy. Hat making, dyeing and calico printing, bleaching oils.	As gases, through the respiratory system.	Anemia, thirst, spasmodic cough, dyspnea, perspiration, hematuria, albuminuria, coma, death through pulmonary edema. Methemoglobin may be present. Destruction of teeth, cold sweats, prominent eyes.
Phosgene or *Carbon Oxychlorid:* A colorless, suffocating gas.	Production of various organic compounds.	As a vapor, through the respiratory system. Decomposes in lungs, with formation of hydrochloric acid.	Erosion of lung tissue, intense dyspnea and pulmonary edema, cyanosis, feeble heart, death in coma.
Phosphorus.	Preparation of phosphorus matches, bones and calcium phosphate, bronze, dyes, rat poison, etc.	As a vapor, through the respiratory system, and in various compounds; as a solid conveyed to	*Chronic poisoning:* Necrosis of the jaw and turbinated bones, loss of teeth, swelling and ulceration of mucous membranes

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
		the mouth by unclean fingers. Children may swallow phosphorus match heads.	of the mouth and nose, formation of fistulas from suppurating bones, diarrhea, emaciation, pallor, amyloid degeneration of kidneys.
Phosphoretted Hydrogen: A colorless, nauseous gas. (*See* also Ferrosilicon.)	Extracting phosphorus, making red phosphorus and the sesquisulphid in the match industry, making acetylene.	As a gas, through the respiratory system.	Oppression, burning and pain in thorax, vertigo, headache, tinnitus aurium, thirst, disorganization of blood, coma.
Sulphur, Sulphur Dioxid Vapor (SO_2), Sulphurous Acid.	Roasting of sulphur ores, manufacture of sulphuric acid and ultramarine, bleaching of straw hats, wax, silk, wool, bristles and catgut, sulphite, cellulose, sulphuring of hops and casks, making of candles, brick work, pottery, glue, disinfection, preserving wine and fruits, lime burners, ice machines, bone fertilizers. This acid is produced in considerable quantity in the incomplete combustion of coal.	As a gas, through the respiratory system.	Bronchitis, coryza, coughing, bluish discoloration of mucous membranes, spasmodic laryngitis, angina, bronchopneumonia, dyspnea, bloody sputum, digestive disorders.

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Sulphur Chlorid.	Solvent of sulphur, India rubber industry.	As a vapor, through the respiratory system. In contact with moisture it forms hydrochloric acid in the lungs.	Dyspnea, vomiting, depression of heart action, faintness, dyspnea, pulmonary edema.
Sulphuretted Hydrogen.	In sewers, tanning, roasting of flax, coal gas manufacture, ultramarine works, Leblanc process, making of matches, bronzing, cesspool and sewer cleaners.	As a gas through the respiratory system, frequently mixed with other harmful gases.	(a) *Acute poisoning:* Disorganization of blood, forming methemoglobin, burning pains in the eyes, nose and throat, coryza, cough, dyspnea, palpitation, headache, perspiration, numbness, contracted pupils, slow pulse, nystagmus, tetanus, convulsions, gastritis, conjunctivitis, spasms, paralysis. (b) *Chronic poisoning* causes conjunctivitis, exhaustion, dyspnea, pallor, slow pulse, furunculosis.
Turpentine.	Varnish, paint, match factories, linoleum.	As a vapor, through the respiratory passages.	Nausea, vomiting, headache, vertigo, bronchial irritation, conjunctivitis. May cause strangury and hemoglobinuria. Locally causes eczema.

C. ACIDS

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Carbolic Acid or Phenol.	Paraffin factories, pharmacy, picric acid making, dyeing and calico printing, lampblack, photogen, antiseptics.	As a vapor, through the lungs. As a cutaneous irritant.	Nausea, vertigo, smoke-colored urine, icterus, collapse and, locally, gangrenous sloughs.
Hydrochloric Acid.	Chemical processes associated with sodium chlorid and protochlorid of tin, glass manufacture, fertilizers, pottery glazing, enameling, soldering, rubber shoe industry, shoddy manufacturing, calico printing, bleaching, tinplating, damask workers.	As a gas, through the respiratory system.	Violent coughing, dyspnea, bronchitis, destruction of teeth, contraction of throat, coma.
Hydrofluoric Acid.	Manufacture of glass, glass etching, bleaching of cane and wicker chairs, artificial fertilizers, superphosphates, etc.	As a gas, through the respiratory system; as a liquid, through the skin.	Conjunctivitis, coryza, bronchitis, irritation of nasal mucosa and mouth, blisters and ulcers of skin.
Nitric Acid.	Making nitrobenzol, sulphuric, picric and oxalic acids; false pearl making, metal etching and	As fumes, irritating the respiratory mucosa and eyes, and eroding the	(a) *Acute Type:* Conjunctivitis, bronchitis, capillary hyperemia of brain and lungs, pulmonary

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
	plating, metallurgy; textile printing, chrome compounds, as a deoxidizing and bleaching agent, jewelry making.	teeth. In solution, irritating the skin.	edema, dyspnea, indigestion, colic, cyanosis, delirium, convulsions. (b) *Chronic Type:* Anemia, chronic bronchitis with bloody sputum, erosion and perforation of nasal septum.
Oxalic Acid: White crystals.	Metal polishing, dye works, chemical cleaning plants, straw hats and braids.	As a dust, through the respiratory passages.	Cyanosis of fingers, face and body, feeble pulse, convulsions, coma.
Picric Acid.	Chemical and dye works, explosives, gun powder manufacture.	As a dust, through the respiratory system, irritating the skin.	Yellow discoloration of the skin and conjunctivæ, pruritus, inflammation of the mucous membranes of the mouth, gastritis, vomiting, diarrhea, vertigo, coryza, decomposition of the blood, convulsions.
Sulphuric Acid.	Accumulator works, metal burnishing, powdered fertilizers, sugar industry, petroleum distillation, hat making, textile manufacture.	As a vapor, through the respiratory system. Locally as a cutaneous irritant.	Acute and chronic bronchitis, bronchopneumonia, decay of teeth; on the skin, local pain, white eschars, redness, edema, ulceration.

D. MISCELLANEOUS FLUIDS

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Chinin.	A petroleum by-product.	Locally irritates the skin.	Pruritus and scaly eczema of face, arms and sometimes the entire body.
Chinone.	In a mixture of anilin, hydrochloric acid and potassium chromate.	As a vapor irritates the eyes and skin.	Keratitis, brown pigmentation of cornea and skin.
Metol.	In photography.	In solution irritates the skin.	Erythema and ulcers of skin of the hands, arms, and sometimes entire body.
Nitroglycerin: An oily, colorless, odorless fluid.	Explosives, especially dynamite and nitrocellulose.	Inhalation of vapor, absorption through skin. In explosions CO_2, NO and unaltered nitroglycerin are present.	Redness of face and conjunctivæ, intense headache, mental disturbance, repeated fainting, vertigo, tremors. Burning sensations in throat and stomach, nausea, vomiting, colic. Paralyses of ocular and head muscles and extremities; bradycardia, stertorous, slow breathing, suf-

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
			focation, cold cyanotic skin. In handling dynamite ulcers of fingers and soles of feet, dry, fissured hands and feet. *Chronic poisoning:* Tremors, neuralgias, digestive disturbances.
Paraffin.	Waterproofing, electric wire insulation, protection of dynamite cartridges, etc.	As a vapor, when melted, acts on digestive and circulatory systems; locally, irritates the skin.	Headache, vertigo, gastralgia, enteralgia, diarrhea, thoracic oppression, sweating. Pustular eczema and rarely epithelioma.
Petroleum: A hydrocarbon, oily mixture of methane ethyl and certain of the aromatic series.	Production of oil. As furniture polish. Has many derivatives, such as anilins, paraffin, gasolene, etc.	As a vapor, through the respiratory system. As an oil is a cutaneous irritant.	Inhalations cause drunkenness, with shouting, incoördination, drowsiness, with no recollection of the occurrence. In severe cases there are pallor and cyanosis, contracted pupils, fixed gaze, feeble pulse, asphyxia, coma. In chronic cases the Schneiderian membrane is numb and irritated. Handling petroleum, as in barreling it, causes

HARMFUL SUBSTANCE	INDUSTRY WHERE PREPARED OR USED	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
			acne and abscesses of the skin of the hands and arms.
Phenylhydrazin: A yellowish-brown, pungent, oily fluid.	Making antipyrin and various organic compounds.	Skin absorption.	Vesicular eruption, with pruritus and burning of skin. Diarrhea, granular degeneration of red cells, methemoglobin, weakness.
Pyridin: A colorless, pungent fluid.	In denaturing alcohol.	As a vapor, through the respiratory system. As a fluid, irritant to the skin.	Coryza, laryngitis, hoarseness, choking, headache, vertigo, trembling and weakness of limbs, dyspnea, convulsions. Locally, eczema of hands and arms.
Tar.	Making illuminating gas, coke, tar products, for preserving wood, roofing paper, concrete pavements, painting metals, fuel briquettes.	As a vapor, on burning, acts on the respiratory system; locally, a cutaneous irritant.	Conjunctivitis, bronchitis, headache, vertigo, nausea, diarrhea, anesthesia, ischuria, strangury, albuminuria. Locally, "tar itch," with eczema, acne of the arms, hands and scrotum, with tendency to epithelioma.

E. INORGANIC DUSTS

HARMFUL SUBSTANCE	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Cement.	As dust, irritating the eyes, bronchi and skin.	Conjunctivitis, chronic bronchitis, asthma, pneumonoconiosis, ulceration of nasal septum and skin, pruritus.
Diamonds and Other Precious Stones: Often embedded in lead for cutting; also soldered.	As dusts, cutting and irritating the respiratory mucosa.	Bronchitis, tuberculosis, lead poisoning from solder fumes.
Emery.	As dust, injuring the eyes and bronchi.	Chronic bronchitis, pneumonoconiosis, tuberculosis, ulcers of nasal septum, atrophic rhinitis, otitis media, trauma of the eyes.
Glass, and emery dust from glass cutting and polishing, lead and other metals used in glass making; putty powder.	As dust, injuring eyes and bronchi. Excessive heat and light in glass blowing.	Chronic bronchitis, pneumonoconiosis, tuberculosis, conjunctivitis, eczema, rheumatism, trauma of eyes and hands, injury to eyes from heat and light.
Meerschaum.	As dust, irritating the respiratory system.	Chronic bronchitis and fibroid phthisis.

HARMFUL SUBSTANCE	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Metal Filings: Iron, steel, copper, etc.	As dust, irritating the respiratory system. Also if soluble may cause specific poisoning, like lead filings.	Chronic bronchitis, asthma, fibroid phthisis.
Stones and Earths: Flint, granite, marble, silica, limestone, terra cotta, brick dust, etc.	As dust, irritating the respiratory system.	Chronic bronchitis, asthma, pneumonoconiosis, tuberculosis.
Ultramarin (associated with sulphuric acid fumes).	As a dust, irritating the respiratory passages, and also acting by absorption.	Nasal and bronchial catarrh, perforation of nasal septum.
F. ORGANIC DUSTS		
Acridin: Colorless needle crystals: used in organic dyes.	As a dust, irritating skin and mucous membranes.	Serious pruritus and burning of the skin, conjunctivitis, rhinitis, sneezing, and tracheitis.
Asphalt.	Fumes, irritating conjunctiva and respiratory system. Locally irritating the skin.	Conjunctivitis, bronchitis, acne and yellow discoloration of skin.

HARMFUL SUBSTANCE	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Cotton.	As fiber dust, irritating the respiratory passages. Excessive humidity is encountered in cotton spinning.	Chronic bronchitis, emphysema, dyspnea, anemia, dysmenorrhea, rheumatism.
Feathers.	As dust and by conveying dirt and germs into the lungs. Poisonous dyestuffs, as lead chromate or arsenic, may be inhaled.	Chronic bronchitis, asthma, pulmonary abscess.
Felt and Fur.	As dust, irritating the lungs. Mercury nitrate added in carotting may cause mercury poisoning.	Chronic bronchitis, asthma, pulmonary abscess, bronchiectasis, chronic mercury tremors, marasmus and premature senility.
Flax and Hemp: Macerated in sulphuric acid.	As dust, irritating the respiratory passages, also by irritating fumes from macerating and bleaching agents.	Flax-beater's ague, headache, neuralgia, acute coryza, rhinitis and bronchitis, fever, epistaxis, dryness of mouth and throat. Chronic otitis media. Eczema of hands and arms.
Grain and Flour.	As dust, irritating the respiratory passages.	Catarrh of nose and bronchi, epistaxis, atrophic rhinitis, otitis media. "Miller's asthma," atelectasis. Pneumonia and tuberculosis.
Horn, Bone and Shell.	As dust, by inhalation.	Chronic bronchitis, fibroid phthisis.
Horsehair and Other Hair.	As dust, by inhalation in upholstery, brush making, etc.	Bronchitis, pustules and carbuncle, epistaxis, asthma.

HARMFUL SUBSTANCE	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Jute.	As fiber dust, by inhalation.	Conjunctivitis, eczema of scalp and hands, rhinitis, asthma, bronchitis, anemia, nasal polypi, furunculosis.
Rags and Paper.	Dust and dirt; anthrax infection; excessive moisture; bleaching agents as lime, etc.; in paper making; irritation of respiratory mucosa; poisoning by dyes, such as chrome pigments, and by acids.	Bronchitis, bronchorrhea, gastric catarrh, rheumatism, poisoning by acid fumes and dyestuffs, causing further respiratory irritation, eczema, etc.
Straw and Broom.	As dust fibers, irritating the respiratory mucosa; poisoning by bleaching agents, as acids or lime, and dyestuffs, as lead chromate.	Chronic bronchitis, eczema.
Street Dust, containing manure, asphalt, soot, ashes, earths, disintegrated brick, granite or other pavement substance, sand, concrete, etc.	By inhalation, irritating respiratory passages and conveying germs to lungs. Locally, irritating the eyes.	Acute coryza and bronchitis. Conjunctivitis.
Sugar.	Excessive heat and moisture; inhalation of charcoal dust.	Dermatitis, lymphangitis, furunculosis.

HARMFUL SUBSTANCE	MODE OF ENTRANCE INTO BODY	DISEASES OR SYMPTOMS
Tobacco.	As dust, by inhalation.	Insomnia, palpitation, vertigo, pharyngitis, cough, nausea, vomiting, diarrhea, conjunctivitis, anemia, emaciation, scotoma, dysmenorrhea, tuberculosis, tendency to abortion.
Wood: Boxwood, teak, rosewood, ebony, etc.	By inhalation of dust and varnish solvents, as benzene and wood alcohol, etc., sandpaper dust, floor-scraping dust, etc.	Bursitis and deformities among floor polishers, etc. Bronchitis, asthma, rhinitis, dermatitis. Special poisons: acute coryza, urticaria, nausea, vomiting, vertigo, etc.
Wool.	As fiber dust, by inhalation.	Nasal and bronchial catarrh, anthrax.

APPENDIX II

TABULAR LIST OF IMPORTANT INDUSTRIES IN WHICH THE WORKMAN IS SUBJECTED TO SEVERAL HAZARDS

INDUSTRIES	HAZARDS
Bakers.	Heat, carbon dioxid and monoxid.
Brass workers.	Lead poisoning: brass and emery dust; mineral acids; hot potash and cyanid fumes; wool alcohol and benzene (as shellac solvents); overheating and dampness.
Brick and Tile Makers.	Wetting, overheating, dust, lead glaze and iron filings.
Bronze Workers.	Antimony, lead, arsenic, and other metals. Mineral acids.
Butchers; Slaughterers.	Cold and damp, lifting heavy weights, septic infection, local tuberculosis.
Button Makers.	Dust of bone, shell, celluloid, emery, sandpaper, vegetable ivory, mica, wood, silica, conchiolin (causing osteomyelitis).
Calico Printers.	Heat and moisture, arsenic, antimony, chromates, lead, chlorin, cyanids, anilin, hydrochloric, sulphuric, formic and acetic acids, quicklime, carbon monoxid (coke ovens), cotton dust.
Canners.	Extreme heat and moisture, steam, solder.
Dyers.	Chrome, lead, arsenic, various acids, naphtha, gasolene, ammonia, lime, anilin, wood alcohol, steam and moisture.

INDUSTRIES	HAZARDS
Emery Workers	All forms of emery grinding and polishing; emery paper.
Felt Hat Makers.	Mercury, fur dust, steam heat, shellac, wood alcohol, grease, illuminating gas (CO), emery and sandpaper, nitric acid, arsenic, dyestuffs.
Fertilizer Makers.	Bone dust, phosphates, nitric, nitrous, sulphuric, hydrochloric, hydrofluoric and other acids, benzene. Septic infection.
Furriers	Lime, arsenic, mercury dyes, anthrax, fur dust conveying germs to lungs and causing pulmonary abscess.
Gardeners and Hothouse Men	Heat and humidity, arsenic, tetanus, poisoning by the primula and rhus plants.
Garment Workers and "Operators"	Carbon monoxid (from gas stoves and irons), neurasthenia, anemia, dust of cotton and wool.
Glass Makers and Grinders	Excessive heat and light, excessive blowing (emphysema), emery, lead, glass and sandpaper dust.
Glove Makers	Lead, chrome, anilin, pumice, acids and lime.
Hides and Leather; Tanners	Dyestuffs, arsenic, lead, chrome, leather dust, dampness, lime, naphtha, turpentine, extreme heat, wood alcohol, amyl acetate, anthrax, septic infection.
Horsehair and Other Hair Workers	Dust, anthrax, dyestuffs, bleaching agents.
Illuminating Gas	Coal dust, smoke, steam, sulphuric and hydrocyanic acid, carbon monoxid and dioxid.
Iron and Steel Work	Steel and iron dust, carbon monoxid, sandblasting of castings, eye injuries.

INDUSTRIES	HAZARDS
Jewelry Makers	Solder, acids, diamond dust, emery dust.
Laundresses	Extreme heat and humidity. Carbon monoxid from gas irons. Flat-foot, varicose ulcers.
Linoleum and Oilcloth	Sulphuric acid, acrolein, iron dust (from grinding machines), cork dust, zinc oxid, lead oxid and acetate, manganese.
Linseed Oil	Litharge, excessive heat and moisture, oil fumes.
Lithotransfer, Lithographing and Engraving	Acids, lead, bronze powders.
Masons and Plasterers	Cold and damp, dust of bricks, tile, lime, cement, plaster-of-Paris.
Metal Grinders and Polishers	Emery, iron, steel and brass dust, lead fumes (tempering), acids.
Mining and Handling Coal	Carbon monoxid, CO_2 and marsh gas, temperature changes, gases of explosives, nitroglycerin, ankylostomiasis and other soil infections. Rheumatism, chronic bronchitis. Nystagmus.
Painters	Lead, turpentine, wood alcohol, benzene.
Photographers	Platinum, silver, vanadium.
Pottery: China and Porcelain	Dust, heat, dampness, lead, flint, clay, chrome, lithograph transfer, bronze powders, cobalt, manganese, plaster-of-Paris.
Rags and Paper	Dust, moisture, anthrax, lime, acids.
Roofers	Solder, tar, insolation.
Rubber Manufacturers	Carbon disulphid, sulphur chlorid, lead, naphtha, benzol, benzene, wood alcohol, mercury and various acids.

INDUSTRIES	HAZARDS
Sand Workers	Sandblasting metal castings, smoothing wood in planing mills, sandblasting stonework, slate, marble, limestone, granite and sandstone, quarrying and cutting, manufacturing of paint, sandpapering of paint, etc.
Shoemaking by Machinery	Leather dust, emery, glass and sandpaper dust, brass filings, various pigments. Septic infection.
Silk Manufacturers	Lead and tin (used for weighting), dyestuffs.
Smelters	Heat and light, fumes of metals, as lead, antimony, etc. Carbon dioxid and monoxid, sulphuretted hydrogen, clay dust of molds.
Soap, Margarin, Stearin	Lime, potassium hydrate, sulphate of iron, sulphuric acid, acrolein, ammonium cyanid, pyridin, fatty acids, essential oils.
Textile Workers, Spinners, Weavers, Carders	Dust of cotton, wool, jute, hemp, flax. Excessive moisture. Anilin and other dyestuffs.
Tobacco Workers	Tobacco and cigar box dust, tinfoil (lead).
Wood Workers, Furniture Makers, etc.	Wood, sandpaper dust, turpentine, benzene, wood alcohol, specific poisons of boxwood, teak, etc.

APPENDIX III

TABULAR LIST OF THE PRINCIPAL INDUSTRIES IN WHICH DUST CONSTITUTES THE ESSENTIAL HAZARD

I. Metallic Dusts

Founders and molders, especially of brass and steel
Polishers, especially of brass, bronze, copper
Dyers (chrome, arsenic, lead and other pigments)
Grinders of steel, iron castings, and all heavy metals, especially cutlers, needlemakers
Locksmiths
Tinsmiths
Jewelers
Painters
Watchmakers
Printers, lithographers and engravers
Typefounders
Metal lacquer workers, gilders
Paint makers
White lead and zinc white producers
File and nail makers

II. Mineral Dusts

Cement grinders
Brick makers
Masons
Builders
Concrete mixers
Pottery grinders
Sandblast workers
Stonecutters
Slate, marble, limestone, granite and flint workers
Grinders using emery and flint
Basic slag workers
Diamond cutters
Stokers, coal and coke heavers.
Chimney sweeps
Plasterers
Makers of fertilizers

Glass grinders and cutters
Workers with gypsum and mineral wool
Brick and tile makers
Sandpapering
Meerschaum grinding
Users of silica and siliceous minerals

III. Vegetable Dusts
Bakers
Flour millers
Grain elevator men
Threshers
Tobacco and cigar makers
Weavers, carders, spinners, sorters of flax, hemp, jute and cotton
Wood sawyers and turners
Furniture makers
Carpenters
Broom and straw hat makers
Charcoal handlers.
Cork and boxwood workers
Paper and rag workers
Workers in asphalt

IV. Animal Dusts
Furriers
Tanners
Makers of bone fertilizers
Hair brush makers
Workers in feathers and hair
Workers in leather (shoemakers, harness makers, etc.)
Button makers
Felt hat makers
Wool sorters
Carders and weavers
Workers in bone and ivory
Handlers of guano

V. Mixed Dusts
Street sweepers
Pottery workers.

APPENDIX IV

MAIN PROVISIONS OF EXISTING LAWS (1914) RELATIVE TO THE REPORTING OF OCCUPATIONAL DISEASES BY PHYSICIANS

(Table prepared by Dr. John B. Andrews for the American Association for Labor Legislation).

STATE	DISEASES TO BE REPORTED	REPORTS TO INCLUDE	TO WHOM TO REPORT	PENALTY
California C. 485, Laws 1911. In effect, June 20, 1911.	Anthrax, compressed air illness, and poisoning from lead, phosphorus, arsenic or mercury, or their compounds.	Name and full postal address and place of employment of the patient, and the disease.	State Board of Health and thereby transmitted to the State Commissioner of Labor.	Not more than $10.
Connecticut C. 159, Acts 1911. In effect, Sept. 1, 1911. Am'd by C. 14, Laws 1913. In effect, April 22, 1913.	Same as California, and brass and wood-alcohol poisoning.	Same as California.	State Commissioner of Labor.	Same as California.
Illinois H. B. 250, Laws 1911. In effect, July 1, 1911.	Law is obscure, but apparently includes poisoning from "sugar of lead, white lead, lead chromate, litharge, red lead, arsenate of lead or Paris green," and "the manufacture of brass or the smelting of lead or zinc."	Name, address, sex and age of employee; name of employer and last place of employment; nature, probable extent and duration of the disease.	State Board of Health, and thereby transmitted to State Department of Factory Inspection.	First offense, $10 to $100; subsequent offense, $50 to $200.
Maine C. 82, Laws 1913. In effect, July 11, 1913.	Same as California (and "any other ailment or disease contracted as a result of" the patient's employment).	Same as California (and "the nature of the occupation" and "such other specific information as may be required by the State Board of Health").	State Board of Health.	$5 to $10.
Maryland C. 165, Laws 1912. In effect, April 8, 1912.	Same as Maine.	Same as Maine.	Same as California.	Same as California.

STATE	DISEASES TO BE REPORTED	REPORTS TO INCLUDE	TO WHOM TO REPORT	PENALTY
Massachusetts C. 813, Sec. 6, Laws 1913. In effect, June 16, 1913.	"Any ailment or disease contracted as a result of the nature . . . of the patient's employment"—if required by the joint board of the State Board of Labor and Industries and the Industrial Accident Board.	To be determined by the joint board.	State Board of Labor and Industries, and thereby transmitted—upon request—to the State Board of Health and the Industrial Accident Board.	Not more than $100 for each offense.
Michigan No. 119, Acts 1911. In effect, Aug. 1, 1911.	Same as California.	Same as California (and "the length of time of such employment").	Same as California.	Not more than $50.
Minnesota C. 21, Laws 1913. In effect, July 1, 1913.	Same as California.	Same as California (and "such other specific information as may be required by the commissioner of labor").	Commissioner of Labor.	$10, or imprisonment for not more than 10 days.
Missouri H. B. 536, Laws 1913, In effect, June 23, 1913.	Poisoning from "antimony, arsenic, brass, copper, lead, mercury, phosphorus, zinc, their alloys or salts or any poisonous chemicals, minerals, acids, fumes, vapors, gases, or other substances."	Name, address and business of employer, all the diseases the employee has, their probable duration, name and business of employee, last place and length of employment.	State Board of Health, and thereby transmitted to the state factory inspector and the superintendent of the factory.	Not less than $50.
New Hampshire C. 118, Laws 1913. In effect, July 1, 1913.	Same as California.	"Name, address and occupation of the patient, name, address and business of the employer, nature of the disease, and such other information as the state board of health may reasonably require."	Same as California.	For each offense, $5.
New Jersey C. 351, Laws 1912. In effect, July 4, 1912.	Same as California.	Same as Maryland.	Same as California.	For each offense, $25.
New York C. 258, Laws 1911. In effect, Sept. 1, 1911. Am'd by C. 145, Laws 1913. In effect, Oct. 1, 1913.	Same as Connecticut.	Same as California ("with such other and further information as may be required by the Commissioner of Labor").	State Commissioner of Labor.	Same as California.

STATE	DISEASES TO BE REPORTED	REPORTS TO INCLUDE	TO WHOM TO REPORT	PENALTY
Ohio H. B. 187, Laws 1913. In effect, April 23, 1913.	Same as Connecticut (and "any other ailment or disease contracted as a result of" the patient's employment).	Same as New Hampshire.	State Board of Health, thereby transmitted to "the proper official having charge of factory inspection."	None.
H. B. 483, Laws 1913. In effect, Oct. 1, 1913.	Lead poisoning.	Same as above (and "probable extent of disease").	State Department of Factory Inspection, State Board of Health and the employer.	$10 to $100.
Pennsylvania No. 851, Laws 1913. In effect, Oct. 1, 1913.	Lead poisoning.	Same as New Hampshire (and "probable extent of disease").	State Department of Labor and Industry, State Department of Health, and the employer.	$10 to $100.
Wisconsin C. 252, Laws 1911. In effect, June 5, 1911.	Same as California (except that "anthrax" is omitted).	Same as California.	State Board of Health.	Same as California.

In all states except Illinois, Missouri, and Pennsylvania the obligation to report falls upon every medical practitioner or physician; in the three states named (and in Ohio under one of the two acts above analyzed) it falls upon any physician making the required monthly examination of employees in certain specified industries. In all states except California and Connecticut, where a fee of fifty cents is allowed, no compensation for reports is paid by the state.

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