

OFFICERS

OFFICERS

OFFICERS AND DIRECTORS p. 1-2

WHAT INDUSTRIAL DUSTS ARE HARMFUL p. 33-34
respiratory dust p. 37

ENGINEER ELIMINATION LIST p. 35-36

INDUSTRIAL DUST CONTROLLING LIST HAZARDOUS p. 37-38
respiratory, silicosis, and lung p. 38

INDUSTRIAL DUSTS, DUSTS, DUSTS p. 39-104
Dusts p. 100-101
respiratory p. 101

A.S.S.E. - ENGINEERING SECTION p. 101-102

CEMENT AND QUARRY SECTION p. 103

NATIONAL SILICOSIS CONFERENCE p. 107-108
dust diseases

INDUSTRIAL SECTION p. 109-110

INDUSTRIAL SECTION p. 111-112

INDUSTRIAL SECTION AGAINST SILICOSIS p. 113-114
Dusts, dust p. 113
respiratory p. 114
dust diseases p. 115-116

INDUSTRIAL SECTION PREVENTIVE p. 117-118
respiratory diseases p. 117

INDUSTRIAL SECTION p. 119-120

INDUSTRIAL SECTION p. 121-122

INDUSTRIAL SECTION p. 123-124

INDUSTRIAL SECTION p. 125-126

INDUSTRIAL SECTION p. 127-128

INDUSTRIAL SECTION p. 129-130

INDUSTRIAL SECTION p. 131-132

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National Safety

Congress

Transactions
NATIONAL SAFETY COUNCIL, Inc.

KANSAS CITY, MISSOURI
OCTOBER 11 to OCTOBER 15, 1937

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Foreword

THE Transactions of the Twenty-sixth National Safety Congress, 1937, are published by the National Safety Council in two volumes. This, the first, contains the general, the special subject, and the Industrial Section sessions. The second volume contains the sessions of the Child Education, Home Safety, Street and Highway Traffic, Commercial Vehicle and Transit Sections.

All industrial members of the Council automatically receive Volume I. Volume II is sent to members believed to be interested chiefly in the sessions it covers. Other Council members, however, may obtain it upon request.

Many members have found it worth while to distribute copies of the Transactions to supervisors, foremen, and others in an administrative or supervisory position who may make practical use of them for reference purposes. The following quantity prices are quoted on extra copies: 1 to 10 copies of the large volume (Volume I), \$2 each; 11 copies or more, \$1.75 each; copies of the smaller volume (Volume II), 75 cents each.

THE Transactions are published as a condensed record of the proceedings at the National Congress. The papers of each session or division of the Congress have been edited carefully to eliminate extraneous matter and to abbreviate the less essential portions because of space limitations. Thus the material herein presented is not a verbatim report of all the speeches presented at the Congress, but rather an abridged version made as compact as possible, yet without injury to the technical aspects of any address. The original manuscripts are on file in the Council's Bureau of Information, where they are available for additional reference. Where illustrations were sent by the speakers to the Council, these also are on file.

The National Safety Council at its Congresses seeks to eliminate from discussion matters which are not pertinent to the aim of the Congress or which are contrary to Council policies. It cannot accept responsibility for the views expressed either in the papers presented or in the discussions based upon the papers.

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Contents

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ITY COUNCIL, INC.

five

Council Officers and Directors.....	4
Council Purposes and Policies.....	9
Annual Meeting of Members.....	11
Annual Banquet.....	31
Subject Sessions—	
After Work Accidents.....	33
Agricultural Safety.....	41
Community Safety Organization.....	51
Fire Prevention.....	59
Health Service in Industry.....	71
Industrial Dusts.....	85
Industrial Fumes, Gases and Vapors.....	99
Industrial Safety Lectures.....	109
Maintaining Interest in Safety.....	141
Pressure Vessels.....	157
Safety Fundamentals.....	173
Safety Inspectors.....	183
Safety Training.....	193
Safe Use of Acids.....	201
Aeronautical Section.....	211
A.S.S.E.—Engineering Section.....	221
Automotive and Machine Shop—Power Press Sections.....	225
Cement and Quarry Sections.....	249
Chemical Section.....	271
Construction Section.....	285
Food Section.....	307
Industrial Nursing.....	323
Marine Section.....	341
Meat Packing, Tanning and Leather Industries Section.....	371
Metals Section.....	381
Mining Section.....	401
Paper and Pulp Section.....	429
Petroleum Section.....	489
Power Press Section.....	535
Public Utilities Section.....	537
Quarry Section.....	557
Refrigeration Section.....	559
Rubber Section.....	577
Safety Equipment Section.....	581
Steam Railroad Meeting.....	587
Textile Section.....	601
Wood Products Section.....	611
Index.....	621

000112

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The conservation of his purpose of the National Council works through a continuous campaign of prevention that is national in scope and applies to all types of hazards, directly or indirectly resulting in accidents.

Recognizing that improving conditions and the prevention of diseases in industry are essential to accident prevention, the Council is active in these fields.

The National Safety Council is a profit, non-sectarian, non-political organization.

It has approximately 300 chapters in every state in the United States, and in the Canadian provinces. It has 100 foreign members. Its membership are industrial organizations, individuals, public officials, chambers of commerce, clubs, unions, etc. About 70 per cent of the members are industrial concerns, including the large oil companies, most of the United States, the largest and others of outstanding importance.

Origin and

The history of the Council is the first cooperative Safety Council under the auspices of the Iron and Steel Electrical Association in 1912. As an organization, the National Safety Council was organized in New York City in 1913. Its membership increased to 971.

These safety pioneer organizations were based on the assumption that unnecessary and avoidable accidents could be prevented by developing the principles and making accident prevention a part of the business of the community.

The continuous growth and expansion of its activities are based on the soundness of these principles. It is a coordinated program of

000107

Industrial Dusts

WEDNESDAY MORNING SESSION

October 13, 1937

The meeting was called to order by Chairman A. S. Regula, Executive Secretary, Industrial Relations Counselors, Inc., New York City, and Vice-President for Engineering, National Safety Council, who introduced the speakers.

What Industrial Dusts Are Harmful? Why?

By SENIOR SURGEON R. R. SAYERS

Chief, Division of Industrial Hygiene, U. S. Public Health Service

While dusts exist everywhere in the atmosphere, it has been recognized for centuries that workers in certain dusty occupations are less healthy than those not so exposed. The number of persons exposed in dusty occupations comprises one of the largest industrial groups. The occupational diseases of workers in dusty atmospheres have been found to be due to entrance of dust into the system by inhalation, by ingestion, by direct absorption through the skin, by irritation of the skin, or by a combination of the foregoing.

The suspensions of particulate matter in air have been broadly termed dusts, fumes, and smokes. Such a classification is necessarily arbitrary, since the line of demarcation between them is not very sharp, and the chief differentiation is based on the size of the particles. Investigations by the Public Health Service in dusty industries¹ revealed that about 70 per cent of the dust particles examined were between 1 and 3 microns in size, only about 20 per cent were less than 1 micron, and the median size was 1.3 microns. Industrial dusts are mainly less than 10 microns in size. However, fibrous dusts in the air, such as asbestos, have been found to contain particles as large as 200-250 microns in the greatest diameter.

While, generally speaking, according to Collis, dusts are more injurious as their chemical composition differs from that of the human body, or from the elements of which the body is normally composed,² it

is difficult to establish a comprehensive definition for *toxic* dusts. Sollmann,³ after analysis of various definitions for poison, felt that it is very difficult to give a definition which will not be ambiguous in some cases, but believed that the following covers most of the points which must be considered in classing a substance as such:

"A poison is any substance which, acting directly through its inherent chemical properties, and by its ordinary action, is capable of destroying life, or of seriously endangering health, when it is applied to the body, externally, or in moderate doses (to 50 Gm.) internally."

Some dusts are known to be poisonous, while others, in the concentrations usually encountered, are comparatively harmless. However, it may be stated that *breathing* dust in high concentration is not desirable.

According to Fairhall, the damage arising from the inhalation of toxic dust may be either local or remote, and depends upon whether the material is a protoplasmic poison, whether it is caustic in reaction, or whether it is absorbed into the blood stream and carried to other centers which are in turn affected.⁴

It is now well established that exposure to certain kinds of dusts, such as those containing considerable quantities of free silica, has increased the morbidity and mortality rate from *respiratory* diseases, while metallic dusts, such as lead and its compounds,

have been associated with general systemic poisoning.² Dusts may be swallowed with saliva, water, or food, and direct poisoning has been traced to absorption by this method; other dusts may act as irritants and produce affections of the skin, irritate mucous membranes of nose, eyes and throat, often causing inflammatory diseases of these organs.⁴

Some inorganic dusts are able to penetrate the deep lung tissues and are sufficiently insoluble to be retained there. Some of these may be active in the human tissues, causing definite and permanent injury, while others are inert and may be retained for years, apparently without serious damage; some are gradually absorbed without causing pathological changes.¹

All inhaled particles are soluble, at least to a small extent. If harmless, cell activity is stimulated so that phagocytes remove the dust. If the solute is toxic, the viability of the phagocyte is affected and an ineffective accumulation results. At the same time, further solute may diffuse into neighboring tissues, setting up an irritation and subsequent fibrosis. The nature as well as the solubility of the solute is an important factor, but of two substances of approximately equal toxicity, the more soluble form causes the greater damage. However, substances of such low solubility as silica may ultimately produce extensive injury.¹

Kettle has stated that harmful dusts, if inhaled into the lungs, may activate a latent tuberculous infection; they may exaggerate an active tuberculous lesion or a coincident infection. If sufficient quantities of a harmless dust are inhaled, some of it remains in the lungs and causes a mild degree of fibrosis merely through mechanical irritation, but such fibrosis is never sufficient to interfere with the function of the lung.³

Some writers state that while the influence of nonpoisonous dusts on health is a debatable subject, abnormally high death rates from bronchitis and pneumonia are sometimes attributed to chronic exposure to nontoxic dusts. Large amounts of dust are occasionally found in supposedly normal lungs, at autopsy.²

According to Drinker, there are four different types of reaction produced in man by the inhalation of dust. The first and most important are the pneumoconioses, such as silicosis and asbestosis, which cause specific lung pathology and often are followed by

pulmonary tuberculosis. The second type of reaction is caused by toxic dusts like lead, cadmium, and radium. A third type of malady follows the inhalation of finely divided metallic fume particles such as zinc oxide, and is known as metal fume fever. The fourth reaction, allergic in character, is caused by breathing organic dusts such as pollen and certain types of pulverized wood and flour. In all four cases the sole cause of the disability may be dust inhalation, but the reactions from toxic dusts result from swallowing as well as from inhalation.¹

For various reasons it is difficult to set up an absolute classification for dusts. Opinion is rapidly changing regarding so-called inert or harmless dusts and further investigation may prove some of them to be injurious. Some dusts may have both a toxic and an irritant action; while on the other hand, the poisoning resulting from exposure to a dust may be the combined effect of more than one mode of entrance into the body. However, the following classification of dusts, according to physical characteristics and physiological effect, is used for convenience.

I. Organic Dusts

Organic dusts are those which contain carbon, and were originally supposed to come from organized substances derived from animal or plant life. Living dusts come under this classification, and are thought to be of the same order of size as industrial dusts, with which they are frequently associated. Bacteria are usually between 0.5 and 3 microns, except in a few cases, such as the anthrax bacillus, which ranges from 1 to 1.25 micron in breadth and 4.5 to 10 microns in length and 10 or 12 microns in diameter. However, it is possible that the larger and heavier varieties, like the larger and heavier dust particles, settle due to gravity, and do not remain suspended in the air.

Many thousands of organic substances, carbon-containing, are made synthetically by chemical processes, such as dyestuffs, explosives, etc.

1. **NONLIVING ORGANIC DUSTS.** As the name implies, these are comprised of nonviable particles, which may or may not be inherently toxic or irritant, but which nevertheless produce unusual effects in the human organism. "Allergic" dusts, or those to which certain persons are or may

0001-9

become hypersensitive, with resulting asthma, rhinitis, or other disturbances, are included in this classification.

a. *Toxic and/or Irritant.* Toxic or irritant dusts are all organic dusts which produce untoward symptoms, either systemic or local. Those producing local symptoms are usually described as irritant; those producing general or systemic symptoms are termed toxic. A dust may be both toxic and irritant.

In reported cases of injury or death following inhalation of dust from organic compounds, among the chief offenders are paranitraniline, the dinitrobenzenes, chlorodinitrobenzenes, trinitrophenol, and nitro-naphthalene. Eye damage due to inflammation of the cornea has occurred among workers exposed to methyl violet dust. The dust from paraphenylene diamine derivatives is particularly irritating and dangerous, causing not only a severe form of dermatitis where the dust comes in contact with the skin, but also producing acute inflammation of the mucous membrane of the respiratory passages.⁴ Toxic dusts may be generated during the handling of powdered dyes and in preliminary dyeing operations, particularly the hydro-extractor process, where particles are disseminated in all directions.¹² Coal tar and indigo dyes are substances most frequently used.

Cases of amblyopia have been reported from exposure to inhalation of tobacco dust.¹³ It has been found that inhaled tobacco dust exerts a nicotine action on the organism fifteen times greater than that produced by the same quantity of smoked tobacco with an equal nicotine content.¹⁴

Severe dermatitis is experienced by many workers handling powder containing T.N.T., which is used in making high explosives. Picric acid, which is also used for this purpose, requires drying, and in this latter state has been found to produce a dermatitis. Picric acid is also the oldest synthetic organic dyestuff.¹⁵ Dermatitis occurs among handlers of silk with varying frequency. Sails determined that a rash occurring among workers in a silk factory was due to dust from silk cocoons imported from Africa.¹⁶

Persons engaged in the manufacture of quinine and quinine preparations suffer from skin phenomena, which occur for the most part on exposed parts of the body, and may be caused by ingestion or by quinine

dust, or powder form of the preparation, exerting a direct irritating effect on the skin.¹⁷ Dermatitis due to other vegetable dusts such as vanilla, powdered arnica, pyrethrum, etc., have been reported.¹⁸

Dental lesions, of occupational origin, have been reported among workers in sugar. The gingivitis caused by sugar dust is classified as purely mechanical, with later-developing caries. Digestive disorders, respiratory conditions, and cutaneous conditions (especially of the face) were also found.¹⁹

Dock workers, transporters of grain, workers in grain and flour mills, etc. are exposed to dusts during their work. Dusts from cereals may contain many impurities, which may cause an irritating action on the respiratory passages, as well as inflammation of the skin. Digestive disturbances, dental defects, diminution in hearing, and conjunctivitis have been observed among millers, and have been attributed to the dusts to which such workers are exposed.²⁰

b. *Allergic.* Many apparently innocuous substances may produce reactions in persons of peculiar personal susceptibility. The term "allergy" is used to describe this condition of hypersensitiveness or susceptibility, and allergic phenomena most frequently manifest themselves in skin reactions. However, they may cause acute reactions elsewhere in the body. When the respiratory tract is involved we have such well known diseases as hay fever or asthma. These diseases may develop as a result of hypersensitiveness to such substances as pollens from plants, horsehair, rabbit's fur, furs, feathers, etc.

For instance, furriers, workers in clothing industries who are exposed to wool dust, etc., may suffer from hay fever or asthma.²¹ It is unnecessary for the offending dust to reach the depths of the lungs—giant pollens for example are reported to produce their effect after being caught in the upper respiratory passages. Should such an offending substance be finely ground it could reach the alveoli and as a result probably all physiologic reactions would be accelerated.²²

In a survey of a plant where resin is mixed, ground, and molded, it was found that 80 per cent of the occupational dermatitis there was due to hypersensitivity to hexamethylenetetramine and formaldehyde contained in the dust to which the workers were exposed.²³ During the first process

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of cotton spinning, cotton-strippers are exposed to dust arising from cotton husks and debris, which produces a typical form of asthma.²

Ordinary wood dust has been of interest due to its purely mechanical action, but still greater care is required in handling certain kinds, especially woods coming from abroad, because of the essential oils impregnating them, which when freed in the dust may affect the health of the workers concerned. Some of the woods capable of causing skin lesions are Brazil wood, satinwood, teakwood, cumaru or tonka wood, black ebony wood, West Indian mahogany, Japanese tagayasan, coccoloba, chestnutwood, olivewood, California sequoia, etc. All persons who handle these woods are not injured, only those particularly susceptible to the substances they contain becoming affected.²

2. LIVING ORGANIC DUSTS. These contain particles capable of exhibiting the phenomena of life² (especially the property of reproduction or multiplication), such as bacteria and fungi. They are usually found in low concentrations and are associated with nonliving dusts in the air.

a. Bacteria. One of the most important among these is the anthrax bacillus, which is contained in the dust from skins, furs, wool, and animal hair, horns, hoofs, bones, etc. This disease may occur in two forms: *cutaneous* (in which the organism affects the skin), and *pulmonary* (when it is inhaled, as in the form of anthrax known as wool-sorters' disease).¹²

Cases of tetanus, reported in connection with jute manufacture, were traced to the raw material, the bacillus having been found in the factory dust.¹³ Diphtheria, tuberculosis, smallpox, typhoid, or other bacillus-produced diseases, may result from exposure to infected dusts.

Bacterial sensitization can be the cause of any of the allergic diseases, namely, asthma, perennial hay fever, urticaria, angioneurotic edema, eczema, or migraine headaches.¹⁴

b. Fungi. Dusts containing the mycelia and spores of parasitic fungi give rise to annoyance and discomfort. "Maltster's" itch from the dust alone has been reported. In Provence, reeds used for ceilings are stacked while still wet and undergo fermentation; they become covered with a white powder (a dry fungus of the *Mucor* family; *Spor-*

trichum dermatodes), which is scattered when the bark is stripped off. This powder is irritating to the skin and mucous membranes. Mycelia and spores of moulds are commonly found to cause rashes: for instance, the black powder coming from macerated sugarcane stalks. Among basket-makers, the mycelium and spores, in the form of a white mould (*hyphomycete*) from the rattan canes used, get shaken out when the canes are split, hammered, and cut, causing painful fissures to develop on the skin where they alight.¹⁴

A form of asthma or spasmodic cough, suffered by cotton weavers and known as aspergilliosis, has been considered due to inhalation of spores of a mildew which sometimes occurs on the threads.¹⁵ In a study of silicosis among miners, made by the Public Health Service, a number of cases of typical milary calcification were encountered. Unstained smears of those cases examined were positive for fungus, two types of *Aspergillus* fungi being identified. All of the subjects but one were farmers, teamsters, feedmill workers, or residents of small agricultural towns where grain is marketed. Farmers are exposed to fungi in threshing wheat, baling hay, or handling various small grains.¹⁶

Some other fungus diseases such as actinomycosis and blastomycosis are associated with occupational exposure to dust. The former occurs among workers handling straw, hay, grass, vegetable debris contaminated with mould, etc. Actinomycosis is likely to affect people engaged in commercial handling, storing, and cleansing of grain (grain distilleries, flour mills, grain crushing, breweries, and malting houses, etc.).¹⁷

II. Inorganic Dusts

Inorganic compounds are of mineral origin, not requiring a living organism to produce them.¹⁸ A number of dusts not usually classed as toxic may, under some conditions, produce untoward effects on the human organism. Classified under inorganic are toxic and/or irritant, fibrosis-producing, and nonfibrosis-producing dusts.

a. Toxic and/or Irritant. Toxic dusts are those which are inherently toxic when inhaled, ingested, or otherwise absorbed. Among those which produce systemic poisoning, some of which are also irritant, are the dusts from heavy metals and their salts, such as lead, mercury, arsenic, cadmium,

000131

zinc, etc. Irritant dusts are injurious by reason of their strong irritative or corrosive properties.

As a rule, inhaled irritant substances immediately cause a reaction in the upper respiratory tract of such severity that they are prevented from reaching the lungs, although they may cause lung damage by extension of inflammation if the mucous membrane is corroded. Lime, calcium oxide, and the di-chromates are examples of irritant dusts. An inorganic dust may possess both toxic and irritant properties, and the poisoning produced may be the combined effect of more than one mode of entrance into the body.

Of the directly poisonous dusts, the most widely prevalent are those of certain lead compounds, particularly the oxide, carbonate and the chromate. The dust is readily absorbed by the mucous membrane; some dust passes into the stomach and is dissolved by the gastric juice.⁴

According to Fairhall, perforated nasal septum is a common occurrence among workers with bi-chromate dusts.⁴ In a study made by the U. S. Public Health Service it was found that continuous daily exposure to concentrations of chromic acid mist greater than 1 milligram in 10 cubic meters is likely to cause definite injury to the nasal tissues.²² It is believed that a similar concentration of the dust would be equally toxic.

In the case of poisoning from some heavy metals, exposure may be to both dust and vapor. For instance, investigations have shown the safe limit of total exposure to lead oxide dust and fumes to be less than 1.5 mg. per 10 cubic meters of air, except for prolonged exposure.²³ In exposure to mercury dust and vapor, it was shown that the incidence of chronic mercurialism increases rapidly with increasing mercury concentration, after such concentration exceeds 2.0 mg. per 10 cubic meters.²⁴

Alkalis and metallic oxides are common causes of dermatoses. Lye, potash and lime are known to cause irritation to plasterers, cement-makers, bricklayers, masons, stonecutters, modellers, and metal platers.²⁵ Ulceration and perforation of the nasal septum occur among workers exposed to the dust of soda ash; systemic poisoning also occurs from inhalation of calcium cyanamide dust.²⁶

Cases of dermatitis, scleroderma and can-

cer are reported to have been caused by exposure to dust of arsenic compounds. Certain aluminum salts are skin irritants and aluminum dusts may contribute to the infection of skin and mucous membranes, through mechanical action.²⁷

b. Fibrosis-Producing Dusts. The most important of these are the inorganic, slightly soluble dusts which cause fibrous changes in the lung tissues, some of which are serious, and some of which cause little or no disability.²⁸ So far as is known, no inorganic substances other than silicon derivatives cause more than a very moderate degree of fibrosis of the lung. Moreover, there seems to be no evidence that any other constituent of ordinary dusts can influence so unfavorably a pulmonary infection.²⁹

Although other dusts, when inhaled in sufficient concentrations over a long period of time, have been shown capable of producing a pulmonary fibrosis; nevertheless, the pneumoconiosis characterized by nodular fibrosis has to date been shown clinically and experimentally to be associated only with the inhalation of dusts containing free silica.

Since this dust, to exert its harmful action, must enter the finer divisions of the lung, the particle size of the atmospheric dust may bear a definite relationship to the injurious effect produced. The silica must be present in the air in particles small enough to enter the finer air spaces and of such dimensions that the phagocytic cells may engulf them. The greater majority of particles found upon microscopic examination of the lung fall within the limits of from 1 to 3 microns.³¹ Examples of siliceous dusts are granite, quartz, sand, pumice, slate, etc.

In a recent study among anthracite miners, the correlations between exposure to dust (which contained silica) and the evidence of constitutional changes left little doubt as to the etiological significance of the dust in the air breathed. Like correlations were found between the silica exposure and the extent of pulmonary changes.³² When the inhaled dust consists of silica combined with bases, silicates, some degree of change in the pulmonary tissue may result. In this respect asbestos dust seems to be unique among silicates in the prevalence and severity of the disease it causes.³³

The chief distinction between silicosis and conditions due to simple reactions caused by other dusts is the active proliferative

000102

reaction in the tissues which results in progressive nodulation. Silicosis, when once established, strongly predisposes the lungs to infection, especially with the tubercle bacillus. Chronic interstitial pneumonia, chronic bronchitis, and emphysema are frequent complications of advanced degrees of silicosis.

The relation of the acute respiratory infections to the reaction due to dusts other than free silica has never been established, though a heightened incidence has often been shown statistically in workers in dusty trades. It is fairly certain that a dust damaged lung, whatever the cause, fares much worse if an acute infection does supervene upon it.

In a study conducted by the U. S. Public Health Service among marble finishers in Vermont, it was found that marble dust when inhaled in the concentrations found in the examined plants produced a mild, bilateral, linear fibrosis in some cases, but no serious lung changes were noted and there was no disability due to the dust, even after years of exposure."

c. Nonfibrosis-Producing Dusts. These are inert, that is, they do not cause fibrous tissue to be produced, but may become encapsulated or lie free in the tissues; or they are absorbed without production of fibrous tissue. Included among them are alundum, coal, corundum, emery, limestone, magnesite, marble, plaster of paris (gypsum), and polisher's rouge.

Dust Control

Engineering and medical control are the two most important factors in combating the industrial dust hazard, and are to a large extent complementary.

Engineering Control. As Lanza²² has stated in a recent paper, "It is a basic principle in dealing with a dust hazard that the dust should be attacked at its point of origin and thus prevented from being disseminated into the atmosphere." After the dust has been spread throughout the air it is difficult to deal with it, and reliance must be placed on individual protection, which is never wholly satisfactory.

Lanza further cites various methods used in controlling dust. These will be reviewed but briefly, since a paper dealing with the subject of dust control in detail will follow on this program.

Dust may be entrapped at its source by suction devices and thus removed and collected. Familiar examples are exhaust hoods in grinding operations, and the devices used in rock drilling.

Generally speaking, the exhaust ventilation method, where applicable, is to be preferred in controlling a dust hazard. Water may be used to entrap dust and prevent its dispersal, and under certain circumstances it may be of advantage to combine the use of water and the use of suction. Sometimes a dusty process can be completely enclosed in a sealed room or compartment. It must be remembered, however, that any mechanical device of this kind offers adequate protection only if it is properly designed, installed, and maintained.

A great deal of attention has been given the subject of individual protection from dust, and there are many types of respiratory protective devices now available. These are generally of two types: those which provide fresh air from an uncontaminated source and those which rely upon a filtering medium for removing dust from the air breathed. Where the use of such a device is indicated, only one of the types approved by the U. S. Bureau of Mines should be used. As a rule, it may be said that masks, respirators, or other such protective device should be used only where exposure to the dust is intermittent and brief, or where some unusual condition makes a more adequate dust control impracticable."

Where bacteria or other living dusts in the air are associated with a process, sterilization methods such as increased temperature, ultraviolet radiation, and chemicals like chlorine or other bactericidal substances, may be of use. Pasteurization temperature (about 140° F.) will kill most organisms except those bearing spores. Steam disinfection is used for horsehair, and proves to be practicable if the temperature does not exceed 230° F. Wool fibres, however, lose their elasticity by steam disinfection, and the "Duckering" process now used in England includes soaking of the wool in a formaldehyde solution, and drying in a current of air at a temperature of 160° F.²³ There are few occupations in which there would be a sufficient concentration of dead bacteria to cause untoward effects in man.

In the case of dusts producing external irritation, auxiliary protective measures may include the use of protective clothing,

gloves, goggles, protective salves, poultices to de-action. General house-keeping.

Medical Co-closely interphase, is me hazards. In a placement of health of all a check on control meth measure of t vices.

It has be found that t injuries and and medical ment and pe one of the prevention.

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goggles, goggles and aprons; as well as pro-
tective salves, ointments, or other com-
pounds to delay or diminish the irritant
action. General rules for hygiene and good
housekeeping should also be observed.

Medical Control. Equally important, and
closely interrelated with the engineering
phase, is medical control of occupational
hazards. In addition to directing the proper
placement of new workers, and guarding the
health of all employees, medical control is
a check on the efficacy of the engineering
control methods already instituted, or a
measure of the need for new protective de-
vices.

It has been stated that "Industry has
found that the best way to treat industrial
injuries and illness is to prevent them."¹
and medical control, through preemploy-
ment and periodic physical examinations, is
one of the most important factors in such
prevention.

The preemployment examination is made
to determine the employee's physical and
mental fitness for work. It serves to dis-
close the presence of any contagious dis-
ease, reveals any minor physical defects
which might later become serious, or whether
the examinee's condition precludes his em-
ployment in certain or in all types of work.
It should be remembered that such preem-
ployment examinations are not to be made
for the purpose of eliminating an employee,
but rather for allocating him to the type of
work for which he is physically suited. A
worker should be given employment unless
totally unfit, or unless his disability, even
though slight, would cause him to be a haz-
ard to himself or his associates. Further-
more, the practice of preemployment
examinations should be extended to include
executives and officials of industrial organi-
zations.

"The purpose of periodic physical
examinations is to secure and maintain
physical fitness and thereby lengthen work
spans."² Reexamination of employees some-
times results in the discovery of defects and
disabilities which were not observed at the
time of employment. In such cases, an oc-
cupational adjustment should be made to
provide continued employment, but remove
the risk of permanent injury.

Reexamination of employees is required
by law in certain occupations in which the
handling of poisonous or otherwise deleteri-
ous substances may result in the contraction

of disease." Since some occupational dis-
eases tend to clear up and recur, records of
previous occupations should be included in
the physical examinations. The frequency
of examinations should be determined by
the medical director, unless otherwise speci-
fied by law. Those exposed to known occu-
pational disease hazards may have weekly
or monthly examinations.³

"It should always be kept in mind that the
basic principle of physical examinations in
industry is to keep men on the job and not
allow the physical examination to be merely
a weeding out process."⁴

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pensive methods for making the air clean are still in the realm of dreams. Much work must be done to know more about silicosis and more how to make atmospheres safe *inexpensively*. As an accident prevention job, dust control lies almost entirely within the administrative responsibility. The control measures are capital expenditures of considerable size.

A plant with a dust hazard is sick, it needs an expert diagnosis and scientific treatment, which may include expensive major operations. Home remedies are seldom much good, and supervision and employee safety consciousness alone cannot accomplish anything. There may be observed in countless shops installations for exhausting dust which are derisively called "tin knocker" jobs in which the horsepower dissipated is out of all proportion to the air-borne dust moved. Tonnage efficiency of material moved may be the proper yardstick for pneumatic conveyors but if the material to be moved is air, contaminated with nearly weightless particles of dust, the entire health hazard can lie in the half of one per cent of material not moved.

That goes for handling the dust hazard in a given plant. It goes double for acquiring knowledge to the end that the whole problem may reach ultimate solution. Right now our knowledge of the problem is in big chunks, loosely put together and largely empirical.

There are estimates only to judge the magnitude of the dust health problem, and it is so closely associated with other health problems that a clean-cut estimate of it alone is impossible. We do know that it is great in the aggregate, and for the individual plant it may be very bothersome and expensive.

What actually makes quartz dust cause silicosis is not known. It does, so the air breathed by workmen must not contain harmful quantities of respirable quartz dust. Inex-

I do not mean that unless a dust suppression job was engineered it can be no good. There are many good installations that were never figured at all but grew like Topsy.

sulting freedom in
factor: that either
the owner of the
I offer the consumer
should be of interest

A design engineer developed a section of pipe with no sense of economy. A safety is not possible a minimal residual more positive design than to find a margin that is not the reasonable safety the last design.

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Let us examine
which are required
leaving the same

In order to determine the need for such a system, it seems desirable that we can do the following: which deal with: parliament's main components: system of exposure, the protection and health of industrial complex case against the commitment via and demonstrating control system installed to test that the system is reliable and that it is required to maintain

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resulting freedom from dustiness was so satis-
factory that efficiency held little interest to
the owner. This is exceptional, however, and
I offer the opinion that dust suppression jobs
should be engineered.

A dust-suppression installation is a safety
device, designed and operated to provide pro-
tection against possible disease and provide a
sense of security which must be absolute. Its
safety is not rushing air and rattling chips but
a minimal residual dustiness. There is no
more pathetic defeat for a dust control job
than to find faith in its effectiveness so low
that workers must wear respirators to find
the reasonable safety that was expected from
the hoods, ducts and fans.

Diagnosis and Control

Let us examine some of the features by
which we recognize this dust hazard problem,
leaving out the socio-legal aspects.

In order to develop more fully the engi-
neer's place in this dust control program, it
seems desirable to separate as sharply as we
can the diagnostic considerations from those
which deal with control. In the first com-
partment we can place all the analytical com-
ponents which describe the hazard and its
exposure, the probability of its producing ill
health and all the rest of the medical and
industrial hygiene facts which make out a
case against the existing dust. In the second
compartment place the knowledge of physics
and engineering necessary to plan the dust
control program and so design it that when
installed its performance follows prediction
that the probability of industrial disease is
reduced to insignificance.

The Industrial Hygienist

Our first feature of interest would naturally
be the specific and relative toxicity of silica,
silica-bearing and other dusts which make up
the dust health hazard. Much might be said
to advantage about the quality and quantity
of hazard in many dusts. The acquiring of
this knowledge has been, and must remain a
medical problem. It involves gross and micro-
scopic pathology and x-rays, and experimental
animals. Engineers do not talk that language.
Industrial hygienists do; they are a happy
combination, half doctor and half engineer.
Many of them are quite capable of handling
the dust health hazard in all its phases of
investigation and control. For the purpose of
this discussion I throw their interest in with
the doctors.

I want to go so far in my opinion as to
state that the engineer should not attempt to
define the quality of health hazard in a given
plant or industry, nor should he establish
threshold limits of safe or permissible dusti-
ness. This may be debatable, but I shall con-
tend that the engineer who writes the speci-
fications of hazard and dust tolerance is really
an industrial hygienist, and is using a very
much broader knowledge than engineering
alone.

In the first case the quality of the health
hazard is an opinion arrived at after studying
all the environmental conditions including the
general sanitation, occupational analysis and
a scientific analysis of the dust exposures.
In the exploration of dust exposures, the
nature of dusty operations must be viewed
from physical, chemical and mechanical
aspects, the determinations of dustiness must
be not only counted and classified by particu-
late sizes, but chemically and mineralogically
analyzed. The plant layout must be studied
with respect to dust production and distribu-
tion, and the housekeeping and existing dust
control equipment evaluated. The presence of
specific hazards, such as toxic gases, abnor-
mal temperature and humidity conditions, etc.,
must be explored for their complicating effect
upon the whole picture. This is distinctly an
industrial hygiene job, and some of the most
critical data requires only medical viewpoint.
This is absolute in the case of tuberculosis
study and the qualifying of men for employ-
ment.

So far, not one atom of engineering to
suppress dust is involved. It is entirely anal-
ysis of hazard. The diagnosis must be that
the dustiness is hazardous to health or that it
is safe. If it is hazardous, it must be brought
down to a specified residue. If it isn't, leave
it alone. On the second point, if the hygienists
can not specify threshold limits graduated
upward for relatively less hazardous dusts,
let the engineer not worry about it. The
diagnosis is dust which is harmful and too
much of it. The remedy is control of the dust.
The engineer designs controls which will
produce the lowest practical residual dusti-
ness. He should not attempt to write his own
specifications of threshold limits or permis-
sible dustiness. This may be an important
goal in the study of dust health hazards.

Safe Limits

At the present time the medical men and
hygienists believe that quartz dust is safe

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below five million particles. They seem willing to graduate upward to 20 million for medium silica and 50 million for low silica percentages. Five million particles is virtually dust free, and is very difficult and expensive to achieve and maintain. The declaration of safety of the installations must remain in the hands of the medical and hygiene groups in whose hands now lies the responsibility for determining the hazard.

We now enter the chapter of our discussion intended to demonstrate that dust control is an engineering job, that it must be given scientific treatment, not guess work, applying engineering methods which are based upon a knowledge of physical law, the behavior of dust, the performance of air-moving machinery, etc.

Prerequisite Knowledge

Let me recite briefly, a few of the things which, in my opinion, the engineer should know to do this job correctly. He must know how to make a survey. Surveys depend upon sampling, and sampling is not a catch-as-catch-can proposition. It involves the place, the time, the frequency, the amount in a sample, and the number of samples so that maximum, minimum and average data mean something, so that credibility can be given them.

For the type of sample involved he must know how to weigh or count respirable dust, as distinguished from large masses of non-respirable dust which complicate the picture. He must know how to observe the sources of dust floods as distinguished from conditions of normal dustiness. He must know the sources of dust and the principles involved in the dispersion of dust. He must determine how much dust enters the problem because it is part of the material, and what dust is created in the process by the fracturing of the material.

Any less survey cannot tell the engineer what his task of dust control is. To visualize that task intelligently he should know the physics of Brownian motion, laws of resistance to the motion of particles moving in air, both when the air is in turbulence and for stream-line motion. He should know terminal velocities, movements due to centrifugal motion; flocculation and the effects of air motion and the effects of humidification on it. He must know all about the difficulties of wetting and what is known about overcoming these difficulties. He should know the several elec-

trical phenomena which bear upon dust behavior.

Those are all principles of physics which explain the behavior of dust and upon which engineering practice must be based. They must be understood and be taken into account. Dust control is not a matter only of general ventilation; the engineer must study the production as well as the dispersion. The problem should be analyzed to determine the applicability of segregation, enclosure, wetting, local exhaust and general ventilation.

In some instances, substitution of non-hazardous material, or non-dust-producing operations may have specific application, and they should be explored first. This implies plant engineering. I am convinced that many bad installations are bad because plant engineering was not used. In the designing of exhaust systems installed to capture the dust at the points of generation, the physical behavior of air moving toward hoods and in ducts must be known, and that knowledge used. Each system must consist of collection hoods, piping, air-cleaning plant and a source of suction. Before selecting a hood for a job the engineer must know dust dispersion by dynamic projection as well as dust dispersion by air currents, and design the hood accordingly.

Knowledge Needed

The aero-dynamic characteristics of suction hoods appear to be little known because little thought was given to them in designing thousands of hoods which can be found everywhere in industry. All the possibility for entrapping dust and much of the efficiency of the system lies in this factor. Air velocity, static suction, and rate of air flow are all related, and they must be known. It is essential to use high velocity of air in certain types of exhaust systems to entrap dust projected at high velocities as in the case of a granite surfacing machine, and low velocities must be used in others, as in the case of cleaning asbestos fibre of dust to prevent wasting material.

Quantity of air and its velocity must be determined, then the piping should be designed to take into account the behavior of air-flow through pipes at low and high velocities. Where the problem is complicated by the large sized particles which go along with the fine dust, how these behave must be taken into account. Pressure losses are very important elements in the design of an exhaust

system. Loss at the end and loss in the duct. Pipe design must take of the metal and pressures and erosive

The selection of a is a matter of calculation. Power consumption, fans follow certain rules, must know the behavior of cyclones, radial other fan performance.

More physics and goes into the air-cleaning selection of gravitation method depends upon calculation for any edge of discharge termination of sizes of behavior of cyclones, a filter, and if so, to perform, how big it resistance and how it say nothing of their relation to cleaning, items for accurate en

Apparatus to check

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Considerable confusion past as to just what is the prevention of dust, just what is the engineering upon even cases two sciences must with their efforts to solve the

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The selection of a fan and its motive power is a matter of calculation, not guess work. Power consumption in the system is calculable, fans follow certain laws, so the engineer must know the behavior of axial flow, propeller type, radial flow, paddle wheel and other fan performance.

More physics and engineering calculation goes into the air-cleaning apparatus. The selection of gravitation, inertial or filtration method depends upon what the dust is, the calculation for any methods requires knowledge of discharge through stacks, the determination of sizes of settling chambers; the behavior of cyclones. The use or non-use of a filter, and if so, what type, how it should perform, how big it should be, what kind of resistance and how much each kind offers, to say nothing of their proper location with relation to cleaning, accessibility, etc., are all items for accurate engineering determination.

Apparatus to check the behavior of installa-

tions must be known and used. Performance cannot be left to guess work. Supplying sufficient air to be exhausted is part of the problem. The same may be said of heating.

Do I give the problem too severe a build-up? I think not. Remember these two things:

1. You are dealing with hazardous material so small in size and so little of it by weight that it is as invisible as the air that bears it.

2. Physical laws involved in the behavior of dust and air do not permit inexpensive methods of control. I am acquainted with budgets set up for this purpose which amount to more than a quarter of a million dollars, and I know of many where 60 to 80 thousand dollars is involved.

The need for this much engineering is recognized by men who know. Already much has been done toward getting the knowledge into handbook shape. Perhaps the best job of this sort to date is "Fundamentals Relating to the Design and Operation of Exhaust Systems" developed under American Standards Association procedure.

The Doctor's Part in Controlling Dust Hazards

By A. D. LAZENBY, M.D., F.A.C.S.

Chief Surgeon, Maryland Casualty Co., Baltimore, Maryland

Considerable confusion has existed in the past as to just what is the physician's function in the prevention of dust diseases, and just what is the engineer's. It is very obvious upon even casual thought that the two sciences must work hand in hand in their efforts to solve the problem.

The physician through his special training must be able to tell the engineer what dusts are dangerous and what are not. He must know how those dusts enter the body and the manner in which they do their harm. He must be trained in the examination of persons who are to be employed to work in dust, and to discover those who are already diseased, or are peculiarly susceptible to dust disease. He must be able to detect the first signs of disease in workers who are exposed to dust, and must be prepared to

recognize the disease when it is fully developed.

It is not necessarily the physician's function to analyze dust. That is a task for the chemist and the petrographer. It is not the physician's function to count the particles of dust in a given industrial atmosphere. That, in reality, is the function of the engineer. It is not the physician's function to devise ventilating equipment for the removal of dust, nor even to be more than an adviser as to the means that must be adopted to render the atmosphere safe.

The physician nevertheless must correlate with his medical knowledge and with his studies of the industrial worker the findings of the engineer. Diagnosis of silicosis, for example, requires not merely characteristic occupational history and characteristic phys-

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Cement and Quarry Sections

Cement Section

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F. E. TOWN, Medusa Portland Cement Co., Manitowoc, Wis.
J. B. ZOOK, Great Lakes Portland Cement Corp., Buffalo, N. Y.

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course, some similarity of procedure in di-
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different industries employ such different
types of people, under such a wide variety
of circumstances, and place such a diver-
gence of requirements upon them that the
problem of supervisory training in its more
comprehensive aspects is peculiar to each
type of industry.

The general treatises on leadership give
the groundwork, but the subject matter for

any supervisory training course for any par-
ticular industry lies within that industry. We
must go out and see how our job is being
supervised now; analyze the procedure of
every foreman and supervisor; compare them
and select the best; look upon supervision as
a process in itself, and see how best to direct
the work of the people. It is a long, tedious,
and costly process, but one which, carried
through to completion, will pay dividends in
the end.

WEDNESDAY LUNCHEON SESSION

October 13, 1937

22*

The Wednesday Luncheon session of the
Cement and Quarry Sections was addressed
by Isaiah Hale, Superintendent of Safety,
Atchison, Topeka and Santa Fe Railroad,
who spoke on "The Common Sense of

Safety." The address was substantially the
same as another address by Mr. Hale before
the Steam Railroad Meeting. The complete
paper will be found in the Steam Railroad
section of this volume.

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WEDNESDAY AFTERNOON SESSION

October 13, 1937

Work of the National Silicosis Conference

By R. CAMPBELL STARR

Assistant Safety Engineer, U. S. Department of Labor, Division of Labor Standards,
Washington, D. C.

Silicosis is strictly an occupational disease.
Medical science has not reported silica dust
as affecting any individuals except those who,
over relatively long periods of time, have
worked in an atmosphere where the air
which they breathe contained excessive con-
centrations of free silica.

The interest of the U. S. Department of
Labor in a broad social and economic prob-
lem such as this has its origin in the Organic
Act, effective March 4, 1913, which created

the Department. This act, among other
things, gives the Department of Labor the
duty "to foster, promote, and develop the
welfare of the wage earners of the United
States, to improve their working conditions,
and to advance their opportunities for profit-
able employment."

With this in mind, and believing that
through joint effort all concerned much
could be done to eliminate the hazard, the
Secretary of Labor called together in Wash-

000151

ington on February 26, 1936 a group of about 75 men representing leaders in industries having a silica problem, labor leaders, and outstanding representatives of the medical, legal, and engineering professions, as well as insurance carriers and State administrators.

After considering various phases of the silicosis problem, this group generally agreed that through a pooling of knowledge and a frank discussion through the conference method important advances could be made toward, first, overcoming the hysterical attitude on the part of employers, labor, and others; second, after careful investigation, to consolidate in one place all known data with regard to the preventive engineering methods; third, analysis and recommendations in connection with adequate standards of compensation for those workers disabled as a result of the disease.

As an outgrowth of this initial meeting, another group, similar in composition to the first conference, but expanded to include some 200 individuals, was invited to come to Washington on April 14, 1936 to outline ways and means of attacking the problem. After hearing silicosis discussed from the standpoint of the employer, labor, and the medical profession, by outstanding experts in the field, this large group endorsed the conference method as proposed, and as a result four main working committees were appointed by the Secretary of Labor with the advice and consent of the group to investigate and report upon the outstanding phases of the silicosis problem. These committees were:

- (1) Committee on the Prevention of Silicosis through Medical Control,
- (2) Committee on the Prevention of Silicosis through Engineering Control,
- (3) Committee on the Economic, Legal and Insurance Phases of the Silicosis Problem,
- (4) Committee on the Regulatory and Administrative Phases of the Silicosis Problem.

A fifth committee, known as the Correlating Committee, was named. It was under the chairmanship of W. H. Cameron, Managing Director of the National Safety Council, and consisted of the chairman of the four technical committees just mentioned and two ad-

visors, one on labor problems and one on mining matters.

These committee members served without compensation and gave freely of their time and effort in studying the problem from their respective viewpoints. After nine months of careful and searching study, these committees advised the Secretary of Labor that they were ready to report. Consequently, on February 3, 1937 the Second National Silicosis Conference was called in Washington. At this time summary committee reports were presented to the Secretary and considerable discussion was given them.

Shortly after this second national conference the Department published, as Bulletin No. 13 of the Division of Labor Standards, the summary reports of the four committees referred to above, together with an abstract version containing the principal findings and recommendations written in non-technical language.

The full reports of the committees, comprising several thousand typewritten pages, are now being edited and will go to the printer very shortly. It is expected that they will be issued in four separate volumes sometime during the fall or early winter.

Nature and Extent of Silicosis

Physicians generally agree that silicosis, in the layman's language, is a disease of the lungs, caused by breathing air containing silica dust, in which the normal lung tissue is replaced by fibrous or scar tissue.

Silica dust is found in many industrial operations, but the hazard is acute only in such industries as metal mining; anthracite mining; quarrying, drilling, and tunneling in granite, gneiss, and sandstone; smelting and refining; foundries; potteries; glass works; stone-products industries; grinding; buffing; and sandblasting.

Of the 49,000,000 workers in the United States, only 1,000,000, or 2 per cent, it is estimated, are in any way exposed to the hazard of silicosis. About half of this number, or 1 per cent of the total number of workers in the country, are exposed to a serious hazard, and approximately 110,000 of these have silicosis to some degree. Medical examination of men actually at work indicates that between 4,000 and 5,000 workers are seriously affected by the disease, in addition to

those already permanently disabled by their employment by reason of silicosis.

The status of the 1,000,000 exposed to the hazard of silicosis by the committees.

A percentage of the workers having silicosis are partially disabled because of the disease and have their difficulties complicated with tuberculosis.

The remainder of the silicosis and disability is due to tuberculosis.

Approximately 105 but no disability and

Approximately 900 silica dust, but have no disease.

Contrary to popular belief, silicosis does not develop. Usually it is the result of exposure to silica dust. It has been known to develop in a period as long as one and one-half years, and under extreme and unusual conditions, in less than 30 years without trouble whatever that silicosis.

Silicosis I

Silicosis can be prevented by: First, by preventing silica dust; second, by preventing the dispersion of dust into the working area; and third, by applying the first two methods of personal protection, respirators, to prevent dust.

In carrying out many agencies must be called on. The employer is called on to spend money and work and money to maximum results in order to cooperate in responsibility for and for using the method.

In addition, physicians have a part in preventing

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The status of the 1,000,000 workers ex-
posed to the hazard of silicosis was analyzed
thus by the committees making the survey:

A percentage of the 4,000 to 5,000
workers having silicosis are completely or
partially disabled because of this disease
and have their difficulties further com-
plicated with tuberculosis.

The remainder of the 4,000 to 5,000 have
silicosis and disability in some degree, but
no tuberculosis.

Approximately 105,000 have silicosis,
but no disability and no tuberculosis.

Approximately 900,000 are exposed to
silica dust, but have not contracted the dis-
ease.

Contrary to popular belief, silicosis is slow
to develop. Usually it takes seven years or
more of exposure to silica dust for a worker
to contract the disease. A few cases that
have been known to develop in as short a
period as one and one-half years occurred
under extreme and unusual conditions. On
the other hand, many workers have labored
under ordinary exposures to silica for more
than 20 years without demonstrating any
trouble whatever that could be diagnosed as
silicosis.

Silicosis Prevention

Silicosis can be prevented in three general
ways: First, by preventing the creation of
silica dust; second, by preventing the dis-
persion of dust into the atmosphere of a
working area; and third, if it is impossible
to apply the first two methods, by the use
of personal protective equipment such as
respirators, to prevent the inhalation of the
dust.

In carrying out a prevention program,
many agencies must cooperate. In the view
of the committees studying the problem, the
employer is called on to do most of the work
and to spend most of the money. But his
work and money will never accomplish the
maximum results unless the worker is will-
ing to cooperate and carry his share of the
responsibility for helping to control dust
and for using the personal protective equip-
ment.

In addition, physicians can play a definite
role in preventing silicosis, as can also en-

gineers, insurance companies, legislators, ad-
ministrators, and others.

The reports of the conference committees
on engineering control and medical control
recommend specific procedures for attack-
ing the problem through those two avenues
of prevention. A partial list of these recom-
mendations follows:

Survey the working conditions to deter-
mine the severity of the hazard and indi-
cate what needs to be done to decrease it.

Secure information on best procedure.

Design plant for dust control.

Provide building ventilation.

Store dusty materials in dusttight bins.

Enclose material-handling equipment.

Isolate dusty processes.

Provide wet methods of operation.—

Water, oil, and other liquids may be used
effectively—

1. To suppress dust at the point of origin
in such operations as rock-drilling; hand-
ling, pulverizing, and milling rock and
ore; grinding metal on grindstones;
abrasive-wheel cutting of granite and sand-
stone.

2. To prevent the redispersion of dust
that has settled on the floors, walls, and
other surfaces such as in the granite in-
dustry and in foundries.

Design equipment to control dust.

Establish good maintenance and house-
keeping procedure.

Provide respirators.

Instruct the workers.

Responsibility of Workers

The cooperation of the workers is neces-
sary if the hazard of silicosis is to be re-
duced to the minimum. The worker should
realize that the safe practices recommended
and the equipment provided are designed to
prevent injury to himself and to his fellow
employees. The equipment should be used as
directed and every effort should be made to
maintain it in good working order. Further-
more, the worker is frequently in a posi-
tion to observe faulty equipment and unsafe
practices, and he should make it a point to
report all such conditions to his supervisor.

Statutory Regulation

It is the primary responsibility of the pro-
fession to prevent the spread and diminution

000153

of the hazard, the fact must be recognized that until silicosis has been wiped out, workers who now have the disease, as well as those who may contract it, must receive workmen's compensation just as do those workers who are injured in accidents.

Accordingly, the committees of the silicosis conference were unanimous in presenting the following recommendations:

Coverage for silicosis in the compensation acts of all States.

This coverage should be compulsory.

Because of competition between the same or similar industries in various States, the laws, rules, and regulations of the several States should be as uniform as practicable.

Should Be Insured

The employer should insure his obligation for compensation either through self-insurance subject to the posting of adequate funds, or with an authorized insurance institution.

Insurance should not be denied any employer, provided the State authorities certify that he complies with the State requirements as to proper safe working conditions, and pays the premiums involved.

Workers having active pulmonary tuberculosis and silicosis should be removed from employment. Such workers should be granted suitable compensation payments and medical care.

Workers disabled from silicosis (but with no tuberculosis) should ultimately be granted the same amount of compensation as those disabled by accidental injury.

Two years is a reasonable minimum limitation period for filing claims subsequent to the date of the last exposure.

Further Activities of the Department of Labor

In carrying out its duty as stated in the basic law, the U. S. Department of Labor has conceived that there is immediate need

for the conversion of known facts in the medical and engineering fields working toward prevention, and in the legal, insurance and regulatory phases looking toward adequate workmen's compensation, into a practical, readily understood program which will adequately take care of the silicosis problem.

In its program of cooperation with the 48 States, the Department of Labor has included a section covering silicosis and similar dust diseases. This breaks down into three main sub-headings: (1) Assistance in the preparation of reasonable and adequate codes, rules, and regulations prescribing methods of prevention; (2) assistance in the establishment of equitable standards of workmen's compensation for those employees disabled as a result of the disease; (3) a general educational program among State officials, factory inspectors, etc. so that they will be equipped with adequate knowledge concerning the disease, its method of prevention, and its proper treatment under the workmen's compensation law.

Follows Two Lines

This application program, which is just now getting under way has been commenced along two principal lines: (1) The compiling of practical information concerning actual dust control installations in typical silicosis hazardous plants, together with approximations as to cost, not only of installation, but also of maintenance of dust control equipment in such plants; (2) a program of visual education supplementing the summary and final committee reports of the National Silicosis Conference. It is contemplated that in this field such media as film strips, lantern slides, posters, illustrated bulletins, etc. will be utilized. Further, in connection with the various exhibits of the department, shown at various large expositions, trade association meetings, labor and technical organization meetings, etc., it is contemplated that much factual information will be used, pointing toward ways and means of correcting the hazard and of establishing adequate standards of workmen's compensation.

Following the address by Mr. Starr a round table discussion of outstanding

problems in quarry operation took place. It concluded the Wednesday program.

Methods

Safety Dire

The Lyman-Rickard operates 22 the state. Each individual unit, foreman and from shift. Total annual to 250, with an average man hours.

All production dredges, involving result in electrocution.

Although our same as those of record in the year was 79 lost man hours' experience so many accident very unfavorable Compensation Commission firms flatly.

It was evident plant looking out "haywire," so a was decided upon the following method:

First, an old plant operations rector, devoting

Second, all employees pass a physical examination number were for

Third, all made as mechanical guards placed moving parts, and guards built on boards placed stairways, etc. improper

Fourth, men with plans, etc.

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PETER M. WILSON, Mathieson Alkali Works (Inc.), Niagara Falls, N. Y.

Officers Elected for 1937-38

- General Chairman*—H. L. MINER, E. I. du Pont de Nemours & Co., Wilmington, Del.
Vice-Chairman in Charge of Program—RALPH L. ROGERS, JR., Tennessee Eastman Corp., Kingsport, Tenn.
Vice-Chairman in Charge of Engineering—RALPH O. KEEFER, Aluminum Co. of America, Pittsburgh, Pa.
Secretary—R. S. MACKIE, General Electric Co., Nela Park, Cleveland, Ohio.
News Letter Editor—F. W. DENNIS, Hooker Electrochemical Co., Niagara Falls, N. Y.
Occupational Disease Committee Chairman—DR. LEONARD GREENBURG, New York State Department of Labor, New York, N. Y.
Membership and Publicity Committee Chairman—C. E. SEVRENS, Merrimac Chemical Co., Inc., Boston, Mass.
Poster Committee Chairman—R. C. STRATTON, The Travelers Insurance Co., Hartford, Conn.
Statistics Committee Chairman—E. L. ROOT, Celluloid Corporation, Newark, N. J.

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 E. F. KING, Lever Brothers Co., Cambridge, Mass.
 S. D. KIRKPATRICK, Chemical & Metallurgical Engineering, New York, N. Y.
 JOHN ROACH, Deputy Commissioner of Labor, Trenton, N. J.
 JOHN S. SHAW, Hercules Powder Co., Wilmington, Del.
 PLUMMER WHEELER, American Cyanamid Co., Linden, N. J.
 S. E. WHITING, Liberty Mutual Insurance Co., Boston, Mass.

TUESDAY LUNCHEON SESSION

October 12, 1937

Sessions of the Chemical Section opened with a luncheon meeting with H. L. Miner, E. I. du Pont de Nemours & Co., Wilmington, Del., general chairman of the section, presiding.

William P. Yant, director of research and development, Mine Safety Appliances Co., Pittsburgh, Pa., addressed the delegates, "Latest Protective Devices and Safety Equipment for Chemical Workers."

TUESDAY AFTERNOON SESSION

October 12, 1937

Safety in Chemical Laboratories

By A. B. RITTER

Chemist, Hercules Powder Company, Wilmington, Del.

It is generally accepted that all of the hazards which arise in the several stages of chemical manufacture are present in the research laboratory on a small scale at least. It is also accepted that there exist the additional hazards of experimental chemical work. How can both types be designated in order to help the chemist protect himself and his equipment?

We suggest that this be done by dividing the hazards into two groups, known and unknown. In the known group we should include the physical hazards, not only as they pertain to machinery, equipment, apparatus, and temperature, and illumination, etc., but also as they relate to the human body. This known group includes exposure to harm from physical forces; such as, heat,

light, and electricity, and that physical strain which is associated with the human body.

For the dangers in the unknown group which the chemist must face, it is suggested that they be given the names under which they will probably be classified after their initial display. These terms may be defined as follows: *Explosion hazard* is exposure to danger from a violent expansion of gases. *Fire hazard* is exposure to danger from burning or combustion. *Toxicity hazard* is exposure to danger from poisons. *Personal equation hazard* is exposure to danger from the tendency of an individual to err. There may be a few who seldom err and there are those who are prone to err more or less frequently. Therefore, the

personal equation hazard is not a safety unknown but a safety

We will now give you a list of unknown hazards in the research chemical laboratory.

At the completion of a miniature test, two detonation test method were employed. The oil reacted with materials were known. No particular significance was attached to this observation made a day later to establish a further miniature test. A brief but impressive

reaction bulb when it was composed, bursting the reaction bulb was classified as a hazard. The oil as submitted was a hazard in nitromethane of the exposure to danger.

Let us take another instance. An explosion hazard in a cellulose had been observed in the laboratory. A mixture of nitrating acid was used. It had been customary to filter off the acid accordingly, the same was cleaned with acetone, or the liquid acetone, and a respirator. Immediately started, an explosion occurred in the flask. The nitrocellulose scattered but did not explode. We, as witnesses, noted that two workers, one seriously injured, one seriously injured. The explosion probably occurred from vapor coming into nitrating acid.

Now let us consider a hazard. It was desirability of chlorine in its use in chlorination of certain base material. Chlorine and methanol are dangerous. A search was made with thought. Thereupon, methanol was measured in a washing bottle and a chlorine was bubbled

000156

OFFERS

payments to injured workers
more real cost which is the
and anxiety that results from
which no amount of money can
etc.

Construction Section

Officers 1936-37

- General Chairman*—W. A. SNOW, Associated General Contractors of America, Inc., Washington, D. C.
Vice-Chairman for Heavy Construction—R. J. REIGELUTH, C. W. Blakeslee & Sons, New Haven, Conn.
Vice-Chairman for Highway Construction—F. L. ROWE, W. L. Johnson Construction Co., Hicksville, Ohio.
Vice-Chairman for U. S. Engineer Department—MAJOR ELLIOTT VANDEVANTER, C. of E., Office of the Chief of Engineers, Washington, D. C.
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Secretary—ROBERT MCKINLEY, General Accident, Fire & Life Assurance Corp., Detroit, Mich.
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Engineering Committee Chairman—THOMAS S. CLE, Industrial Indemnity Exchange, San Francisco, Calif.
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Program Committee Chairman—V. P. AHEARN, National Sand & Gravel Assn., Washington, D. C.
Publicity Committee Chairman—W. P. COHN, "The Constructor," Washington, D. C.*
Statistics Committee Chairman—C. H. BLACK, Stone & Webster Engineering Corp., Boston, Mass.
Past General Chairmen—
 W. F. AUSTIN, W. E. Wood Co., Detroit, Mich.
 EDGAR N. GOLD-TINE, Consulting Safety Engineer, San Francisco, Calif.
 JOHN RUSSELL, JR., Public Service Electric & Gas Co., Newark, N. J.

Officers Elected for 1937-38

- General Chairman*—W. A. SNOW, Associated General Contractors of America, Inc., Washington, D. C.
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Vice-Chairman for Highway Construction—F. L. ROWE, W. L. Johnson Construction Co., Hicksville, Ohio.
Vice-Chairman for U. S. Engineer Department—MAJOR ELLIOTT VANDEVANTER, C. of E., Office of the Chief of Engineers, War Dept., Washington, D. C.

Visual Education Committee Chairman—S. M. LAUDERDALE, Civilian Conservation Corps, Washington, D. C.

October 12, 1937

The first session was called to order by Edgar N. Goldstine, consulting engineer, San Francisco, who acted as chairman in the absence of W. A. Snow.

By R. J. REIGELUTH

Vice President, C. W. Blakeslee & Sons, New Haven, Conn.

As all contractors today are seeking means to check the increasing costs of material and labor, we were concerned about a further increase in the cost of our compensation insurance. While the insurance costs are only a part of the cost of a high accident record, they are an indication of how those costs are running. Most of us construction men do not record all of the costs of an accident in our cost books and do not know the cost involved in time lost by the associated workers of the injured man, the cost

We made a thorough study of what was involved in our accident records and had conferences with two insurance companies who carry our compensation insurance. There were several jobs in our record which had operated without a lost time accident, including various typical kinds of construction work from operating a crushed stone quarry to reconstructing a bridge on which a pier had failed.

We determined that the savings in insurance costs would have been on the jobs which had a record of no lost time accident.

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To qualify must be a man payroll at least \$100,000 a year. There is no requirement of time that a man in a fireman's record baseball league average. We only to "bat" in a perfect game for only one accident record. ~~It could be~~ for performing.

000158

By Hours of the Day
 By Body Part Injured
 By Nature of Injury
 By General Cause
 By major sub-classifications under General Cause
 By Primary Basic Causes
 By Secondary Contributing Causes

By Foremen in Charge
 By Manner of Performance
 By Agency (Machine, Material, etc.)
 By Part of Agency
 By Method of Contact

The figures may be summarized using days of time lost, medical expense, compensation awards, or other associated data.

WEDNESDAY AFTERNOON SESSION

October 13, 1937

Methods for Protection Against Silicosis, and When They Are Justified¹

By DANIEL HARRINGTON

Chief, Health and Safety Branch, U. S. Bureau of Mines, Washington, D. C.

While the hysteria with regard to silicosis and other occupational diseases has largely subsided and this subject is being more carefully considered and soberly judged, it would be poor policy for any employer to maintain that the storm has ended and that he can relax and revert to conditions as they were some years ago. The fact is that the plan of paying occupational-disease compensation is now in its infancy and can be expected to grow rapidly.

At present while all the States of the Union, including the District of Columbia and excepting only Arkansas and Mississippi, have compensation acts, only the following make provision for occupational diseases to some extent: California, Delaware, Connecticut, District of Columbia, Illinois, Indiana, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, Washington, West Virginia, and Wisconsin.

Silicosis is compensable in one way or another in California, Connecticut, District of Columbia, Illinois, Kentucky, Massachusetts, Missouri, New York, North Carolina, North Dakota, Ohio, Pennsylvania, West Virginia, and Wisconsin, and possibly in other States. It will be surprising if comparatively comprehensive occupational-disease legislation is

not on the statute books of nearly every state in the Union within the next five years.

With this situation confronting him, the farsighted industrialist who has the interest of his organization at heart will immediately start to "put his house in order" by studying possible occupational disease hazards to his employees and promptly applying known remedial measures or attempting to devise such measures if none exist. Unquestionably, one of the most important of the surveys to be made relates to dust occurrence.

While the state dust laws and regulations apply primarily to silica dust and resultant silicosis insofar as the health hazard is concerned, those most familiar with dust occurrence and its possible hazards recognize not only that the breathing of large quantities of dust of free silica (SiO₂) is probably the greatest hazard to health likely to be found where dust is involved, but that not even silica dust is harmful to health unless it occurs in very finely divided form and is breathed in relatively large quantities more or less continuously for a considerable length of time. Moreover, many thoughtful experts on dust harmfulness are now becoming convinced it is to be expected that health will be harmed when human beings are obliged to breathe high concentrations of any kind of dust more or less continuously. Professor Philip Drinker, of Harvard, as chairman of the Preventive Engineering Committee of the Air Hygiene Foundation, Pittsburgh,

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000159

cal findings, but the knowledge as well that the patient has been exposed to hazardous dusts in dangerous concentrations.

All dusts when inhaled in excessive quantities may be considered as harmful, but only a few can be regarded as dangerous. From the standpoint of their dangerous properties, they may be divided into three general groups.

1. Those which are dangerous because of their poisonous action, such as lead, arsenic, mercury, and similar substances.

2. Those which cause only irritation in the respiratory tract, resulting in such conditions as bronchitis or local inflammation; such substances as vegetable fibre, cork dust, flour, starch, and other relatively innocuous organic or inorganic materials.

3. Those which tend to produce fibrosis of the lungs, thereby predisposing to respiratory infections, especially tuberculosis, such dusts as asbestos, silica dioxide or magnesium silicate.

I shall confine my remarks chiefly to dusts occurring in the latter category.

It has been generally believed that the harmful effects of dusts inhaled into the lungs depended more upon their physical structure than upon their chemical. It was believed, for example, that silica dioxide, or quartz, was particularly harmful because of its crystalline structure, and the hardness and sharpness of its particles. This conception is now known to be faulty. The dusts which cause their damage by mechanical interference with function are the dusts which are relatively innocuous, whose symptoms are transitory, and which subside upon removal from exposure to the dust.

Chemical Effect Is Harmful

The disease of particular interest to us today, silicosis, owes its harmful effects very largely to a harmful chemical reaction occurring between silica dioxide and the body tissues. It so happens that silica dioxide is decidedly a tissue irritant to the body, regardless of the part of the body it invades, it causes local irritation, local destruction of tissue, and the replacement of that tissue by scars.

Thus, given a dust containing silica dioxide in sufficient concentration, in sizes small enough to permit its entrance to the ultimate air spaces in the lungs, we have a situation which offers danger to the worker.

We have no real knowledge as to true figures, but as a simple rule, we can adopt for practical purposes the thought that the human body can withstand successfully a concentration of dust containing 100 per cent silica dioxide in a particulate size less than 10 microns, in a concentration not in excess of 5,000,000 particles per cubic foot. If we decrease the percentage of silica dioxide present in the dust, we can correspondingly increase the concentration with comparative safety. We must, of course, take into account the portion of the worker's time spent in the dusty atmosphere.

To arrive at a rough conception of a safe atmosphere, we multiply the percentage of free silica in a given dust by the total number of particles per cubic foot. If the result is under 5,000,000 the condition may be considered relatively safe. If the result is over 5,000,000 the condition must be regarded as unsafe.

Bear in mind too that silicosis is essentially a disease of great chronicity. Except in a few exceptional instances it will require from seven to thirty years for a worker to develop advanced silicosis. It is evident too that coincident dusts may either retard the development of silicosis or hasten it. Recent research seems to indicate that the admixture of aluminum dust to a silicious dust will greatly inhibit the reaction of the latter, whereas a silicious dust combined with some alkaline coincident dusts may hasten the development of silicosis.

Much research is now under way in problems such as this. We have never learned how to cure silicosis, but we are learning rapidly how to prevent it. Our knowledge in this respect seems to be limited to the removal of dust from the breathing zone of the worker. Later discoveries may show us how to modify existing dusts with contaminant dusts that will render silica dioxide innocuous.

Owing to its very great chronicity, it is only the rare case who actually develops disabling silicosis during his industrial lifetime. It is realized, of course, that exceptional instances take place, but the coincident ravages of age usually keep pace with the effects of dust, so that much of the disability usually attributed to silicosis is often in fact, actually attributable to other diseases or infirmities which advancing years bring in their wake. To me the great peril of silicosis, the peril not only to the industrial

worker himself, but and the public generally, is its susceptibility to

Complicated

Silicosis per se does as a complicating factor, recovers despite the individual so afflicted disabled himself, but a with whom he comes the fellow worker. So perhaps the method which the services of trade are necessary discovering and ban a silicious dust that ready have arrested only, discovering it posed to dust, poses whom tuberculous developed.

It is well recognized should be exposed to silica dioxide until he has physical examination made and interpreted. It is likewise familiar with silicosis exposed to silicosis the privilege of fractions and x-rays to discover the extent but to discover a such exists.

A man so diseased himself and to a in contact, be recommended emphasize the examination, unless properly taken of gross tuberculosis.

It is the function, therefore, to conduct in a proper manner the detection of all persons in a dusty trade examination should discover and ban any person who silicosis in an arrested state.

A possible explanation individuals suffer from a primary complication. It is well

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worker himself, but his family, co-workers and the public generally, is the accompanying susceptibility to tuberculosis.

Complicated by Tuberculosis

Silicosis per se does not kill. Tuberculosis as a complicating factor of silicosis rarely recovers despite treatment, and the individual so afflicted is not only totally disabled himself, but a definite menace to all with whom he comes in contact, particularly the fellow worker who may have silicosis. So perhaps the most important places in which the services of the physician in a dusty trade are necessary are—first, along lines of discovering and barring from exposure to a silicious dust those persons who may already have arrested tuberculosis; and secondly, discovering those persons already exposed to dust, possibly already silicotic, in whom tuberculous infections may have developed.

It is well recognized that no individual should be exposed to dust containing silica dioxide until he has undergone a thorough physical examination, including carefully made and interpreted x-ray films of his chest. It is likewise obvious to anyone familiar with silicosis that no person who is exposed to silicious dust should be denied the privilege of frequent physical examinations and x-rays of the chest, not entirely to discover the existence of possible silicosis, but to discover a coincident tuberculosis if such exists.

A man so diseased should, in protection to himself and to all with whom he comes in contact, be removed from industry. Let me emphasize the uselessness of a physical examination, unless it be accompanied by properly taken x-ray films, except in cases of gross tuberculosis.

It is the function of the physician, therefore, to conduct in a thorough and an intelligent manner the pre-employment examination of all persons who are to be engaged in a dusty trade. The purpose of this examination should be threefold. First, to discover and bar from employment in dust, any person who is suffering from tuberculosis in an active, a quiescent or an arrested state.

A possible exception might be made in individuals suffering from a so-called healed primary complex, or a healed childhood infection. It is well known that exposure to

silica dioxide is very likely to excite into activity a tuberculous lesion which may be quiescent or arrested, and once such a lesion is reactivated, the chances of recovery are remote.

The second problem which confronts the physician at the pre-employment physical examination is whether a given individual is, by reason of secondary physical defects, more susceptible to the development of silicosis than a normal. Is he suffering from diseases of the nose or upper respiratory tract, such as chronic sinusitis, disease of the lungs or air passages, or obstructions which produce mouth breathing?

We must remember that silica dioxide is not dangerous until it reaches the lungs, and that the normal individual retains in the nose and the upper air passages a large quantity of the dust inhaled from the atmosphere. In instances where this nasal retention is disturbed, exposure to silica dioxide dust may be dangerous to that individual, where it would not be to another.

It is believed that certain diseases of the heart and circulation, of the kidneys, possibly syphilis, chronic coincident diseases of the lungs, all may render a man more susceptible to silicosis than normal. The physician at his pre-employment examination must follow certain established criteria in this respect, and bar from exposure to dangerous dusts those persons who through existing disease may be more ready prey to silicosis or tuberculosis.

Re-Examination Needed

After the applicant for employment has successfully passed his physical examination and is engaged in a dusty trade, the duty of the physician is not yet ended. This workman must be periodically re-examined, first to discover the early appearances of pulmonary fibrosis, but what is even more important, to detect the early evidences of complicating tuberculous infection.

A man should not be dismissed from employment in a dusty trade merely because he has evidences of non-disabling silicosis. Workers in dusty trades, especially stone cutters, moulders, pottery workers, and similar craftsmen, are usually highly skilled, and it seems unfortunate from a social and economic point of view to deny them employment so long as they are physically able to carry on, especially since the actual disabling qualities of silicosis are in doubt.

000140

They should be denied employment in a dusty trade if that condition is found at pre-employment examination, but they should not be barred from continuing an employment in which they are already engaged. Of course, in such instances you, as engineers, must realize that you have failed, because if you had kept the breathing zone of the worker free from dangerous dusts, silicosis would not be present on physical examination.

In this work of preventing dust diseases in industry, it should be evident that the closest and most intelligent cooperation between the physician and the engineer is necessary. The physician must, through his knowledge and research, tell the engineer what dusts, or, for that matter, what other substances used in industry are harmful. He must tell the engineer how such dusts or other materials enter the body, how they leave the body and what they do in their passages through or their residence in the body.

Must Make Analyses

The engineer must in turn tell the physician of the harmful dusts and other substances surrounding his workers. He must make chemical and petrographic analyses of the dusts, and other indicated analyses of the atmosphere in the workshop. He must make dust counts and check his counts at regular

intervals, conferring with the physician in an effort to discover whether, in the light of their joint knowledge, working conditions are dangerous. He must develop and install carefully designed ventilating equipment. He must arrange for modification of chemical and other industrial processes, where such modification is possible, and must bend his efforts toward removing from the danger zone of the worker the offending substance, whatever it may be.

Too many engineers construe this function loosely. They pass on to the physician as his responsibility certain functions which essentially are theirs; such functions as dust analyses, dust counts, and similar technical duties. All too often it is considered adequate merely to install a fan.

Ventilating devices in dusty work rooms must be constructed only after careful engineering study has given a knowledge of the physical properties of the air and of substances polluting it. It is possible to calculate to a very fine point the volume of air that must be removed from a given spot to remove the dust originating at that place, and the engineer must approach his task from just as scientific an angle as the physician approaches his.

There is no room in industry for hazardous methods on the part of either the physician or the engineer.

ADJOURNMENT

Industrial

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The meeting was called to
Wabetz, Chairman, Indust

Injurious Effects

Division of Labor, St

The inhalation of metal mon cause of illness among occupational groups. Two very reactions may result from containing particulate metal pounds: (a) metal fume transitory, non-fatal disease temporary disability; (b) poisoning, mild, severe, or effect. The same occupation produce both reactions, developing following the exposure, chronic systemic ing later as a result of pr

We may consider metal particles generated by metal in a gaseous state usually accompanied by o

There are two chief physics of metal fumes relationship to the ease will be absorbed: (a) The much finer than atmospheric averaging less than .5 m (b) they tend to flocculate the air as dust. The finer suspended in the air, the required for them to settle the coarser dust particles trapped in the upper respiratory tract, the ciliated cells lining the bronchi, while the fine carried to the terminal lungs. Here they are tak

000141

Industrial Fumes, Gases and Vapors

THURSDAY MORNING SESSION

October 14, 1937

The meeting was called to order by Voyta of Wisconsin, Madison, who presided and Wrabetz, Chairman, Industrial Commission introduced the speakers.

Injurious Effects of Metal Fumes and How to Prevent Them

By ROY R. JONES, M.D.

Division of Labor Standards, U. S. Department of Labor, Washington, D. C.

The inhalation of metal fumes is a common cause of illness among certain occupational groups. Two very different systemic reactions may result from breathing air containing particulate metal or metal compounds: (a) metal fume fever, an acute, transitory, non-fatal disease causing slight or temporary disability; (b) systemic metal poisoning, mild, severe, or even fatal in its effect. The same occupational exposure may produce both reactions, metal fume fever developing following the worker's early exposure, chronic systemic poisoning developing later as a result of prolonged exposure.

We may consider metal fumes as solid particles generated by condensation from metal in a gaseous state. Condensation is usually accompanied by oxidation.

There are two chief physical characteristics of metal fumes which bear a direct relationship to the ease with which they may be absorbed: (a) The solid particles are much finer than atmospheric dust, probably averaging less than .5 micron in diameter; (b) they tend to flocculate and settle out of the air as dust. The finer the solid particles suspended in the air, the longer the time required for them to settle out. Many of the coarser dust particles in the air are trapped in the upper respiratory tract and by the ciliated cells lining the trachea and bronchi, while the finer particles may be carried to the terminal air spaces of the lungs. Here they are taken up by the phago-

cytic cells and are eliminated chiefly by way of the blood and lymph.

Sayers and his associates¹ found that only about 15 per cent of inhaled particulate matter, such as lead dust from automobile exhaust gas, was retained in the lungs, the remainder passing out with the exhaled air. Drinker and his associates² and Brown³ made quantitative measurements of fumes retained in the lungs. They found a direct relationship between the percentage of fumes retained and the size of the particle and the density of the fumes breathed. They also showed that slow deep breathing increased the reaction resulting from inhaling zinc fumes. Such breathing should increase the percentage of particulate matter retained.

Hazardous Processes

For convenience we may place the more common occupational environments which are likely to afford a harmful exposure to metal fumes in three large groups:

1. Smelting of ores and refining of metals.
2. Employment at processes handling molten metal such as molding, cutting, and welding operations.
3. Salvage and cleaning operations, including the burning of metals or metal covered objects, especially by means of acetylene torch or electric arc.

In the first class, the ores or metals processed provide the source for the generation

000142

of fumes. Such operations are usually permanent and exposures tend to be more constant, although as a rule the greatest amount of fumes is generated during tapping operations.

Likewise, in the molding processes the molten metal is the source of metal fumes. In welding, cutting, and salvage operations, the metal fumes may originate from metal products processed, coated surfaces of the metals, fluxes used, or from the coating or core of the electrode used.

These latter operations may provide exposure to a greater variety of toxic metals, but as a rule such exposures are to lesser concentrations. Exposure usually is less regular since the operations vary from time to time both as to extent and raw materials used.

Atmospheric Concentrations

Data relative to the minimum concentrations of metal fumes which will produce metal fume fever are limited. It is believed by some that, except in case of the super-sensitive individual, metal fume fevers can be avoided by keeping atmospheric concentrations below 10 milligrams per cubic meter of air. Drinker and his associates¹ suggest 15 milligrams per cubic meter as a safe limit where workers are exposed to the fumes of zinc oxide, provided the fumes of such impurities as lead, cadmium, and arsenic are not also present in harmful amounts.

Our knowledge of safe limits from the viewpoint of chronic metal poisoning is likewise meager. Prolonged exposure to lead concentrations in the air breathed should be kept below 1.5 milligrams per 10 cubic meters of air.² In the study of chronic mercurialism among fur cutters³ it was found that cases developed after prolonged exposure to atmospheric concentrations varying from .6 to 7.2 milligrams of mercury per 10 cubic meters of air.

Less than 5 per cent of those exposed to concentrations which did not exceed 2 milligrams per 10 cubic meters of air developed symptoms of chronic mercurialism, and all cases that developed under such exposure were mild. Canavan and his associates⁴ reported upon a case of chronic manganese poisoning which developed following exposure to manganese dust, where the concentration in the atmosphere was from 10 to 20 milligrams per cubic meter of air, 9 to 12 per cent of which was manganese.

Metal Fume Fever

A strict interpretation of the term "metal fume fever" does not place it in the class of conditions termed "metal poisoning." The reaction set up in the body is not directly attributable to the toxic metal, or dependent upon the inherent toxicity of the metal particles inhaled. The superficial action of the finely divided metal destroys the tissues, and the absorption of these altered body proteins affects the individual much the same as typhoid inoculation or the injection of other foreign proteins.

Metal fume fever has long been recognized as an industrial disease. Other terms commonly applied to the condition are: "Brass foundry's ague," "brass chills," "zinc fever," or "zinc chills," "spelter shakes," etc. Formerly it was thought due to the poisonous effects of zinc and zinc alloys. Various workers in the past quarter century have shown, however, that it may be produced by the fumes of metals other than zinc; notably copper, magnesium, manganese, and probably lead. Koelsch⁵ in 1923 reported upon the occurrence of metal fume fever among employees in a copper rolling mill.

Investigation showed the men to be working under conditions which caused them to breathe air containing heavy concentrations of copper dust. The symptoms resembled "brass foundry's ague." In his report he quotes Kissalt⁶ as showing that mercury, nickel, and probably other heavy metals when inhaled in vaporized form caused symptoms similar to those of "brass foundry's ague."

Drinker and his associates⁷ in 1927 reported that men experimentally exposed to fumes of magnesium developed the classical symptoms of metal fume fever.

Clinical Picture of Metal Fume Fever

The clinical manifestations of metal fume fever are as follows: At the end of the day or 2 to 12 hours following exposure to metal fumes, the individual notices a dryness of the throat in addition to the metallic taste which most workers commonly experience during exposure. A feeling of tightness of the chest, varying with the exposure, usually indicates the severity of chills and fever which are to follow. In mild cases the individual may not be aware of any fever and may complain only of a chilly sensation, followed by sweating and general weakness.

Exposure to extreme onset of fever and the worker awakens from temperature and chills, far to the chills and attacks of malaria. A cold, nothing in the world hot baths appears to. Toward the end of the sweats profusely and of marked weakness. cases some weakness day. It is commonly to and hot drinks of tea. ceed in partially abate taken at the first sign such as a dry throat the chest. Drinker and their experimental show that even excess individual 2 to 4 hours tered the reactions in:

Examination of the suffering from metal gradual increase in the leukocytes which began the attack and persist the fever has disappeared white blood cells appearing upon the demerit established.

This probably accounts for the characteristic clinical observations are most likely to be a period. More cases occur on the first day or absence of one or two. The condition is frequently affecting new employees returning to work after exposure.

As a rule, gastroenteritis seldom complained of exposure has been affecting the digestive it is well known that in other toxic metals welding and cutting toxic substances from the zinc, as we fluxes which are used.

We have no conclusive chronic effects produced by zinc fumes. brass foundries" showing experiencing attacks of somewhat poorer

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the term "metal fume fever" is in the class of "poisoning," not directed at the metal, or dependent on the metal, but on the action of the tissues, the body protects itself in the same manner as in the action of other poisons.
been recognized in terms of "Brass fever," "zinc fever," etc. For the poisonous effects. Various cases have been produced by zinc; notably, and probably based upon the fact among em-

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Exposure to extreme cold may hasten the onset of fever and chills, but as a rule the worker awakens from sleep with a high temperature and chills, which are quite similar to the chills and fever experienced in attacks of malaria. After they have developed, nothing in the way of extra covers or hot baths appears to affect these chills. Toward the end of the attack the individual sweats profusely and is left with a feeling of marked weakness. In the majority of cases some weakness is still felt the next day. It is commonly believed that hot baths and hot drinks of tea or lemonade may succeed in partially aborting the attacks, if taken at the first sign of respiratory difficulty such as a dry throat or tight sensation in the chest. Drinker and his co-workers¹ by their experimental work were unable to show that even excessive "sweating" of an individual 2 to 4 hours after exposure altered the reactions in any manner.

Examination of the blood of workers suffering from metal fume fever shows a gradual increase in the polymorphonuclear leukocytes which begins toward the end of the attack and persists for some time after the fever has disappeared. This increase in white blood cells appears to have a direct bearing upon the degree of temporary immunity established.

This probably accounts for another characteristic clinical observation. The workers are most likely to be affected after a vacation period. More cases develop after a holiday or on the first day of the week, after an absence of one or two days from exposure. The condition is found more frequently affecting new employees or old employees returning to work after a prolonged absence from exposure.

As a rule, gastrointestinal disturbances are seldom complained of except in cases where exposure has been to fumes of substances affecting the digestive system. For instance, it is well known that zinc coated metals contain other toxic metals as impurities. The welding and cutting of these release the toxic substances together with the fumes from the zinc, as well as fumes from certain fluxes which are used.

We have no conclusive evidence regarding chronic effects produced by repeated exposure to zinc fumes. A study of workers in brass foundries² showed that the group experiencing attacks of metal fume fever were in somewhat poorer physical condition than

were those who did not develop fever and chills. Theoretically, those experiencing irregular exposures and complaining of repeated attacks of fever and chills which leave them in a generally weakened condition would, in a measure, develop lessened resistance to acute and chronic infection.

Detailed information regarding the pathology of metal fume fever is not available. A search of the literature at hand fails to show any record of death from metal fume fever, uncomplicated. The illness is of such a transitory nature that most of our knowledge regarding blood changes is the result of experimental work and isolated case reports.

In view of the fact that zinc is relatively nontoxic, and of the conclusions expressed by Drinker and Fairhall³ regarding the hygienic position of zinc, it is difficult to show why chronic illness should result from exposures producing simple metal fume fever. It would seem, however, that in consideration of the recent work showing the role played by zinc in the treatment of diabetes with insulin, possibly some investigation should be made to determine if exposure to metal fumes capable of producing metal fume fever may not affect the endocrine system, especially in persons with some metabolic disturbances, such as potential diabetes or thyroid dysfunction.

Differential Diagnosis

Metal fume fever may sometimes be overlooked, unless the physician considers occupational environment. The condition may simulate attacks of grippe or bronchitis; or, if in a malarial region it may be mistaken for a fresh attack or a relapse from a former attack of malaria. Careful study of the blood will aid in diagnosis; those suffering with grippe or bronchitis seldom show the increase in white cells usually found present in persons suffering from metal fume fever, while those with malaria usually show the organisms present in their blood. The duration of symptoms is usually less in the case of metal fume fever.

However, it is not uncommon to find persistent rales upon examination of the chest several days after an attack. However, in persons with grippe or bronchitis, these rales are usually associated with a slight elevation of temperature, which is not found persisting in metal fume fever, uncomplicated. Prolonged exposure producing metal

000144

fume fever may be followed by attacks of bronchial pneumonia, as a result of pulmonary irritation and infective organisms commonly present in the respiratory tract.

Metal particles are not the only injurious substance present in fumes generated by some industrial processes. The use of an acetylene torch in a space with poor ventilation has resulted in incomplete combustion of the gas and the liberation of carbon monoxide gas.

Doig and McLaughlin¹² reported upon an illness affecting welders of galvanized metal, using an electric arc. The men complained of lung irritation so severe that their sputum was often blood-tinged. Investigation showed this to be caused by excessive concentrations of nitrous fumes generated by the processes. X-ray examination of the chests of several in this group, who had been employed for many years, showed changes thought due either to the prolonged irritation caused by nitrous fumes, or possibly to the fumes of silica inhaled. The electrodes used were silica-coated.

Chronic Poisoning by Metal Fumes

It is generally recognized that the most serious exposures to toxic metals in industry occur in occupations where the worker breathes air contaminated with these poisonous substances. It is true systemic poisoning by metals may develop in an acute or sub-acute form, as a result of massive exposure. However, the vast majority of such cases are chronic, caused by frequent and prolonged exposure which leads to an accumulation of the toxic metal in the body. Poisons entering the body by way of the lungs, to be eliminated must be taken up by the blood and lymph. When present in the blood, they are carried to all parts of the body.

Poisons taken in by way of the mouth may not be absorbed but be passed out with the feces. If absorbed, it may be trapped in the liver and returned to the intestinal tract in the bile, and eliminated with the feces. Some, it is true, may be transferred by the blood to distant organs. Most heavy metals and their salts are true protoplasmic poisons. Some, such as iron and zinc, are more common constituents of body tissue. The action of these toxic metals is generally cumulative and no immunity, temporary or permanent, may be established if exposure is to sufficient concentrations.

Because of the fact that metals are usually

toxic, the possibility of poisoning from inhaling fumes generated in the processing of any metal should always be given consideration. While zinc itself may be relatively nontoxic, it is seldom used in industry in a form free from toxic substances such as lead, arsenic, selenium, cadmium, and many others.

Following the initial attack of metal fume fever, because of the temporary immunity which they develop, workers may continue under conditions which caused the attack and not suffer a recurrence. It must be borne in mind that these very conditions may afford exposure to other toxic metals which have cumulative effects and later lead to a chronic poisoning. If atmospheric concentrations of the fumes are kept below those capable of producing metal fume fever in the new worker, the chances of chronic poisoning by the toxic metals present as impurities are definitely reduced.

On the other hand, however, these impurities may be present in amounts sufficient to lead to chronic illnesses later, although the concentration of fumes has never produced metal fume fever.

Clinical Picture of Chronic Poisoning by Metal Fumes

The symptoms produced by poisoning from metal fumes will vary. Some metals affect chiefly the nervous system, others the lining of the blood capillaries, while others exert most characteristic injury upon the blood-forming organs.

Generally speaking, the clinical picture of metal fume fever, regardless of the metal responsible, varies only in severity, while that of metal poisoning per se varies with the particular metal fume inhaled and with the degree of exposure. For example, massive doses of lead fumes inhaled may produce such acute conditions as lead encephalitis and severe gastrointestinal complications; while continued exposure to smaller concentrations will cause such chronic changes as anemia, lead palsy, and chronic nephritis.

Exposure to heavy concentrations of mercury vapor leads to acute nephritis, salivation, and diarrhea, while the more common industrial exposures to but slight concentrations will eventually produce the typical mercury tremor and psychic changes characteristic of chronic mercurialism. Strictly

speaking, there are no signs of poisoning from metals without reference to other causes. For this reason always a matter of differential diagnosis, metal poisoning can only be detected by careful consideration of the occupational history, medical and laboratory findings.

While laboratory findings are an important factor in diagnosis, they are often relied upon as the sole

Prevention of Metal Poisoning

While the responsibility for preventing health hazards associated with the fumes of toxic metals lies with the employer, effective measures can only be secured by the hearty cooperation of the State, and other agencies. Three fundamental principles must be followed: most to actual preventive measures, housekeeping, supported by medical supervision.

Good Housekeeping

We think of good housekeeping as applying to clean floors, walls, materials, tools, and premises maintained in good order and no overcrowding of workers and materials. All these factors can be controlled by the concentration of the atmosphere, but seldom processes so effective as to not escape into the general room. From here they may contaminate the workers. So general housekeeping is a factor in good

The provision of adequate ventilation is a prerequisite for good housekeeping. Lockers and showers are necessary for the safe processes.

As a rule sweeping is done after regular work can be more thorough but what is more important will not be subjected to atmospheric contamination methods. If vacuum used, accumulated dust and safely removed.

000145

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burgh, has expressed the considered opinion of a body of outstanding dust experts as follows:

"There is no satisfactory medical answer at present to this question, but the engineer is making a bad mistake if he lets men breathe heavy dust concentrations of any material. If no other reason for dust control can be found, then one should read transcripts of some of the recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. The courts and compensation boards are not impressed with subtle distinctions between dusts with 10 per cent and 40 per cent quartz, especially when medical experts are reluctant to make definite statements as to the comparative significance of such differences.

"It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument."

It should also be remembered that the inhaling of dust is by no means its only hazard in industrial work that may require compensation payment; and even here the harmful effect of breathing dust is not necessarily confined to the lungs, as some kinds of dust are known to have detrimental health effect on the nose, throat, and bronchial passages as well as (indirectly) on the heart, stomach, and possibly other internal organs. Externally, dust may cause injury to the eyes, ears, and skin; and some dusts, in contact with the perspiration, are absorbed with definite harm to the health of the victim.

Dust Cuts Visibility

Moreover, heavy concentrations of dust in the air reduce visibility materially. Obviously, in industrial occupations in which but limited amounts of natural light are available or in which artificial light is used entirely, any decrease in visibility due to air-dust concentrations (and the decrease in visibility may, under some circumstances, amount to 75 per cent or more) is likely to result in materially reducing efficiency and also in the more frequent occurrence of accidents accompanied by an increase in compensation commitments. Some dusts (coal, zinc, aluminum, and scores of others, mineral and nonmineral) are explosive and many

are subject to spontaneous combustion with consequent hazards to health, safety, and property. Many dusts have detrimental effects of various kinds on property as distinguished from persons. Machinery, growing vegetation, animals, dwelling houses, and other types of property are damaged by dusts, and compensation of some kind often is obtained from industrial concerns through damage suits or otherwise.

From the viewpoint of respiratory harmfulness, it is generally stated (though actually knowledge on this point is by no means certain) that the particle sizes of dust (such as that of free silica) that affect health adversely upon entering the lungs are those that are less than 10 microns in size, different persons having different ideas as to what the maximum may be—10 microns or 8 or 6, and some say that the harm really is done by particles less than 2 microns in size. As against this, it is stated that fibers of asbestos dust as long as 200 microns have been found in the lungs of men, and that undoubtedly these long asbestos fibers exerted at least some detrimental effect.

Since a micron is only about one twenty-five-thousandth of an inch, or much smaller than the naked eye can see, it is usually assumed that the larger dust particles that can be seen floating in air, and which settle out relatively fast are not harmful to health. Certainly, this is not so, as the larger particles that float in the air (some of them 100 or more microns in size), if present in considerable quantities clog the air passages to the lungs, some of which have agencies that under ordinary conditions intercept dust particles before they can reach the lungs and this clogging then allows the smaller and probably most dangerous dust to enter the lungs unimpeded.

A common-sense opinion as to what constitutes an atmosphere so dusty that dust-prevention action should be taken is that any atmosphere in which dust can be seen by the naked eye is too dusty, not only for health but also, at least in many cases, for safety and efficiency. If the visible dust is eliminated, much of the invisible or probably most dangerous dust will unquestionably have also been removed and very likely the health as well as other hazards much minimized or even removed.

After the visible dust has been removed, it may be necessary, under some conditions or with some types of dust, to make more in-

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tricate investigations as to the occurrence of invisible dust, using the impinger, konimeter, or other instruments; but unless litigation is in effect or threatened, those intricate studies are relatively unimportant if the visible dust is eliminated from the air of working places.

Prevention Is Best

Manifestly, if dust is not produced, it can't get into the air or become harmful otherwise; and some relief from dust troubles in industry can be achieved by using construction, practices, processes, or equipment that tend to eliminate dust formation.

In designing and equipping the places in which employees must work, the forward-looking industrialist will be wise to prevent the making of dust or to control it if it must be made, by using machinery, methods, processes and construction with dust-eliminating characteristics rather than those that produce or spread dust, even though some additional expense in construction or operation may attach to the dust-prevention features. The emphasis now being placed on dust in its various phases and the expense which dust may cause make it almost imperative that in the future much more thought be given to dust prevention and handling than has been given in the past.

For instance, processes or practices that produce excessive dust should be discarded for others that produce less dust, or they should be isolated somehow, such as by housing them tightly in a separate part of the plant or using them at times when the least number of persons would be exposed to them or when there is ample time to remove the dust from the atmosphere of the working places. Such installations or practices must be operated efficiently at all times, however. Common sense should be used in handling a dust control device or method; certainly it is foolish to use an elaborate exhaust system to take the dust out of part of an establishment and then exhaust the dust-laden air at such point or in such manner that it will be taken into the same or some other part of the establishment or into an adjacent one through doors and windows.

If dust must be formed, several effective methods are available to prevent the dissemination of dust into the air or into places where it may cause trouble. Among these are wet methods, such as wet drilling in-

stead of dry drilling, wet crushing instead of dry crushing, wetting or washing down floors, walls, and rock faces. In general the use of water in industrial processes and otherwise is one of the most effective available aids in the prevention of air dustiness, even though in some cases wet drilling does give off some dust. Notwithstanding a growing tendency in some quarters to decry the effectiveness of wet methods, up to now the use of water is probably our best defense against dust dissemination, especially in mining and tunneling.

Dust-exhaust devices, such as hoods, traps for drilling, etc., have a definite place in dust control, particularly in surface plants and operations. Under some conditions exhaust systems, when well installed and kept in repair and operation, not only remove dust but also more than pay for themselves in dollars and cents value of recovered dust. It costs approximately \$7,000 to install such a device in a surface plant processing one of the metals, and the value of the dust recovered daily averaged about \$25. In addition, the device kept the air of the plant as well as the surrounding walls and other surfaces practically free of dust.

On the other hand, the use of dust traps in dry drilling, while definitely applicable to certain types of surface or near-surface rock-excavation work, has not been found applicable to general rock-drilling practice in underground work. There are several reasons for this, some of which may be overcome in time.

Some types of rock cannot be drilled dry with any degree of effectiveness, and as yet the available types of rock-drilling traps are not workable with wet drilling; if dry drilling can be done, the traps ordinarily will do a good job of removing the dust from drilling, but this will leave the rock surfaces (top, sides, and floor in many cases) dry, and subsequent operations (blasting, mucking, timbering, hauling, etc.) will throw into the air dust certain to be created in large quantities by the other processes. The dust thus thrown into the air will settle on dry surfaces, ready to be thrown into suspension subsequently by any or all activities. Dust traps are somewhat cumbersome, especially when used in the more or less confined places in mining and tunneling.

However, dust traps with dry drilling have definite applicability for use in surface or near-surface operations where dry drilling

can be done, and have no advantage over wet drilling in such cases.

Good Ventilation

Ventilation is probably the most effective dust-control practice in surface plants, though it is not so effective in others. If applied effectively, it removes dust from the air or it keeps it so diluted as to be harmless to workers. It also dilutes dust hazards, including spontaneous combustion, in some instances. In others, where it should be induced, it is more effective. This is true in underground work where temperature, air, dust, water or other conditions of the surrounding

To obtain really good ventilation in such work as tunneling, which is difficult usually because of the opening is driven in pairs as in coal mines, flows in one opening and returns in the other. About by dust may be removed in many of the operations of the underground. The suggestion will raise the question of believing that in the definite dollars and cents value of a parallel-opening system, ventilation, health, and safety advantages, were used in one-opening system, the real advantage the parallel-opening system has been customary.

Dry drilling is common in mining, tunneling, and it continues to be used in the United States; but it is not allowed at all, it is not used in the case of auger twist drills, and the use of up-to-date dust

Wet drilling is common in the States, with water in the drill steel by it is now under fire

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et crushing instead of washing down faces. In general the trial processes and most effective availability of air dustiness wet drilling does. Notwithstanding, a me quarters to decay methods, up to now ably our best defense on, especially in min-

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can be done, and have numerous advantages over wet drilling, especially in very cold weather.

Good Ventilation Needed

Ventilation is probably the most effective dust-control practice available for many industries, though it ranks second to wet methods in others. Where ventilation can be applied effectively, dust can be removed from the air or its concentration can be kept so diluted as to render it practically harmless to workers; ventilation can minimize dust hazards of almost all kinds, including spontaneous combustion, though it may enhance hazards of dust explosibility in some instances. In some cases ventilation should be induced by exhaust methods, but in others forced or blowing systems are the more effective, this being particularly true in underground work in places having high-temperature air due to rock or dripping water or other condition, such as rapid oxidation of surrounding rock or timber.

To obtain really effective ventilation in such work as tunneling and metal mining is difficult usually because ordinarily but one opening is driven instead of having workings in pairs as in coal mining, where fresh air flows in one opening and return or contaminated air in the other. Conditions brought about by dust may force the use of parallel openings in many tunneling and metal-mining operations of the future, and, notwithstanding the violent objections this suggestion will raise, there are good reasons for believing that in many cases there would be definite dollars and cents savings if the parallel-opening system, with its numerous ventilation, health, drainage, and other advantages, were used instead of the present one-opening system, with numerous disadvantages and hazards and with about its only real advantage the fact that its use is and has been customary.

Dry drilling is unquestionably the dustiest work in mining, tunneling and quarrying, and it continues to be used far too much in the United States; certainly, if dry drilling is allowed at all, it should be done only with auger twist drills or with the simultaneous use of up-to-date dust traps.

Wet drilling as practiced in the United States, with water forced or drawn through the drill steel by means of compressed air, is now under fire as producing relatively

large quantities of dust even though the material floating in the air usually is wet; some of this criticism is undeserved but, some of it is legitimate. The trouble is due largely to the fact that the holes are collared or started dry and, in some cases at least, are drilled dry for several inches after starting, and the dust created by this dry starting impregnates the usually stagnant air of the ordinary underground-tunnel or metal-mine working place for much if not most of the working shift.

In some cases the driller drastically limits the amount of water sent through the drill steel and, while nominally drilling wet, the actual practice is closely analogous to dry drilling with compressed air, which flows through the drill steel and forces out of the drill hole and into the air of the working place undue quantities of water-entrained dust or particles. In some cases when the drill is out of repair, the driller allows far too much compressed air to flow through the drill steel.

When present types of wet drills are used properly, the dust from drilling can be kept within reasonable limits, and this is actually being done by numerous alert and conscientious mining and tunneling companies. Some companies in the United States and Canada are experimenting with rock drills that do not allow compressed air to go through the drill steel but require the water to be forced through the steel by its own pressure; such drills are said to produce less dust than the usual types in which water is sent through the steel by compressed air, but the practicability of the newer type of drill is questionable and it has been used relatively little in the United States or Canada.

Must Use Judgment

However, air dustiness can be kept well within safe limits if modern types of wet drills are operated with care and judgment in collaring wet with plenty of clean dirt-free water; if the drills are kept in good repair; if the proportion of water and compressed air flowing through the drill steel are adequately regulated; if the exhaust from the drill is prevented from impinging on nearby dusty surfaces of muck piles, floors, walls, or timbers thereby throwing dust into the air; and, insofar as feasible, the dustiness of upper holes is reduced to a minimum in upper holes, whether

000162

Next to dry drilling, blasting causes more finely divided dust to be thrown into working places than anything else; and, in addition to throwing violently into the surrounding air immense quantities of finely divided dust, blasting with the heavy charges of explosive required in many mining and tunneling operations also impregnates the surrounding air as well as the muck piles with considerable quantities of poisonous gases, such as carbon monoxide, oxides of nitrogen and, in some kinds of rock, hydrogen sulphate and other dangerous sulphurous fumes, practically all of which occur in such quantities and percentages under some circumstances as to asphyxiate persons who may breathe them or to cause serious illness, often of a more or less permanent character. Many persons who have studied the incidence of dust disease are of the opinion that the breathing of even small quantities or percentages of extraneous or harmful gases, such as carbon monoxide, oxides of nitrogen, hydrogen sulphide, etc., inflames or otherwise adversely affects the respiratory organs, especially the lungs, and makes them much more easily and readily susceptible to harm from the breathing of dust particles.

Past blasting practice most certainly must be modified and reformed if the employer is to avoid heavy penalties in compensation and other charges due to the inclusion of legislation on occupational diseases (one being dust disease) in the laws of the various States. If at all feasible, blasting should be done at the end of the working shift or on an off shift, and the dust- and gas-laden air should be removed or thoroughly diluted before the men return to work.

Ventilation is, of course, an essential agency in cleansing the air where blasting has been done, but in addition to ventilating the place it should be thoroughly wetted (walls, floors, roof or top, timbers, etc.) before blasting is done, and a water blast should be kept in effect during and after the blasting; the region should be thoroughly wetted upon return to the face region after blasting, and the muck pile should be kept well wetted at all times while loading it out, as the water not only tends to allay the dust but also either absorbs or otherwise aids in the dilution or elimination of harmful or poisonous gases from blasting, which usually cling to the blasted material.

In general the larger the quantity of explosive used, the more finely divided the blasted material, the more heavily the air is impregnated with dust and smoke, and the greater the quantity of poisonous gases let at the places; hence, methods should be used which will tend to reduce the quantity of explosives used and of gases and dust produced. In this it will be found that the use of stemming or of some types of blaster plugs now available will more definitely confine the explosive; hence, increase its efficiency and reduce the quantity of explosive used and also reduce the amount of poisonous gas produced and possibly reduce the violence of the blast and its tendency to produce dust and disseminate it into the surrounding air.

And it would be well for users of explosives to investigate types of explosives that are known to give off minimum quantities of harmful gases on detonation and to use them; also the elimination of the use of fuse and the substitution of electric blasting would aid in reducing the amount of poisonous gases from blasting. Explosives that have been held in storage too long or that have been stored under unfavorable conditions as to moisture and temperature, are likely to give off maximum quantities of harmful gases if they degenerate at all; hence utmost care should be taken in the storage of explosives and to see that they are not held in storage too long before being used.

feasible, in dust-tight structures, the tightness maintained; ledges or dust may lodge and be thrown into the air by movement, should be change of opportunity for such accumulation cannot be done, such cleaned periodically by washing down, or by being a relatively poor, employed only when as possible are present kept as free of dust as by washing them with air for the working place from dusty sources.

Physical examination is an important part in the determination of harm from dust in the workplace. Controversy has been created by them that their effectiveness is nullified. Unquestionably, dust may be found in the workplace. It is examined by a physician to employment, it reveals the presence of the person should not be especially true if tubercle. At six- or twelve-month intervals in dusty industry, rigid physical examination is shown to be developing. It is transferred to non-dust industry if available. Handling

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My personal experience is mainly in work of bridge building. Our work falls into these two classes. River work consists of rip-rapping river banks and the U. S. Government Bridge Classification includes highway bridges of the type having their foundations in "open dredged." River work, being done in the open, is done with a plant and with a large

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Speaking, there are no signs or symptoms of poisoning from metals which can not be due to other causes. For this reason diagnosis is always a matter of differential diagnosis and metal poisoning can only be established by careful consideration of all factors, including occupational history, medical history, clinical and laboratory findings.

While laboratory findings are a very important factor in diagnosis, they can not be relied upon as the sole evidence necessary.

Prevention of Metal Fume Poisoning

While the responsibility of controlling health hazards associated with exposure to fumes of toxic metals rests primarily upon the employer, effective elimination of such hazards can only be secured by the wholehearted cooperation of employers, employees, the State, and other regulatory inspection agencies. Three fundamentals contribute most to actual prevention. They are: Good housekeeping, supported by engineering control of hazardous processes, and intelligent medical supervision.

Good Housekeeping

We think of good housekeeping as applying to clean floors and work benches; materials, tools, and processes arranged and maintained in good order; adequate lighting, and no overcrowding of work places by men and materials. All these will do much to lessen the concentration of toxic fumes in the atmosphere, but seldom is the control of processes so effective that some fumes do not escape into the general air of the workroom. From here they may be inhaled, or may contaminate the bodies and clothes of the workers. So general workroom ventilation is a factor in good housekeeping.

The provision of adequate washing facilities is a prerequisite. Under certain conditions lockers and showers for workers are necessary for the safe operation of many processes.

As a rule sweeping and cleaning should be done after regular working hours. Not only can a more thorough job be accomplished, but what is more important, other workers will not be subjected to any increase in atmospheric contaminants occasioned by cleaning methods. If vacuum or wet methods are used, accumulated dust is more effectively and safely removed.

Engineering Control

It has been found practical to exhaust, locally, most processes generating metal fumes so that the toxic fume is trapped at its source and does not gain entrance to the workroom atmosphere. This is done by means of hoods or enclosed processes. Special hazardous processes can usually be isolated in the plant, thereby making potential exposure of all employees unnecessary.

Both local exhaust and enclosed methods are more effective if special attention is given to general workroom ventilation. Disposal of fumes trapped by enclosed processes and local exhaust or isolation methods requires that attention be given that such wastes do not contaminate the air drawn into the work places by general ventilation.

Medical Control

Adequate medical supervision entails special care in the placement of workers, and should not be aimed at the selection of only super-men, since it is practical to make work places safe for the average man. Individuals with serious kidney, respiratory, or other systemic diseases should not be placed where they may be exposed even to minimum concentrations of toxic fumes.

Where processes are known to be potentially hazardous, an important check on the efficiency of engineering control is gained through regular periodic examination of workers. By this practice, in many instances, not only will evidence of absorption be detected before serious injury has resulted, but an opportunity is afforded to correct control measures so effectively that the workers showing early signs of absorption may safely continue at their regular jobs. Routine records of illness should be kept.

Any abnormal rate of absenteeism due to illness among an occupational group, regardless of the diagnosis reported, should call for special investigation to determine if there are any environmental conditions aggravating the primary illness.

Personal Protective Equipment

If proper attention is given to the three fundamentals mentioned—good housekeeping, medical and engineering control—only specific and unusual emergency exposure will call for the provision of personal protective equipment.

The masks or respirators provided work-

000146

ers who must necessarily be exposed to metal fumes should be of special construction and adapted to the processes and materials used. The United State Bureau of Mines¹⁴ has, after testing, approved certain types of masks for workers exposed to specific metal fumes.

No filter type of respirator capable of protection against toxic metal fumes has been submitted for approval. While two or three filter type respirators have been approved for protection against lead dust, the use of which may in a small way reduce the hazard of fumes, they cannot be relied upon for full protection. Filter type respirators approved for protection against nuisance and pneumoconiosis-producing dusts will not protect the user from toxic fumes.

Several of the hose-line or positive pressure type masks have been approved, but there are certain limitations to their application which make them impractical for use in some kinds of work.

Substitution

In a vast majority of cases, resort to substitution is an impractical method of eliminating health hazards due to metal fumes. The raw materials used usually have special application. Furthermore, substitution is often a dangerous practice, even though it is practical. Instances may be cited where the substituted product has proven equally as dangerous as the one it replaced, the only difference being that less was known at the time concerning its toxic properties.

Electroplating Fumes and Vapors and Their Elimination

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The industrial physician is responsible for the health of all employees in his plant, in so far as their health may be affected by their occupations and their environment. Consequently he must be familiar with the various jobs and conditions under which the men work to know definitely the associated health hazards. He must work closely with the safety, maintenance, chemical and purchasing departments to keep himself in-

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- ⁶ Lead Poisoning in a Storage Battery Plant. Public Health Bulletin No. 205, June, 1933.
- ⁷ A study of Chronic Mercurialism in the Hatters Fur-Cutting Industry. Public Health Bulletin No. 234.
- ⁸ Chronic Manganese Poisoning. Report of a Case with Autopsy Findings. Canavan, M. M., Cobb, S., Drinker, C. K.: Arch. Neurol. and Psychiat., 9:270, 1934.
- ⁹ Metal Fume Fever. Koelsch, F. Jour. Ind. Hyg., Vol. 5, p. 87, July, 1923.
- ¹⁰ Ueber das Giessfieber und verwandte gewerbliche Metalldampfinhalationskrankheiten. Kissalt, E. Ztschr. f. Hyg., 1912, 71, 472.
- ¹¹ Metal Fume Fever. III. The Effects of Inhaling Magnesium Oxide Fume. P. Drinker, Thomson, R. M., Finn, J. L. Jour. Ind. Hyg., Vol. 9, No. 9, 1927.
- ¹² Health Hazards in a Brass Foundry. Public Health Bulletin No. 157.
- ¹³ Zinc in Relation to General and Industrial Hygiene. C. K. Drinker, L. T. Fairhall. Public Health Reports, Vol. 48, No. 32, Aug. 1933.
- ¹⁴ X-Ray Appearances of the Lungs of Electric Arc Welders. A. T. Doig and A. I. G. McLaughlin. Lancet, April 4, 1936, p. 771.
- ¹⁵ List of Devices for Respiratory Protection Approved by the U. S. Bureau of Mines. W. P. Yant. Bureau of Mines Information Circular No. 6913.

formed on changes in methods and materials that may influence those hazards.

Thus fortified, the physician occupies a strategic position in the hospital, as the employee invariably comes to him first with complaints which he may associate with his work, which are of a nature that would warrant an investigation which may lead to the discovery of an unhealthy condition.

One of the processes which may be sus-

pected of involving a health hazard is the electro disposition of metal. metal for plating as well as during operation, and in the treatment of waste material after plating. chemicals are used, such as alkalis, metals and salts, and offensive fumes and vapors. While it is true our prime interest is in the injurious fumes and vapors, also interest ourselves in the offensive types, since they reflect the worker's mental attitude, giving satisfaction which in turn makes efficient work.

Poison is commonly introduced into the body by three routes, ingestive, mouth, absorption through the skin, and inhalation through the lungs. In our greatest hazard lies in the ingestive route; the ingestion and absorption are of lesser importance.

Fumes and vapors, such as lead, may enter the respiratory tract and produce local reactions in the throat and lungs, while others, such as cyanic acid pass through the blood stream, producing any local symptoms.

Skin absorption is important with the coal tar derivatives, benzene and xylene and the petroleum products as carbon tetrachloride and trichloroethylene. Since these are all volatile, they may occur by inhalation as well as

Ingestion Is Rare

Ingestion of poison by mouth is usually the result of accident. However, in the lead industry, rigid precautions must be taken to prevent the ingestion of lead. It has been deposited on the body of men while working at the tanks.

In general in all electrolytic processes only two gases are liberated, anode and hydrogen at the cathode. The anode efficiency is always relatively low. The fact that the gases are in the relation of two hydrogen to one oxygen at the anode is compared with that at the cathode.

The amount of oxygen generated, as such, is of no consequence.

000147

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WILLIAM P. YANT, Mine Safety Appliances Co., Pittsburgh, Pa.

October 13, 1937

A report of the address delivered at the meeting by Elmer A. Holbrook, dean of the Schools of Engineering and Mines, University of Pittsburgh, Pittsburgh, Pa., will be found elsewhere in this record.

Other sessions sponsored by the ASSE Engineering Section included those on "Safe Use of Air," "Industrial Doses," "Pressure Vessels," "Industrial Fumes, Gases and Vapors," "Safety Training," and "Safety Inspection."

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We did not go far
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was equally potent
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I notice with pleasure the use of the term "engineering of safety." There is no doubt that one must go to college to become an engineer. Nevertheless, it is perhaps the place where one learns how to design things or of the thousands of safety that we are learning. He learns the conclusions from his own later in practice.

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feasible, in dust-tight compartments or
structures, the tightness of which should be
maintained; ledges or surfaces on which
dust may lodge and accumulate, to be
thrown into the air by some shock or move-
ment, should be changed to prevent oppor-
tunity for such accumulation, or, if this
cannot be done, such surfaces should be
cleaned periodically by vacuum process, by
washing down, or by sweeping (the latter
being a relatively poor method, and should be
employed only when as few of other workers
as possible are present); floors should be
kept as free of dust as possible preferably
by washing them with water; and, certainly,
air for the working places should not come
from dusty sources.

Physical examinations should play an im-
portant part in the drive to minimize health
harm from dust in industry, but so much
controversy has been aroused because of
them that their effectiveness has been largely
nullified. Unquestionably, every person em-
ployed in an industry where considerable
dust may be found in the air should be rig-
idly examined by a competent doctor pre-
vious to employment, and if the examination
reveals the presence of respiratory trouble,
the person should not be employed; this is
especially true if tuberculosis is indicated.
At six- or twelve-month intervals every per-
son in dusty industry should submit to a
rigid physical examination; and if disease is
shown to be developing, the victim should be
transferred to nondusty employment if such
is available. Handling physical examinations

in a manner fair to the worker as well as to
the employer should be worked out, and it
must be admitted that to date this has not
been done at all adequately.

Prevention of dust disease is chiefly an
employer responsibility he should shoulder
willingly, not only to safeguard the health of
persons in his employ but also to relieve his
firm of the heavy financial burden likely to
be thrust upon it by compensation or legal
authorities, should employees become af-
flicted with dust disease; and when one takes
into account how little is known as to the
cause of the disease and how to relieve it if
it is incurred, it would seem to be the acme
of common sense to do anything practicable
to reduce the dust content of the air of
places where employees must work. This
does not mean that the employee should not
help himself, as it is manifestly as much to
the interest of the employee to avoid dust
or any other occupational disease as to avoid
having accidents. However, information as
to occupational disease (including dust dis-
ease) is not readily available to the worker
in understandable form, and the employer
should carry on an educational campaign to
inform his safety and operating officials
about occupational disease matters and to
have them transmit the information to the
workers so the latter can cooperate whole-
heartedly in trying to eradicate these dread
diseases from industry or at least control
them to a far greater extent than has been
done.

Safe Practices in Use of Heavy Construction Equipment

By E. A. BLANPIED

Safety Engineer of Kansas City Bridge Co., Kansas City, Mo.

My personal experience has been confined
mainly to work of river improvement and
bridge building. Our records are divided
into these two classes.

River work consists of driving pile dikes
and rip-rapping river banks, generally for
the U. S. Government.

Bridge classification covers railroad and
highway bridges of the heavier type includ-
ing their foundations, both "pneumatic" and
"open dredged."

River work, being mostly done by floating
dredges and with a large percentage of un-

skilled labor, differs greatly from the more
complicated bridge work which uses mostly
skilled and semi-skilled labor under greater
hazards.

The bridge classification is sub-divided into
erection and foundation as each has its own
special hazards and treatment.

River work has been the subject of ex-
tensive research along accident prevention
lines by the U. S. Corps of Engineers and
most of the fatalities are due to drowning.
Special safety requirements, however, this
work have been contributed by being

000174

handy man about the drafts goes into the dispensary with a fine itching rash. The nurse notes the condition of the work. He states he has 10 years and has been doing the work. He has been out of work. He does not think he is due to poison ivy, although he does not know what it looks like at present but will be back soon. The nurse knows the location of the drafting room. Upon inquiry finds that a person is to carry blue prints to the room. A new process has been developed for blue printing within the last year. It is given routine preliminary

attention is submitted to the doctor. The extent to which the nurse enters into the sickness prevention program depends upon the type of industrial medical service maintained. Some industrial plants maintain a nurse primarily for their Employees' Benefit Association, and thus her work is chiefly that of welfare. She administers not only to the members, but to their families as well. What a fine opportunity she has to influence such employees and their families to a better understanding of good health and better living. For after all, the problem of sickness prevention concerns not only the individual employee, but also his family.

ance of occupational diseases is overlooked now that so much is in the press on the subject. Approximately 50 million people are employed in the U. S. at the present time, about 15 million are in industry. A statement is made in the U. S. Public Health report that we are spending five billion dollars annually for compensation and other injuries and occupational diseases.

only a small percentage of this for occupational diseases, while in a much higher figure. But toward a reversal of this. Accidents are controlled to a great extent. Cost is decreasing, while occupational diseases, though probably not increasing, are certainly receiving a great deal more attention than heretofore.

tries to state how many states now

provide compensation for industrial disease disability at a time when new legislation is being enacted so rapidly, but most of the important industrial states now compensate for some or all of the conditions which can be attributed to occupational diseases. Some provide blanket coverage for all such conditions, while others name specific diseases or specific occupations. There have been increases to both employee and employer, but with time and increased study of conditions

we shall eventually arrive at fairer, more equitable adjustments.

The Industrial Nurse finds herself today in this arena of changing policies and evolutionary social adjustment. It is her privilege to be one of the connecting links between employee and employer. If she is the type that commands the respect and trust of the men and realizes her responsibility to them, she will likewise be most valuable to her employer.

The Nurse's Part in the Sickness Prevention Program

By PHOEBE BROWN, R.N.

Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

The extent to which the nurse enters into the sickness prevention program depends upon the type of industrial medical service maintained.

Some industrial plants maintain a nurse primarily for their Employees' Benefit Association, and thus her work is chiefly that of welfare. She administers not only to the members, but to their families as well. What a fine opportunity she has to influence such employees and their families to a better understanding of good health and better living. For after all, the problem of sickness prevention concerns not only the individual employee, but also his family.

To fill her place successfully in such a program the nurse must recognize one basic principle—she must be a humanitarian, and regardless of the problem confronting her she must give relief through aid or counsel, whichever the case may be. She must have knowledge of the personnel she serves, their modes of living, their idiosyncrasies, their families and environments. By keeping her ear to the ground constantly she learns of their problems so that she may then solve them.

Naturally a knowledge of the community served is vital, for often through constructive criticism she is able to elevate the health standards through better sanitation and civic pride.

Perhaps a better conception of the sickness prevention program in connection with welfare work may be had by actual case analysis:

Not long ago I was called to the home of an employee who had been reported sick at frequent intervals during the past two years. He was underweight, nervous, and irritable. On my first visit he was confined to bed and vomiting excessively. His wife informed me that he had attacks of this type periodically. He would not have a doctor, because his doctor did nothing for him except give him a prescription that cost too much and tell him to be careful what he ate.

While in the attack he was careful enough, for he ate nothing for two or three days; but as soon as the illness was over he went back to his old diet of meat, potatoes, plenty of spices and relishes, copious amounts of coffee, two packages of cigarettes a day, plus a goodly amount of beer each week-end.

At one time the doctor had said he should have an X-ray of the stomach, but he complained that this would cost him \$40 which he couldn't afford, and anyway he couldn't get away from work when he wasn't sick.

I finally made him realize that he was losing much more time and money being ill every two or three months, losing four or five days at a time, than if he were to find out just what did ail him and then do something about it.

I took him to a clinic which was conducted on a part-payment basis, and complete examination was made with X-rays and blood work. After he was assured of the necessity of a proper diet, his attacks became less frequent, he gained weight and was a much pleasanter fellow at work.

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In another instance an employee's wife had undergone an operation at a local hospital. Visiting her later at home, I learned that she was recovering satisfactorily but that there were desperate financial troubles. The husband earned 92 dollars a month. There were seven boys in the family, the oldest 18 and unemployed. Questioning the children, I discovered that one, aged 12, was graduating from school but did not even have a graduation suit. His father couldn't afford it because he was paying \$5 weekly on his wife's \$90 hospital bill. He was taking care of the doctor's bill by doing some repairing and cleaning in his office.

After discussing the problem with the employee, I visited the hospital authorities. Hearing the story and realizing the effort the man was making, the hospital gladly discounted \$50 from the bill. Payment of the remaining \$30 was made by the Employees' Welfare Loan Fund, and this is turn was deducted from the employee's pay check at the rate of \$2 a week. The total cost to the Welfare Association was slight, but the assistance and feeling of security given this employee was immeasurable.

But let us leave this type of program and turn to the industrial nurse who serves chiefly in a first-aid department and very seldom contacts the family or the home of the employee. How does she best serve in a sickness prevention program?

Here, again, her knowledge of the personnel is indispensable. She should review the personal record of the employee with the employment manager to obtain a better understanding of the individual. This should be followed by a study of the employee's job; where he works and under what conditions, especially sanitation; the product manufactured and the raw materials it is made of. There the nurse may obtain valuable information as to latent hazards that eventually may affect the health of the employee, oftentimes recognized too late to cure effectively.

From this and a study of past sickness she maps her program of prevention as follows:

1. By suggesting better working conditions, such as improved illumination, sanitation, housekeeping, ventilation, and use of proper and adequate protective equipment.
2. Education of the employee to higher health standards. This requires constant

attention through bulletin boards, mass meetings, news items and personal contacts.

3. By advising and assisting the employee in securing correction of physical defects and social maladjustment.

The following case is an example:

An employee had repeated attacks of rheumatism and had been advised by the family physician to have his teeth extracted, but he did not know where he would get the necessary dental fee.

We had introduced a plan whereby our employees were allowed dental services, in special cases, through the Welfare Association. If an employee were a reliable workman and had been with us for more than six months, we had an opportunity to investigate his financial condition. If he were honest but having a difficult time establishing his credit, he was given an order to one of three dentists whom we were assured were giving our employees fine dental care at a minimum charge. The dentists were glad to render this service, for they were not only sure of their accounts but were also increasing their practice by developing new contacts. This employee as well as many others profited by the plan.

The following are only a few examples of a nurse's function in an industrial health program:

A sudden increase in the number of athlete's foot cases indicated that someone was a carrier and was spreading the germs in the shower rooms. A suggestion to the sweeper brought the condition under control when proper spray and foot baths were installed.

The use of corners by employees as a place to expectorate was effectively solved by painting white triangular areas in the corners and providing cuspidors containing a disinfectant, thus reducing the spread of diseases from respiratory infections.

In another instance three employees from the same department made regular trips to the first-aid station for aspirins each week. Reviewing their personal record cards indicated normal health and habits. A trip to the department revealed inadequate and flickering lights. A proper survey not only corrected the condition from a physical standpoint but likewise increased production to such an extent that a similar survey was made throughout the plant.

A high frequency of illness and fatigue is often the result of poor ventilation, suggesting or protective equipment.

It is quite true that sickness prevention is a real problem, and frequent loss through sickness results.

I wish to quote a report of disabling employees in 1936 years. This report is from the Division of Industrial Health, K. Brundage.

Respiratory

The respiratory system is counted for most of the incidence of illness in 1 of tuberculosis of the diseases of the pharynx and tonsils, higher incidence rate in 1935.

The frequency of 1936 (15.1 cases per 1,000 men) and for 1934 (10.1 cases) was, nevertheless, the rate for low the average rate for five-year period."

Another development was an increase in cases of bronchitis in 1936 this disease of cases per 1,000 men above its average in 1931-1935. The incidence of pharynx and tonsils was higher than in 1931-1935. The rate for pneumonia was below the rate for 1935 (15.1 cases per 1,000 men) and in turn exceeded the rate for 1934 (10.1 cases per 1,000 men). Among the holders of the Mc Company, the death rate in 1936 as compared with 1935 was 100 per cent."

Other diseases

000166

A high frequency of indigestion, nausea and fatigue is often traceable to improper ventilation, suggesting proper air-conditioning or protective equipment to eliminate this hazard.

It is quite true that such a program presents a real problem in selling the idea of sickness prevention to executives—but patience and frequent reference to the time lost through sickness will eventually bring results.

I wish to quote a few paragraphs from the reports of disabling illness among industrial employees in 1936 as compared with earlier years. This report was released by the Division of Industrial Hygiene of the National Institute of Health and compiled by Dean K. Brundage.

Respiratory Diseases

The respiratory group of diseases accounted for most of the increase in the incidence of illness in 1936. With the exception of tuberculosis of the respiratory system and diseases of the pharynx and tonsils, each respiratory disease sub-group occurred at a higher incidence rate in 1936 than in 1934 or 1935.

The frequency of influenza and grippe in 1936 (15.1 cases per 1,000 men), was 19 per cent higher than the rate for 1935 (12.7 cases per 1,000 men) and 50 per cent greater than for 1934 (10.1 cases per 1,000 men). Nevertheless, the rate for 1936 was 4 per cent below the average rate (15.8) for the preceding five-year period."

"Another development of an unfavorable nature was an increase in the number of cases of bronchitis, acute and chronic. In 1936 this disease occurred at a rate of 4.8 cases per 1,000 men which was 41 per cent above its average incidence during the years 1931-1935. The incidence of diseases of the pharynx and tonsils in 1936, although 4 per cent higher than in the preceding five-year period, was below the rate for 1935. The rate for pneumonia (all forms) in 1936 (2.6 cases per 1,000 men) was 13 per cent above the rate for 1935 (2.3 cases per 1,000 men), and in turn exceeded the rate for any year since 1929. Among the industrial policyholders of the Metropolitan Life Insurance Company, the death rate from this disease in 1936 as compared with 1935 increased 5 per cent."

"Other diseases of the respiratory system,

including diseases of the upper respiratory tract, showed a sizeable increase in frequency in 1936 as compared with all the former years. Most noteworthy in the record since 1921 is the downward trend in the new cases of tuberculosis of the respiratory system. The incidence has decreased from 1.9 cases per 1,000 in 1921 and 1922 to .8 cases in 1936."

This is an excellent indication of the effectiveness of educating the child and the adult.

"Rheumatism, acute and chronic, which showed definite improvement in 1934 and 1935 (4.0 cases per 1,000 men) as compared with earlier years increased to 4.2 cases per 1,000 in 1936. This rate was below the five-year average. Diseases of the organs of locomotion, except diseases of the joints, occurred at a rate of 3.2 cases per 1,000 men in 1936, which exceeded the rates for 1933, 1934, and 1935, as well as the average for 1931-1935."

How frequently and to what extent sickness among employees is a factor in causing lost time accidents is often revealed when a thorough investigation is made of all incidents leading up to the accident; such facts properly presented enable one to improve plant conditions for better health.

A good share of the sickness prevention program is education. Few employees, for example, realize that they have more leisure time than they have ever had before. The employee should be taught to use this with discretion. Today we practically have a national 40-hour work week, and allowing at least 56 hours for sleep, we find the employee has 72 hours left out of every week to use as he wishes.

Does he spend his idle time disastrously, thus adding fatigue to an already fatigued body? To safeguard against this you may find it worthwhile to afford him recreational facilities, stimulating in him a desire for hobbies, home ownership, or any other activities that may enable him to spend his time more profitably.

Plan a definite program of Better Health talks during the winter months.

The National Safety Council and leading insurance companies can provide excellent material for these discussions. Your state and national health departments are glad to furnish valuable information free of charge.

000167

One of your local physicians will be pleased to talk to the employees on sickness prevention.

Carefully located bulletin boards with

timely health topics are useful. Articles in plant magazines are far reaching, and pay-envelope inserts discussing health topics have proved beneficial.

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 A. O. WOLL, General Petroleum Corp. of Calif., Terminal Island, Calif.
 JOHN WRIGHT, American Export Lines, New York, N. Y.

L. LUCKENBACH, A.
 J. O. PICKARD, John
 J. P. RONEY, The Te
 J. A. RICHES, Stand
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 H. L. SEWARD, Yale
 A. J. SMITH, Marine
 L. R. SKENSON, Ne
 W. E. STEWARDSON,
 ARTHUR M. TODE, C.
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The opening session
 by Byron O. Pickard,
 Steamship Assn., San
 Francisco, chairman of the

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 2. The presence of
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 3. Insanity;

000170

- J. L. LUCKENBACH, American Bureau of Shipping, New York, N. Y.
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 A. O. WOLL, General Petroleum Corp. of Calif., Terminal Island, Calif.
 JOHN WRIGHT, American Export Lines, New York, N. Y.

TUESDAY AFTERNOON SESSION

October 12, 1937

The opening session was called to order by Byron O. Pickard, Pacific American Steamship Assn., San Francisco, Calif., program chairman of the section. Captain E.

C. Holden, Jr., United States P. and I. Agency, Inc., New York City, general chairman of the section, submitted a review of the year's activities.

The Advancement of Safety in the American Steamship Industry

By R. J. BAKER

President, American Steamship Owners' Association, New York City

The advancement of safety at sea is the result of an endless process of trial and error. It is amusing to compare the present attitude toward safety with the one of some eighty years ago, as indicated in an article published in the "Nautical Magazine and Naval Chronicle" of London in 1856, in which it was declared that the chief causes for loss of ships at sea are:

1. Technicalism—the serving of coffee instead of rum;
2. The presence of the captain's life and the crewmen;
3. Drunkenness and revelry;
4. Mutiny and insubordination;
5. Discord and dissension;
6. No devil being on board;
7. The devil having been let loose.

Today our reliance on safety at sea is placed in the results of the navigation laws of the country; the ice patrol; study of ice and current conditions; load line and stowage regulations; removal of derelicts; installation of safety devices which provide the best available fire detection and extinction apparatus; construction requirements which will enable an endangered ship to

000171

Metals Section

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J. P. GATHERUM, Great Lakes Steel Corp., Ecorse, Mich.
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 FRANK ROWE, Wheeling Steel Corp., Portsmouth, O.
 A. C. SCHULTZ, Bucyrus-Erie Co., So. Milwaukee, Wis.
 J. A. VOSS, Republic Steel Corp., Cleveland, O.

TUESDAY AFTERNOON SESSION

October 12, 1937

The session was called to order by General Chairman C. M. Allen, The American Rolling Mill Co., Middletown, Ohio, who introduced the speakers.

Safety as a Morale Builder

By ROY W. KELLY

Chief, Personnel and Training Division, Soil Conservation Service,
 Washington, D. C.

The maintenance of morale is readily conceded to be one of the major objectives of management. Whether the executive is responsible for building locomotives, making mattresses, managing a Government bureau, or commanding an Army division, his success is dependent in large upon keeping up the morale of his associates.

All of us tend to be influenced by, and to be upset and kept in a most unsatisfactory frame of mind by unsatisfactory living or working conditions. If we want high morale, we must expect to pay constructive attention to such matters as wages, hours, working conditions, basic causes for grievances and complaints, improvement of sanitation, elimination of unnecessary noise, and proper heating, lighting, and ventilation of the work place. Perhaps no other causes contribute more to lowered morale than a feeling of insecurity in one's occupation, fear as to the

future of one's earning power and doubt as to opportunities for advancement and for satisfying achievement.

These are all recognized as matters properly belonging in the field of personnel administration or labor management. They are mentioned merely for the sake of pointing out that safety is an integral part of this functional field. Organization for accident prevention and the maintenance of the safety program, if they are to contribute to improved morale, must be planned and carried out with a view to their direct relationships with these other essential human factors in management. This is a point on which there is much diversity of opinion as well as practice.

Nevertheless, the experience of many organizations tends to indicate that a safety program cannot hope to succeed no matter how well planned, unless conducted in an

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000174

respond to the controls, and little responsibility for keeping the unit in good condition—hence the necessity of an organized maintenance crew to take care of such equipment. The only exception is the crane operator who may have limited responsibilities as to the inspection, lubrication and adjustment of his machine, as well as other machine operators.

Overhead traveling cranes, gantry cranes, trolleys and various types of hoists are a class of equipment which require attention from the standpoint of safety and preventive maintenance. Due to the hazards of falling material, whether it be material, broken parts of the equipment or material dropped due to failure of mechanism, every precaution must be taken to keep this class of equipment in good repair. It has been found desirable to supplement the work of the foreman and repairmen with the proper maintenance of such equipment by the use of Crane Inspector.

The crane inspector goes over all equipment in detail, recording all items of a mechanical or electrical nature which need adjustment or replacement. This survey provides a double check and does not lessen the responsibility of the above-named foremen and repairmen. Copies of these reports are forwarded to the independent and foreman involved, as well as the Plant Safety Department. Recommended repairs or alterations may be composed of either by being carried out immediately, or by being rejected for cause. The inspection covers cleanliness and condition of the equipment in the interest of safety and fire hazard and increased safety factors and repairmen. Safety equipment such as ladders, fire extinguishers, safety belts, gongs, warning light, extension cords, gear guards etc. Loose or scrap material on the approaches or runways is not tolerated. Loose, worn or broken parts are found and recommended for correction.

Inspections at intervals of one to two weeks have been found sufficient for average conditions, with more attention given to heavily hard-worked cranes. Unusual conditions, or failures of parts may require the inspector to make check-up reports when requested.

Mining Section

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JOHN TROW, Homestake Mining Co., Lead, S. D.

TUESDAY AFTERNOON SESSION

October 12, 1937

The session was called to order by General Chairman C. W. Gibbs, Harwick Coal and Coke Co., Pittsburgh, Pa., who introduced the speakers.

The Relationship of Safety to Efficiency in Mining

By JAMES K. RICHARDSON

Safety Director, Climax Molybdenum Company, Climax, Colorado

No person would say that there can be but two ways of doing work—a right way and a wrong way. The whole scheme of mining methods is based on a question of safety and efficiency. If the ore cannot be extracted economically, the system is abandoned. If the ore cannot be extracted without endangering

the lives of the employees the system is abandoned. Unquestionably the latter thought has often been overlooked. We cannot, however, overlook the fact that anything that kills or maims men is morally wrong. Furthermore, if our process or method tears up machines it is not efficient.

000176

Petroleum Section

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R. E. DONOVAN, Standard Oil Co. of Calif., San Francisco, Calif.
C. L. HIGHTOWER, United Gas System, Houston, Texas.
G. O. LOCKWOOD, The Empire Companies, Bartlesville, Okla.
Geo. F. PRUSSING, Union Oil Co. of Calif., Los Angeles, Calif.
R. B. ROOPER, Humble Oil and Refining Co., Houston, Texas.
E. J. SENNE, Socony-Vacuum Oil Co., Inc., New York, N. Y.
C. W. SMITH, Standard Oil Co. (Ind.), Chicago, Ill.
D. J. WALLACE, Sinclair Prairie Oil Co., Tulsa, Okla.
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D. J. WALLACE, Sinclair Prairie Oil Co., Tulsa, Okla.

Secretary—H. N. BLAKESLEE, American Petroleum Institute, New York, N. Y.

MONDAY AFTERNOON SESSION

October 11, 1937

The session was called to order by General Chairman A. W. Breeland, Lone Star Gas Co., Dallas, Texas, who introduced the speakers and directed the discussion.

Industry's Responsibilities in Community Safety

By HENRY W. BOGGESS

Superintendent of Safety, Sinclair Prairie Oil Company, Tulsa, Okla.

During 1936 111,000 American citizens died in accidents. Sixteen per cent, or 18,000 of them, met death while employed at occupations from which they earned their livelihoods and so are called *industrial fatalities*. The remaining 93,000 accidental deaths are broadly referred to as *public fatalities*; at least, they were non-occupational.

The ratio of public to industrial deaths is more than six to one. It is obvious that the broader need for safety is outside and not within the ranks of industry. Whether or not industry has any responsibility for these public or outside accidents, whether or not it has within its power the ability to prevent any of them, is the question.

That these accidents are classified as public is due to point of arbitrarily accidents. The fundaine differ not at the home, or hazardous plant, it w highway or

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Public Utilities Section

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PAUL R. KUHN, Pennsylvania Edison Co., Altoona, Pa.

J. F. McCARTHY
 JOHN P. McCARTHY
 with Committee
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W. H. BROWN

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E. S. LIGHT

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E. P. NOYER

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JAMES B. DOUGLAS

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WILLS M.

B. B. Mc

GEORGE C.

F. M. P.

C. J. R.

C. B. S.

H. F. V.

Special Rep

C. J. G.

L. M. S.

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October 12, 1937

St. Louis, Mo., who introduced the speaker.

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Quarry Section

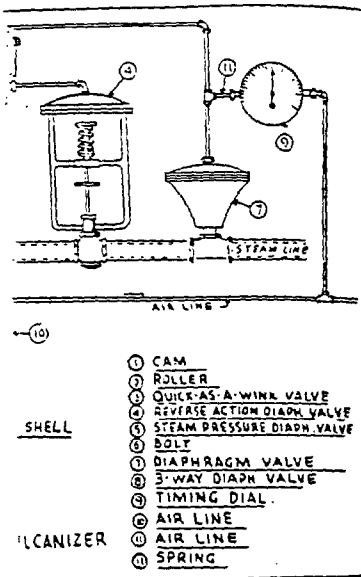
Officers 1936-37

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Secretary and News Letter Editor—N. B. Sipe, J. E. Baker Co., York, Pa.
Poster Committee Chairman—H. F. YOTTER, The General Crushed Stone Co., Easton, Pa.
Publicity Committee Chairman—J. R. BOYD, National Crushed Stone Assn., Washington, D. C.
Statistics Committee Chairman—W. W. ADAMS, U. S. Bureau of Mines, Washington, D. C.
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WILLIAM H. BAKER, J. E. Baker Co., York, Pa.
O. M. GRAVES, The General Crushed Stone Co., Easton, Pa.
S. WALTER STAUFFER, National Lime Association, Washington, D. C.
A. L. WORTHEN, The New Haven Trap Rock Co., New Haven, Conn.

Officers Elected for 1937-38

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Statistics Committee Chairman—W. W. ADAMS, U. S. Bureau of Mines, Washington, D. C.
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WILLIAM H. BAKER, J. E. Baker Co., York, Pa.
O. M. GRAVES, The General Crushed Stone Co., Easton, Pa.
S. WALTER STAUFFER, National Lime Association, Washington, D. C.
A. L. WORTHEN, The New Haven Trap Rock Co., New Haven, Conn.

The Quarry Section met jointly with the Limestone Section on January 24 and 25, 1937. The proceedings will be found on pages 249 to 250 of this volume.



Part III. When cure time is up, time regulator (9) turns air pressure into line (1) closing direct acting valve (7), also closes lower inlet of three-way diaphragm valve (5) which shuts air pressure from air line (1) and vents air from reverse action diaphragm valve (4) causing this valve to close.

Part IV. As steam is exhausted from the boiler and the pressure has reduced to 12 oz. on diaphragm valve (3), spring (12) will pull bolt (11) up, and heater door will be opened.

Note. (a) Tension on spring (12) can be adjusted either to raise or to lower the factor.

(b) Steam line has two valves, one closed with air pressure and the other closed with air off.

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Safety Equipment Section

Accident Prevention Equipment Manufacturers
Who Exhibited at the Twenty-Sixth National Safety Congress
and Exposition

Kansas City, Mo., October 11-15, 1937

Exhibition Hall—Municipal Auditorium

- Acme Protection Equipment Co., Inc., Pittsburgh, Pa.
- Gas Masks.
- Advertising Displays, Inc., Covington, Ky.
- Safety Education Materials in Display Form With Moving Messages.
- Delta Casualty & Surety Co., Hartford, Conn.
- Safe Driving Tests, Safety Educational Films.
- A.S. Aloe Co., St. Louis, Mo.
- First Aid and Hospital Equipment.
- American Abrasive Metals Co., Irvington, N. J.
- Safety Treads for Walkways and Safety Gratings.
- American-LaFrance and Foamite Industries, Inc., Elmira, N. Y.
- Fire Protection Equipment.
- American Mutual Liability Insurance Co., Boston, Mass.
- Insurance, Workmen's Compensation, Property Damage and General Automobile.
- American Optical Co., Southbridge, Mass.
- Head and Eye Protection Products.
- American Safety Tank Co., Kansas City, Mo.
- Automotive Fuel Supply Tanks.
- Switzer, Inc., Chicago, Ill.
- Auxiliary & Emergency Stretcher First Aid Equipment.
- Automatic Traffic Control Corp., St. Paul, Minn.
- Traffic Actuated Control Equipment.
- Boys Manufacturing Co., Rock Island, Ill.
- Safety Inspection and Correction Equipment.
- Edix Products Corp., South Bend, Ind.
- Automotive Equipment.
- Ed-Sivalls & Bryson, Inc., Kansas City, Mo.
- Safety Heads, Tanks and Pressure Vessels.
- Valley Washfontain Co., Milwaukee, Wis.
- Group Washing Equipment.
- Shoe Co., St. Louis, Mo.
- Men's and Women's Safety Shoes.
- W. R. Browne Manufacturing Co., New York City.
- Safety and Special Purpose Lights and Lamps.

R. H. Buhrke Co., Chicago, Ill.
Safety Equipment for Construction and Maintenance.
E. D. Bullard Co., San Francisco, Calif.
Personal Protective Equipment.
Burroughs Wellcome & Co. (U.S.A.), Inc., New York City.
First Aid Kits and Medical Equipment.

Champion Brake Corp., Chicago, Ill.
Hand Brakes for Freight Cars.
Chicago Eye Shield Co., Chicago, Ill.
Head, Eye and Respiratory Protective Equipment.
Columbus McKinnon Chain Corp., Tonawanda, N. Y.
Alloy Steel Sling Chains and Safety Hoists.
H. S. Cover, South Bend, Ind.
Respirators and Safety Goggles.
Crouse-Hinds Co., Syracuse, N. Y.
Traffic Signals and Floodlights.
M. E. Cunningham Co., Pittsburgh, Pa.
Safety Steel Stamps and Type Holders.

Davis Emergency Equipment Co., Inc., New York City.
First Aid and Industrial Safety Equipment.
C. H. Dockson Co., Detroit, Mich.
Head and Eye Protection.
DoMore Chair Co., Inc., Elkhart, Ind.
Posture-Health Chairs for Office and Factory.
Dual Parking Meter Co., Oklahoma City, Okla.
Parking Meter Equipment.
Donald F. Duncan, Inc., Chicago, Ill.
Parking Meter Equipment.

Eagle Signal Corp., Moline, Ill.
Traffic Signals.
Electronic Control Corp., Detroit, Mich.
Electronic and Photo-Electric Equipment.
Elliott Service Co., New York City.
Promotion of Efficiency and Safety.
Emerson Drug Co., Baltimore, Md.
Bromo-Seltzer.
Employers Mutuals, Wausau, Wis.
Fire and Casualty Insurance, Workmen's Compensation.
Enameled Steel Sign Co., Chicago, Ill.
Day and Night Steel Reflecting Signs.

Fairway Laboratories, Inc., Belleville, Ill.
Anti-Fatigue and Heat Exhaustion Antidote Tablets and Dispensing Equipment.

Harley-Davidson Motor Co., Milwaukee, Wis.
Police Motorcycles and Accessory Equipment.
Hercules Friction Grip Co., Kansas City, Mo.
Brake Dressing.
Hild Floor Machine Co., Chicago, Ill.
Electric Floor Scrubbing Machines and Vacuum Cleaners.
Holcomb Safety Garment Co., Chicago, Ill.
Industrial Safety Clothing.
Hoof Products Co., Chicago, Ill.
Motor Vehicle Speed Control Governors.

Huntington L.
Disinfectant.
Hynson, West
Mercuriod

Indian Moto
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Junkin Safety
Power Pro
Juvenile Wood
Automobil

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Walter Kidde &
Fire Protec
Kimball Safety
Industrial S

Lehigh Safety
Leather and
Liberty Mutual
Automobile

The Lima Cord
Non-Slip S
Lumbermens M
Automobile.

Macwhyte Co.,
Wire Rope
The Martindale
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Tablets and Dispensing Equipment.

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Huntington Laboratories, Inc., Huntington, Ind.
Disinfecting and Sanitation Products.
Hynson, Westcott & Dunning, Inc., Baltimore, Md.
Mercurochrome First Aid Antiseptic, Thantis Lozenges.

Indian Motorcycle Co., Springfield, Mass.
Police Motorcycles and Equipment.
Industrial Gloves Co., Danville, Ill.
Industrial Safety Clothing.
Industrial Safety Equipment Assn., New York City.
Association of Manufacturers of Industrial Safety Equipment.
International Shoe Co., St. Louis, Mo.
Safety Shoes.

Junkin Safety Appliance Co., Louisville, Ky.
Power Press Guards.
Juvenile Wood Products, Inc., Fort Wayne, Ind.
Automobile Safety Seats for Children.

The Karpark Corp., New York City.
Parking Meters.
Keystone View Co., Meadville, Pa.
Visual Safety Tests.
Walter Kidde & Co., Inc., New York City.
Fire Protection Equipment.
Kimball Safety Products Co., Cleveland, Ohio.
Industrial Safety Clothing and Supplies.

Lehigh Safety Shoe Co., Inc., Allentown, Pa.
Leather and Rubber Safety Shoes.
Liberty Mutual Insurance Co., Boston, Mass.
Automobile and Industrial Safety Service.

The Lima Cord Sole & Heel Co., Lima, Ohio.
Non-Slip Soles and Heels.
Lumbermens Mutual Casualty Co., Chicago, Ill.
Automobile, Compensation and General Casualty Insurance.

Macwhyte Co., Kenosha, Wis.
Wire Rope and Braided Wire Rope Slings.
The Martindale Electric Co., Cleveland, Ohio.
Dust Respirators and Highway Safety Signals.
McCloskey Torch Co., Toledo, Ohio.
Bomb Shell Torches and Truck Flares.
B. F. McDonald Co., Los Angeles, Calif.
Safety Hats and Respirators.

Metropolitan Life Insurance Co., New York City.
Life Insurance, Industrial, etc.
Michigan Malleable Iron Co., Detroit, Mich.
Traffic Stop Signs.
Milburn Co., Detroit, Mich.
Protective Creams for Prevention of Occupational Skin Diseases.

Mine Safety Appliances Co., Pittsburgh, Pa.
Safety Appliances and First Aid Materials.
Modern Engineering Co., St. Louis, Mo.
Welding Torches and Safety Goggles.
Murray Safety Sling Co., Inc., Pittsburgh, Pa.
Plated Wire Rope Slings.

000185

National Bureau of Casualty & Surety Underwriters, New York City.
 Safety Service, Casualty Insurance.
 National Safety Council, Inc., Chicago, Ill.
 Posters, Bureau of Information, Research and Education Division.

G. H. Packwood Manufacturing Co., St. Louis, Mo.
 Soaps and Cleaning Compounds.
 Panther-Panco Rubber Co., Inc., Chelsea, Mass.
 Safety Soles and Heels.
 The Patent Scaffolding Co., Chicago, Ill.
 Safety Ladders and Scaffolds.
 The Phister Manufacturing Co., Cincinnati, Ohio.
 Fire Protection Equipment.
 Protectoseal Co., Chicago, Ill.
 Safety Devices for Hazardous Liquids.
 Pulmosan Safety Equipment Corp., Brooklyn, N. Y.
 Respiratory Protection and General Safety Equipment.

Railway and Industrial Engineering Co., Greensburg, Pa.
 Interlock Systems, Potential and Phase Detectors, Insulator Testers.
 Reece Wooden Sole Shoe Co., Columbus, Nebr.
 Wooden Sole Safety Shoes.
 Rich Signs Corp., Wichita, Kans.
 Highway Reflecting Traffic Markers.
 Rockwood Sprinkler Co., Worcester, Mass.
 Fire Protection Equipment.
 Rose Manufacturing Co., Denver, Colo.
 Industrial Safety Equipment.

Safeguard Electric Co., Inc., Brooklyn, N. Y.
 Shockproof Portable Lamp Guards.
 Safety Engineering, Alfred M. Best Co., Inc., New York City.
 "Safety Engineering," Insurance Publications and Reports.
 The Safety Equipment Service Co., Cleveland, Ohio.
 Goggles and All Types of Accident Prevention Equipment.
 Safety First Shoe Co., Holliston, Mass.
 Safety Shoes.
 W. H. Salisbury & Co., Inc., Chicago, Ill.
 Linemen's Rubber Protective Devices.
 Shepherd Safety Shoe Corp., Chicago, Ill.
 Safety Shoes.
 The Spencer Turbine Co., Hartford, Conn.
 Industrial Vacuum Cleaners and Dust Collection Equipment.
 Standard Safety Equipment Co., Chicago, Ill.
 Industrial Safety Equipment.
 Stonehouse Signs, Inc., Denver, Colo.
 Accident Prevention Signs and Tags.
 The Strauss Co., Pittsburgh, Pa.
 Safety Belts, Safety Hats, and Foot Guards.
 Sugar Beet Products Co., Saginaw, Mich.
 Industrial Soaps.
 The Surety Rubber Co., Carrollton, Ohio.
 Linemen's Safety Equipment and Synthetic Rubber Industrial Equipment.
 The Surty Manufacturing Co., Inc., Chicago, Ill.
 Dust Counters, Exhaust Units, Safety Guards and Shields.
 S-W Supply Co., Girard, Kans.
 Highway Railroad Signals.

Threeway Signal Co., Okla.
 Safety Signal Equipment.
 Traffic Boy, Inc., Canton, Mass.
 School Zone Traffic W.

United States Steel Corporation
 Steel Products and Co.

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 Industrial Safety and F
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 Automotive Testing Eq
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Safety Equipment Section

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Threeway Signal Co., Oklahoma City, Okla.

Safety Signal Equipment.

Traffic Boy, Inc., Canton, Ohio.

School Zone Traffic Warning Signs.

United States Steel Corporation Subsidiaries, Pittsburgh, Pa.
Steel Products and Cement.

Wahlert Products Corp., Brooklyn, N. Y.

Industrial Safety and Fire Protection Equipment.

Weaver Manufacturing Co., Springfield, Ill.

Automotive Testing Equipment.

West Disinfecting Co., Chicago, Ill.

Products for the Promotion of Industrial Sanitation.

The Western Union Telegraph Co., Kansas City, Mo.

Communication Service.

Willson Products, Inc., Reading, Pa.

Personal Protective Devices.

000187

Textile Section

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CARL E. LINDEMAYER, Forstmann Woolen Co., Passaic, N. J.

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Statistics Committee Chairman—R. J. JENNINGS, Lanett Cotton Mills, West Point, Ga.

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M. W. HEISS, Proximity Manufacturing Co., Greensboro, N. C.

FRANK E. MORRIS, Liberty Mutual Insurance Co., Boston, Mass.

ROSS

intendent made his rounds whenever he observed a soft spot on the floor he picked it up, the time and the department found and handed the bottle

Unless the overseer could see who was responsible for the bottle on the floor, he was to keep it constantly in his hands during the shift.

Required to acknowledge public opinion of his department to obtain with respect to placing these containers provided, it was every overseer had, in this fashion, discovered a way to make the guilty employee and thus to this unsafe practice.

Example of what may be done to occur when the overseer's job seriously is found in a mill in eastern Alabama approximately two and one half hours per year which, for the period January 1, 1934 to January 1, 1935, had 18 accidents with a frequency rate of 8.02, and for the period January 1, 1935, to November 1, 1936, had 18 accidents with a frequency rate of 4. Not satisfied by this progress, the plant designated the month of November as a "No-Accident" month. They succeeded in achieving the record during the month of November. Their campaign through the month. At the time this paper was published, the plant has operated approximately two and one quarter million hours without a single lost time accident.

Wood Products Section

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Vice-Chairman—WILLIAM HAGGERTY, Edward Hines Lumber Co., Hines, Harney Co., Ore.
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Program Committee Chairman—NILS JUELLE, Hayes Body Corp., Grand Rapids, Mich.
Publicity Committee Chairman—ROLAND JONES, The Surty Mfg. Co., Inc., Chicago, Ill.
Statistics Committee Chairman—F. A. POLLOCK, Lumbermens Mutual Casualty Co., Chicago, Ill.

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F. W. BRAUN, Employers Mutuals, Wausau, Wis.
E. ROSS FARRA, Grand Rapids Safety Council, Grand Rapids, Mich.
LOUIS W. KERBERG, Mengel Body Co., Louisville, Ky.
J. A. PURDY, Michigan Mutual Liability Co., Detroit, Mich.

Officers Elected for 1937-38

General Chairman—H. E. SEELEY, The Brunswick-Balke-Collender Co., Chicago, Ill.
Vice-Chairman—J. H. LEE, Liberty Mutual Insurance Co., Rockford, Ill.
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MONDAY AFTERNOON SESSION

October 11, 1937

The session was called to order by General Chairman Harry J. Kelley, American Seating Co., Grand Rapids, Mich., who introduced the speakers.

Combating the Dust Problem in the Wood Products Industry

By J. G. SISSMAN

Director of Research, Surty Manufacturing Company, Inc., Chicago, Ill.

The best protection against fire in wood working plants is dust control cleanliness, which means keeping the air dust-free, preventing the accumulation of litter on floors, benches, and tools, and guarding against the accumulation of dust on oily moving parts where friction will readily raise the temperature to the burning point. An adequate dust collecting system is the best protection against wood-shop fires.

Remember, a dust collecting system itself must be designed with this fact in mind; fire as well as air and dust can be carried through air ducts.

The fire hazards in wood plants are well known. A study of such hazards, made by the National Fire Protective Association which published a report in 1932, gives a full analysis of some 1,700 fires in wood-working plants and shows the proportion of danger in different parts of the plant and the ratio of fires of dust origin in comparison with others.

The explosion hazard also has been carefully surveyed. It is present when dust is sufficient for combustion to be instantaneous over a considerable area. Explosion hazards, like fire hazards are best controlled by ventilation which precludes the accumulation of dangerous dust in plant atmosphere.

Fire danger is present in wood working operations whether performed in open sheds or totally enclosed buildings. Explosion hazard is increased with enclosure of the process in closed buildings. Bulletins 562 and 617 U. S. Department of Labor, Bureau of Labor Statistics, and several pamphlets of the National Safety Council contain complete safety information for prevention of dust explosions. They sum up the collected, classified knowledge in this field and point out the close linkage between fire hazard and explosion hazard and show that either may be the cause of or the consequence of the other. These bulletins in conjunction with the rules or laws effective in your own state for removal of dust and gases, will enable you to work out a campaign against the hazard of dust explosion.

The nuisance problem in woodworking plants also requires dust control. Nuisance

problems fall into several groups. Dust may impair the value of the product by marring its finish. Furniture factories and cabinet makers suffer most from this nuisance. Dust may cause accidents by making the footing uncertain, by hiding obstructions on or defects in floors or the exact location of knives and cutting edges. Dust of any kind in the eyes is a nuisance and a dangerous nuisance. Nuisance dust, like fire hazard dust and explosive dust is adequately and satisfactorily controlled by ventilation.

Wood working dusts, with the possible exception of a relatively small amount of abrasive material which they contain, are bulky. There must be continuous removal of wastes of manufacture to leave room for men, machines and work in the plant. For many years this was the only aspect of the case considered. Broom and shovel methods, which once were standard in the wood working trade for removal of wastes, were sufficient and would still be sufficient, but, the presence of other hazards of wood dusts complicate the problem. Broom and shovel methods are no longer acceptable. Moving air is the one effective means of disposal of wood wastes because it does so in a satisfactory manner and because it fits into the scheme for guarding against other hazards.

The material so collected is frequently usable either as fuel within the plant or is salvagable and saleable which helps reduce substantially the cost of safeguarding the plant. This is the only phase of the dust control problem which shows a direct profit. The others are an immediate charge on the industry which must be met as part of general overhead. They show their profit indirectly in the prevention of injuries to men and the saving of the cost of injury to industry.

The last of the quintette, according to my classification, is wood dust as a health hazard. This quint has several characteristics: effect of wood dust on the human system; effect of abrasive dusts on the human system; effect of dust or materials other than wood or abrasive used in place of wood or in combination with it, on the human system; effect of dusts coming from the machinery on the human system.

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ay, Inc., Chicago, Ill.

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the quintette, according to my is wood dust as a health haz- nt has several characteristics: d dust on the human system; asive dusts on the human sys- E dust or materials other than asive-used in place of wood or n with it on the human sys- dust resulting from the finish- on the human system.

Wood dust is not dangerous in the sense of silica or lead dust; but wood dust is not innocuous. Any dust inhaled in sufficient quantities is detrimental to health and wood dust is not excepted.

The industrial bulletin of the state of New York for July, 1936, contains an article by Adelaide Ross Smith in which the relationship between wood dust and respiratory disease is set forth. Dr. Smith points out that wood working is a dusty trade and while the dusts are not primarily siliceous, more respiratory disease is found in the wood working plants than in plants where dusts are not present. She suggests that perhaps more silica dust is present than is suspected. Studies to determine which of the dusts present in woodworking are dangerous have not been made, at least not with sufficient detail over a long enough period of time. But statistical evidence definitely places wood working in that class of industry in which there is some exposure to silicosis, as shown by the high mortality from pulmonary tuberculosis.

In the study made by Oliver, in which the death rate of the agriculturist from diseases of the respiratory system was taken as a standard or 100, the rate for potters was 150; stone quarriers 261; cotton workers 244; wood workers 238; masons 215; wood manufacturers 202; and bakers 177. If this figure is a true picture of deaths in the wood working trades due to respiratory diseases, 238 as compared with 100 as the standard, it is obvious that wood dusts are definitely detrimental to health.

Reports from the Registrar General of England and Wales, show the same general situation. Under the English system wood workers are rated at 103 per cent, compared with agricultural workers who are rated at 59 per cent. Woodworkers rate 339 compared with the general population rate of 180. In the case of cabinet makers the rate is higher, perhaps because more dusts other than wood dusts are present in the atmosphere they breathe. One hundred and seventy-eight trades are listed in this report, rated from 1 to 178. Under the heading "respiratory tuberculosis" cabinet makers rate 117, other wood workers 81. Under "bronchitis" cabinet makers rank 121, other wood workers 64. Under "pneumonia" cabinet makers 51, other wood workers 28. Excepting under the heading of "pneumonia,"

cabinet makers do not rank well. Other wood workers seem to occupy a middle place.

Dust in wood working trades is therefore a definite hazard to the health of workers and of particular significance in the impetus which it gives to diseases of the respiratory system.

Of less actual significance, but of considerable interest because it is seldom considered as a hazard to wood workers, is contact with woods or wood dusts which are poisonous. Bulletin 616 issued by the U. S. Bureau of Labor Statistics, also the Handbook of Labor Statistics, 1936 edition, contain two interesting references to poisonous woods. The first of these, which appears on page 350, refers to an outbreak of dermatitis in a wood working plant employing 100 men. As a result of contact with Brazilian walnut wood dusts, 11 cases, a rate of about 10 per cent developed dermatitis of varying severity which, in some cases, incapacitated the man for several weeks. The inference was that a large measure of tolerance of toxins in that particular wood can be developed.

An extensive account appears on page 354 of the same bulletin. It is a reprint of a bulletin issued by the International Union of Wood Workers for September-October, 1931. This bulletin states that there are many woods, particularly those grown in the tropics, which contain active poisons.

The actual number of cases reported is relatively small. This is due to the slow action of the dust and the fact that many physicians are not familiar with occupational exposure or the resulting disabilities, and so do not associate the illness with patients' trades.

The most frequent symptom of wood poison is dermatitis which may be slight or severe. Other effects may be palpitation of the heart, shortening of breath, or dizziness. Such symptoms also come from inhaled dust. Repeated contacts do not confer a tolerance of these poisons; in fact they may make one super-sensitive, so that working on ordinarily harmless woods causes a re-occurrence of incapacity. The toxic substance occurs as volatile oils or alkaloids. Quite a number of woods are enumerated.

It is the good fortune of the wood working trade to be able largely to stand aside from the most serious dust problem, the problem of silica dust, since so far there is little to

000191

show that silica is a substantial danger in the wood working field. This is true despite the reference to the report of Dr. Smith. While that danger is slight at present, it is a growing danger, due to the use of extremely high speed sanding devices for finishing operations, using siliceous material as abrasives, and to the growing use of products of non-wood origin in the woodworking shops. Many of the panels now being worked in wood shops contain high proportions of asbestos and other silicious minerals. Where this is done, the worker may be exposed to concentrations of silica dust sufficient to present a definite hazard. It is well to make occasional survey of your plant to determine exposure continuous or intermittent.

While perhaps finishing operations are not properly a part of the woodworking operation they do occur in so many plants that their existence should be pointed out. Changes in the stains, paints or other finishing coatings causing lead poisoning lessen that hazard compared to 20 or 25 years ago. The nitrocellulose and pyroxylin finishes which are displacing paints, are distinctly dangerous. Volatile materials comprise about three-fourths of the mass, which is then thinned by the addition of other volatiles to several times the original volume.

They are dangerous. In addition to health hazard, these finishes add to the fire and explosion hazard of the wood working plant. Acetone and acetates, ethylenes and alcohols are the principal toxics which enter the new finishes. Descriptions of these ingredients will be found on page 337 of Bulletin 116 previously mentioned.

It appears that, from the point of view of health hazards, these conclusions can be drawn: (1) Wood dust is dangerous to health and increases the incidence of respiratory disease. (2) Dermatitis is a result of contact with woods of tropical origin and their dusts, and will follow exposure. (3) Silicious materials are a factor in the high incidence of pulmonary diseases in the wood working plants. (4) New materials, particularly those having appreciable silica content, present new dangers which must be carefully guarded against. (5) The new surface finishes, to a large extent replacing the lead pigment paints, obviate one danger and introduce new dangers of their own.

Dust then presents five different problems to the wood working trade. A good ventilating system will solve all five problems, reducing dangers in four instances, and in the fifth reducing direct costs.

Good Housekeeping in Woodworking Plants

By JAMES C. WILSON

Vice President, Lumbermens Mutual Casualty Company, Chicago, Ill.
Chicago, Ill.

Good housekeeping is and always has been one of the most important features of a successful manufacturing program. Fundamentally it is the outstanding feature if considered in its broadest terms. It includes not only a sensible, intelligent handling of sales, accounting methods, packaging and shipping, but, more specifically, production methods and the habits of the men engaged in production.

It seems obvious to us that when a new plant is being designed or when an old one is being rebuilt, the plans should include and provide for good housekeeping through the following details:

A complete and efficient dust collecting system is a basic necessity, and once installed it must be serviced constantly to retain its efficiency. The removal of all waste material from floors and around machines is a full-time job requiring definite assignment to a clean-up crew.

In laying out the machine setup, good housekeeping requires an intelligent plan under which the machines are grouped so that the progress of stock being processed is such that there is a continuous flow towards completion with no back-tracking.

In many of the older plants, the output has increased and new machines have been

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