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NATIONAL SAFETY NEWS

Published Monthly by the National Safety Council

FEBRUARY, 1948 Vol. 57, No. 2

ARTICLES

THE COVER: To remind employees that the office has its hazards, too, the Wisconsin Power and Light Company, Madison, Wis., staged this scene. The victim of the "accident" is Miss Margaret Kelly, receptionist, in the company's Sales Department.

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In This Issue . . .

Many a poster idea can be blown up into a life-size, animated display — one that people simply can't ignore. Here are some excellent examples that are outstanding because the cleverness of the idea hasn't secured the safety message. (Page 18).

Fume and dust exposures are a problem in many industries. This article discusses some of the more common exposures with an appraisal of the hazards. (Page 20).

Placement tests, like all procedures involving the human element, are not infallible but they do prevent many occupational misfits, some of whom would be serious hazards in certain jobs. Here is a summary of recent developments in this field by a well-known authority. (Page 22).

Fatigue may result from one or more of a vast number of causes, concerning both the individual and his environment. Here are some new angles to the subject presented from the medical point of view. (Page 26).

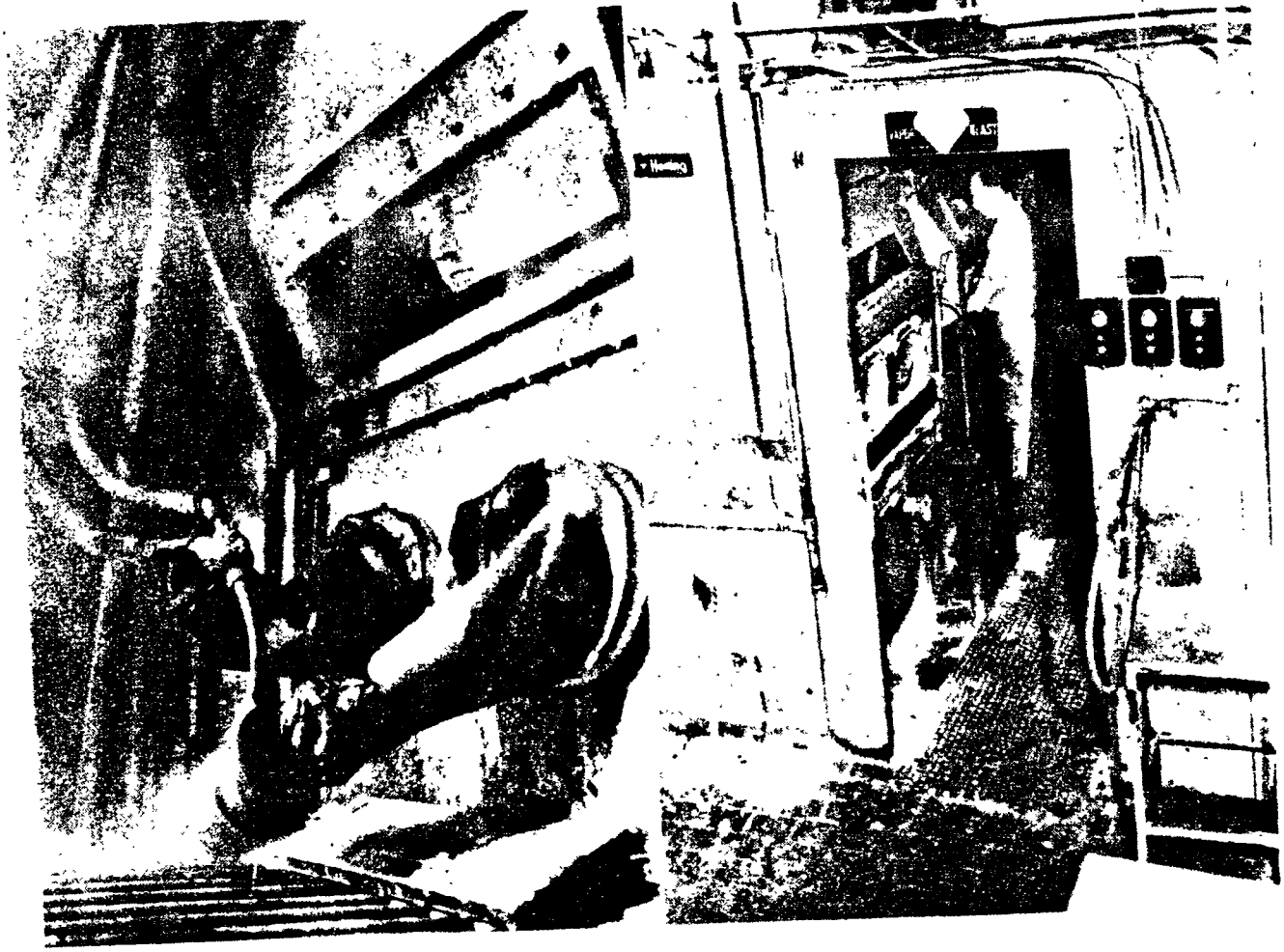
More problems confront the hero of our safety engineer's diary as an unsympathetic boss reminds him that the deadline for showing results is getting closer. (Page 29).

Improvised fire-fighting equipment, supplementing standard apparatus, gave a good account of itself in the forest fires in Maine last October. The idea is applicable to many locations. (Page 30).

Rewarding employees for safe work is sometimes considered in the same class as paying a youngster to be good. But in both cases incentives can be used to advantage and recognition means more than the cash value of the reward. The Industrial Safety Panel discusses this old and controversial subject. (Page 34).

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Recognition and Control of

Fume and Dust Exposure

By V. J. CASTROP

RESPONSIBILITY for employee health is delegated by management to the medical director, while the safety director is charged with accident prevention activities. For the smooth functioning of either department, it is necessary that these individuals work in harmony.

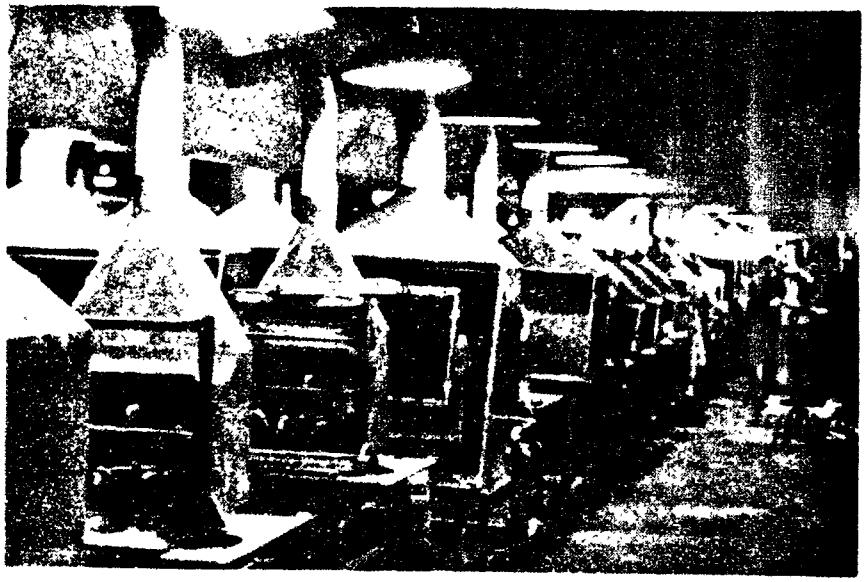
The safety engineer spends much of his time in the plant and usually is well informed about working conditions. The doctor, on the other hand, must spend most of his time tending to the medical needs of the employee and to the administrative work of his department. As a result, he has insufficient time for plant surveys. This is particularly true in plants where the doctor is employed on a part-time basis.

A safety engineer who is capable of recognizing conditions which may be detrimental to health is an excellent team mate for the doctor in a health maintenance program. The safety engineer need not be capable of actually sampling air in the environment or designing a ventilation system for the control of toxic materials. He should, however, have knowledge of the materials which have been proved harmful, and should have some understanding of basic control measures.

The safety engineer, as well as the doctor, should be informed as to where he can obtain the technical personnel to do the sampling and detailed study of the environment and engineering personnel to render assistance in the control of exposure. Such assistance may be obtained from the industrial hygiene divisions of either the health or labor departments of many states. Some city governments likewise have industrial hygiene bureaus.

In addition to these governmental agencies, many insurance carriers have on their staffs men who are capable of sampling and rendering engineering assistance. Private consultants are also available, or you may find that an industrial hygienist is employed by your own organization.

V. J. CASTROP is Assistant Head, Industrial Hygiene Department, Research Laboratories Division, General Motors Corp., Detroit, Mich. This article has been condensed from a paper presented at the Automotive and Machine Shop Section, 35th National Safety Congress.



Inside and outside views of vapor blasting equipment. Fine silica and water under pressure are used. Cabinets must be maintained so that leakage of mist does not occur.

Local exhaust ventilation of soldering operations.

This discussion will be limited to basic principles of industrial hygiene as they relate to fume and dust exposures, to indicate what control measures are available or used to protect the employee's health, and to call attention to operations and materials which are commonly used in industry, at the same time indicating generally accepted opinion as to their effect on health.

Many conditions are improved for reasons other than their effect upon health. Better products, better employee relationship, reduction in maintenance of equipment may be cited as justification for management's decisions for such correction.

Definitions

Laymen frequently designate as "fume" any vapor, fog, gas, etc., they may encounter. In industry, the plating mist over a chrome tank, the vapor or gases, at a metal-cleaning operation or the exhaust gases from a truck are frequently referred to as "fumes." To the industrial hygienist, the term has a more definite meaning. For this discussion, fume may be considered to be particulate matter formed by the condensation of a vapor. A molten bath of lead at a high temperature causes the metal to volatilize and form a vapor. Upon contact with the cooler surrounding atmosphere condensation occurs and the physical state changes from vapor to a solid metallic particle.

While dust is also a solid particle, it is formed by the disintegration of solid materials by grinding, crushing, abrasion, or similar action.

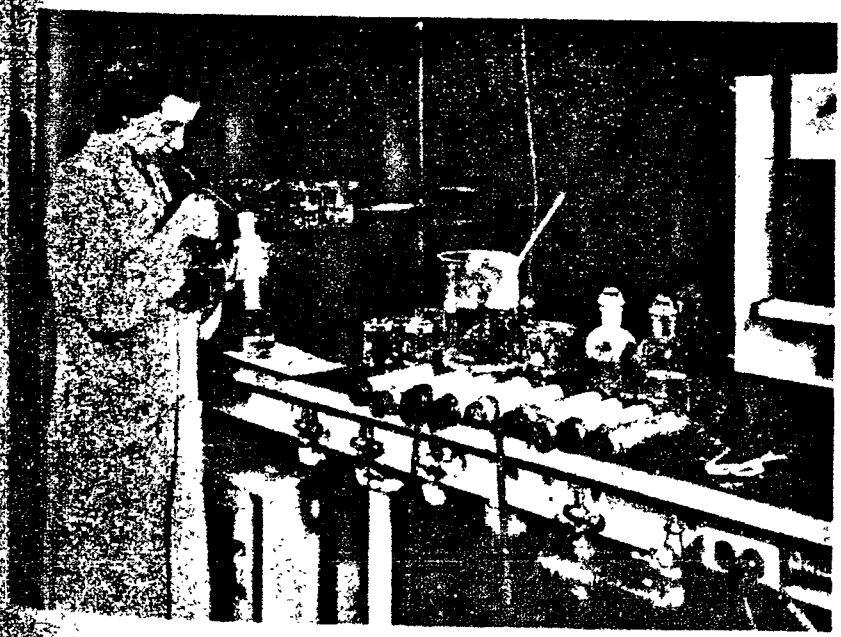
Fume particles are generally small in diameter, with the size dependent upon the type of fume, the extent of flocculation, and other factors. Dust particles of hygienic significance are those beteween one and ten microns in size. (25,400 microns are equivalent to one inch).

Generally speaking, there are two means of entrance of toxic compounds into the human body—by ingestion or via the respiratory tract through inhalation of fumes, dusts, mists or gases. Ingestion is of importance if toxic materials which have a systemic effect are used and adequate washing facilities are not provided, or, where the employees are slovenly in personal habits.

Inhalation is considered the most important portal of entry of fumes or dusts and the particle size, therefore, becomes significant in evaluating exposure. The particles which cause the physiological changes are those which are small enough to remain suspended in the air and not those which immediately fall to the floor. Flying particles, which may cause eye injuries are not of hygienic significance since they are not of respirable sie. To judge the seriousness of an exposure by the quantity of detritus adjacent to an operation is often misleading. This is especially true where mechanical ventilation removes the fine material but is inadequate to trap or convey the larger particles.

In evaluating an exposure it is necessary to consider the toxicity of the material, the duration of the exposure, the average concentration of the contaminant with special attention being paid to those operations which produce high concentrations at some phase of an operating cycle, and the measures which have been provided

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Fume and Dust Exposure

—*From page 21*

to control the exposure. Medical records of the individuals subjected to the exposure may be of value if the examinations are thorough and frequent and not of a cursory type. It must be remembered that occupational diseases are slow in development and in some instances lasting in effect. Slow changes may not be detected, and the mere fact that cases have not occurred does not mean that exposures to known toxic materials may be ignored.

Determination of the concentration of the toxic material in the air is important in evaluating the exposure. Tests of this type are indicative not only of the degree of contamination but also, in some instances, which operation is the major offender.

The apparatus used in collecting the contaminant and the method used in estimating the amount present in the atmosphere vary with the type of material. Tests of this type are specialized in nature and are beset with many pitfalls which can lead to erroneous conclusions if done by inexperienced personnel.

Permissible Limits

In a discussion pertaining to toxic materials it is generally necessary to quote permissible concentrations, or as it is sometimes expressed—maximum allowable concentrations—permissible limits, or threshold limits. These terms are used extensively by industrial hygienists to indicate concentrations of a substance in the air which are considered compatible with good health. The limit usually applies to exposures of eight hours duration for a prolonged period.

The limits are, for the most part, advisory standards or bench marks which are practical to meet. In general, these limits are derived from three types of evidence all of which have value and limitations.

1. Animals have been exposed at different concentrations and the effects noted.
2. A few experiments have been made on human subjects for short periods of time.
3. Safe limits have been arrived at by measuring the concentrations of substance in the workroom air and correlating this information with results of medical examinations of workmen.

The mere fact that these limits are exceeded does not necessarily mean that someone will become definitely ill. But there is a good probability that someone will suffer ill effects if the limit is greatly exceeded for a considerable period. There remains much to be learned regarding the toxicity of many substances used in industry.

So much for the general picture. Now let's look at some specific operations.

Welding

Welding processes most commonly used can be divided into three types, arc, gas, and resistance. The safety measures pertaining to clothing, goggles, and helmets are of common knowledge and will not be considered here.

Arc welding when performed on uncoated steel does not produce a condition considered harmful to the welder, provided it is done in a comparatively large open area. The fumes which result from welding consist essentially of the oxides of iron and oxides of metals which may comprise the steel or coating of the welding rod. Some investigators have found characteristic markings on chest x-rays of men who have welded under severe conditions for long periods of time. These markings are presumably due to the deposition of iron fumes within the lungs, but it has not been demonstrated that such fumes have caused physical impairment.

A frequently suggested limit for welding fume is 15 milligrams of iron oxide per cubic meter of air. Concentrations of this magnitude existing in the workroom would materially reduce visibility and thereby become a nuisance or an unsafe condition requiring correction.

Welding within confined areas such as tanks, inside machinery or equipment, or in small rooms presents a condition which can be of concern. The concentration of fume is materially higher under these conditions as there is little opportunity for dilution by natural air currents normally present in a large shop. Nitrogen oxides formed by the electric arc when inhaled in sufficient quantities causes fluids to form in the lung—edema—with resultant failure of the respiratory system. While welding in large open areas these toxic gases are normally not present in sufficient quantities to cause harmful effects. However, when welding is done in confined areas, the nitrogen oxides may reach a concentration which will be harmful.

Gas welding generally is not productive of harmful fumes. There are, however, in brazing two potentially harmful exposures. While boric acid or borates generally are used in brazing fluxes, some metals require fluxes containing significant quantities of fluoride compounds and fumes from these fluxes have been known to produce significant nasal irritation. Fluorides in general are looked upon with suspicion since they may produce harmful effects upon the bone structure. A limit of 2.5 mg. per cubic meter has been suggested for fluorides, but no standard has been agreed upon. Most industrial hygienists attempt to keep them as low as practicable.

Silver solder is one of the more common alloys used in brazing. Solders of this type vary in composition and may in some instances contain cadmium which, if volatilized in sufficient quantities, is considered harmful. At present the suggested limit for cadmium fume in air is 1 milligram per 10 cubic meters of air.

Resistance, spot, or butt welding of plain steel is of no concern from the physiological standpoint. The fumes arising from such operations generally are caused by the volatilized oil which has come upon the metal stock during previous operations or has been placed upon the metal as a rust preventive.

The preceding discussion of welding operations has been based upon the assumption that the metals being welded are of plain steel. The performance of welding operations, either arc, gas, or resistance, upon metals which have been coated with such toxic materials as lead, cadmium, or mercury may cause harmful exposures. The heat of the flame or of the arc causes volatilization of these metals. Welding or cutting of terne plate or other metals containing significant quantities of lead can result in the volatilization of lead fume, which if inhaled for a sufficient period of time, may result in lead absorp-

—*To page 73*

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New Orleans Public Service Inc.

New Orleans, La.,—Mechanical Operation Section, Power Division, Electric Department—May 17, 1944, to date; 51 employees; 500,000 man-hours as of December 31, 1947.

Fume and Dust

From page 52

tion and ultimate poisoning. The cutting or welding of surfaces which have been coated with paint containing lead has caused lead poisoning.

Welding of cadmium plated material was attributed as the cause of illness and even death to a number of individuals during the war. The reported cases indicated that death occurred in a comparatively short time after the exposure.

Welding of galvanized metal causes the volatilization of the zinc coating. Temporary discomfort associated with metal fume fever may result from such exposure.

Where warranted, control of welding fumes is generally accomplished by providing a mechanical ventilation system. The type of ventilation used is dependent upon the nature of the welding. When the object to be welded is positioned in a fixture or jig it is possible to obtain effective control of the fumes by the use of a grill, side hood, or flexible duct near the source of fume. If the parts are large and it is necessary to weld more than a foot from a fixed point, it is difficult to obtain good control of the fume with reasonable air volumes through a system using flexible ducts.

Since the effective range of most flexible ducts is approximately eight inches from the dust opening, it is necessary for the welder to move the duct whenever the arc is outside this range. The practical result is that

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most ducts are normally not moved and the ventilation system does not remove the fumes. According to reports, this type of system has been effectively used in shipyards for the control of welding fumes in confined areas. In view of this experience it should therefore be a satisfactory means of control for welding fumes in tanks. However, supervision and education are necessary to make such systems effective.

Where the room volume per welder is large, natural ventilation within the plant is usually sufficient to prevent accumulation of excessive conventration of fumes from plain steel welding. Circulating fans directed from the side help to dilute the fume which may be concentrated in the breathing zone of the welder.

Another means of control is the use of personal respiratory equipment. Air line respirators and fume respirators have been developed which will provide adequate protection. Some manufacturers have on the market welders' helmets with facilities for providing fresh air to the wearer. Use of this type of equipment has been limited. Since the welder is already burdened with helmet, goggles, and protective clothing he probably will not be receptive to a respirator. It is sufficient in most welding for the employee to wear an ordinary helmet and to arrange the position of the work so as to prevent the concentrated fume from flowing under the helmet.

Dry Grinding

Dust resulting from the grinding of nontoxic metals which are free of sand is generally considered a nuisance and is not harmful *per se*. Despite this fact some state laws require grinding operations to be ventilated. This requirement has probably been a holdover from the days when sandstone wheels were prevalent and also to prevent the creation of a nuisance condition. Grinding wheels in use in industry have artificial abrasives, such as aluminum oxide or silicon carbide. Emery, a natural product composed essentially of aluminum and magnetic oxide of iron, may also be used. A permissible limit of 50 million particles per cubic foot of air for aluminum oxide and silicon carbide was recently accepted by the members of the American Conference of Governmental Industrial Hygienists. Such a limit is liberal and concentrations of such magnitude are normally not encountered.

When lead, silica, or some similar toxic material comes in contact with the grinding wheel the exposure to the abrasive matter may be ignored and the exposure evaluated on the basis of the toxic material. If this latter material is controlled, the nuisance will also be eliminated.

Ventilation systems for grinding wheels have been fairly well standardized and generally are satisfactory to prevent a nuisance. Hoods should enclose the wheel as completely as is practicable. Air volumes should be sufficient to cause an inward flow into the hood when using the smallest wheel. This is especially true where toxic materials are involved.

Wet Grinding

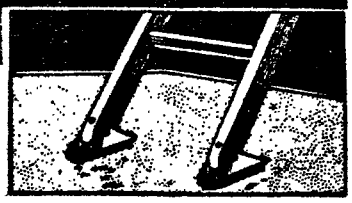
Baffles, hoods, and guards are generally located near wet grinding wheels to prevent dispersion of the liquid used as a coolant. These devices are usually sufficient to control the dust if it is nontoxic in nature. If the dust liberated is toxic, mechanical exhaust ventilation may be required.

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wheels used for buffing and polishing vary in composition. Waxes and various types of abrasives are the major components. These materials, plus lint and fibers from the wheel, are the essential ingredients of the airborne dust. The toxicity is dependent upon the type of abrasive. Generally ventilation is provided to improve housekeeping and reduce the number of complaints and not because of the hazard to health.

Machining

Smoke from oily parts is the prevailing source of air contamination at machining operations. Illness has not been attributed to this type of exposure. As is the case with most fumes and dusts of the nuisance variety, little is known as to what effect such materials have on existing physical abnormalities.

Machining operations on steel produce large chips or turnings; consequently, dust is not a problem. Operations involving the machining of high lead alloys have been studied, and significant quantities of airborne lead have not been demonstrated.

Graphite which becomes airborne during the machining of cast iron is not considered physiologically significant, and therefore, is classified as a nuisance dust. Frequently management considers it advisable to provide ventilation for the machines which are productive of the most dust, as graphite on the clothing and person and surrounding machinery is conducive to many complaints.

Abrasive Cleaning

Since silica is recognized as the most harmful of mineral dusts, an adequate ventilation system is normally provided at the time of installation of commercially built sand blast equipment. Continuous usage and lack of maintenance result in a breakdown of adequate control. Visible escape of dust is the best evidence that this has occurred and it is advisable to correct such a condition without undue delay.

Employees who are stationed in blast rooms are dependent upon personal respiratory equipment. Devices of this type are of the supplied-air variety, and it is necessary that the air provided be free of harmful contaminants. Air compressors should be located in an area free of contamination, otherwise the contaminant will be transmitted to the helmet.

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Normally, ventilation within the room is provided so as to improve visibility and to help prevent the escape of dust to the surrounding areas, not to reduce the concentration of silica dust to a safe level.

Tumblast or rotating table type of sand blast units should be provided with sufficient ventilation to prevent the escape of silica dust. Leakage due to excessive wear should be remedied.

Small sandblast cabinets where the operator controls the blast nozzles from outside the cabinet, frequently have faulty seals around the doors or the rubber gauntlets are loose or torn. The dust which escapes from the cabinet through these openings is in close proximity to the breathing zone of the employee and in many instances exceeds the permissible limit for silica. This leakage should be corrected and the men should not be required to use respirators.

If the articles being blasted are free of silica or other toxic material, the dust resulting from grit or shot blasting is classified in the nuisance category. It follows that the maintenance of ventilating systems for grit blasting, although desirable, is not always so necessary as for sand blasting.

The use of steel grit or shot in blasting rooms produces excessively high concentrations of dust within the enclosure. It is therefore, necessary to protect the worker within the room. The remarks concerning sandblasting rooms are therefore, pertinent when considering rooms in which steel grit or shot are used as the abrasive.

Vapor blasting, a variation of sand blasting, is a comparatively recent development. This procedure involves the use of fine silica and water under pressure. The silica used in vapor blast units varies in size and may even be as small as 1250 mesh (approximately 10 microns). It is generally believed that airborne silica particles below 5 microns are most significant in causing silicosis. It then follows that operations involving the use of silica abrasive whose initial particle size approaches that order of magnitude are more hazardous, and, require continual vigilance in maintaining good control. It is, therefore, essential that the vapor blast cabinets be maintained so that leakage of mist does not occur.

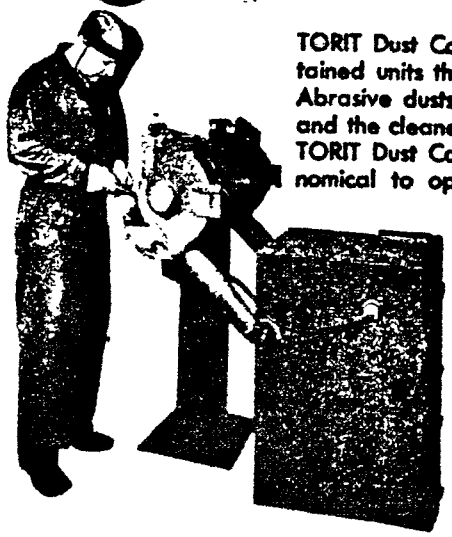
Good housekeeping is also essential as spillage of the sand and water sludge upon the floor will create a source for dust dissemination when the water evaporates. Likewise, containers of the dried sludge should not be allowed to stand in the factory where they can be influenced by air currents of high velocity.

Practically all industrial plants have operations which involve the use of lead base bearing metal or



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solder. Babbitt bearing metal containing approximately 75 per cent lead have been encountered. The composition of solder metal is variable and dependent upon the purpose for which it is used, with ordinary soft solder containing a comparatively high percentage of lead.

Assuming that the babbitt or solder contains a significant amount of lead, the question then arises as to whether or not employees working with this material will become ill. The answer could be given by a qualified industrial hygienist after he had seen the operation and considered such factors as the temperature to which the metal is heated, the method of removing excess solder, the length of exposure, and the effectiveness of the control measures provided.

It is a well known fact that lead causes illness if absorbed in excessive amounts, and therefore operations where lead is used have received considerable study. Out of this experience certain practices are known to produce excessive exposure whereas other practices have been proved not to be harmful. It is generally conceded that excessive concentrations do not result from operations where solder is applied by means of an electric soldering iron. This is probably due to the small amounts of solder used and the comparatively low heat of the metal.

When the iron is heated in a small gas-fired furnace, the exposure may be of greater consequence. Solder which remains on the iron coming into contact with the flame or heat is vulnerable for volatilization. Small amounts of solder drop from the iron onto the hot floor of the furnace where it is readily volatilized or oxidized. The oxidized material may become airborne due to disturbances created by the flame or by removing or placing the soldering iron in the furnace.

Frequently industrial hygienists recommend that ventilation be provided for heating units of this type, thereby removing lead fumes and dust from the environment. This is particularly true in small rooms or where many units are in use.

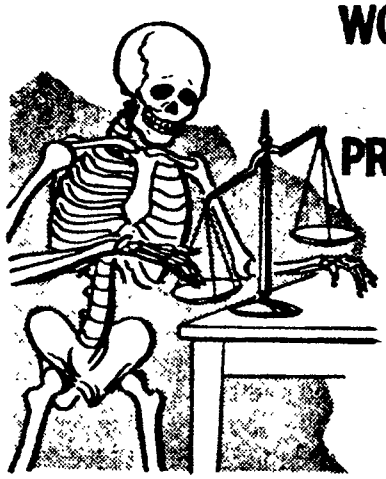
Atmospheric contamination occasioned by the use of either gas or electrically heated pots containing solder is dependent on a number of factors. With higher temperatures more volatilization will occur and the greater will be the exposure. With the higher temperature the metal is more readily oxidized to produce a dross consisting of a high percentage of lead oxide. The dross may provide a protective coating to reduce the volatilization of the lead; however, disturbance of this coating will create an exposure.

As a safeguard against excessive contamination, pots containing solder or babbitt are usually ventilated. Wherever possible, it is advisable to enclose the pot as completely as possible and provide sufficient air volume to overcome the thermal effects of the molten metal. Attempts have been made to use natural draft ventilation systems to control these fumes and in those instances where the ducts were not of sufficient diameter the system was inadequate. A preferable method is the use of mechanical systems.

The removal of excess solder with power-driven tools, such as grinding wheels, discs, or wire wheels, creates airborne dust which may contaminate large areas if the operation is extensive. Diligent use of abrasive cloth will also result in excessive concen-

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trations of lead dust. Filing, however, is not productive of small particles and is preferred over the use of power-driven tools.

If filing is not practicable, it will be necessary to provide some type of mechanical ventilation system for the solder removal operations involving the use of power tools. Since the permissible limit generally accepted for lead is 1.5 milligrams per 10 cubic meters of air (353 cubic feet) it will be necessary to have an effective system to provide adequate control. Engineers experienced in designing ventilation systems to control toxic materials should be consulted, otherwise a costly system might be erected and later found entirely ineffective.

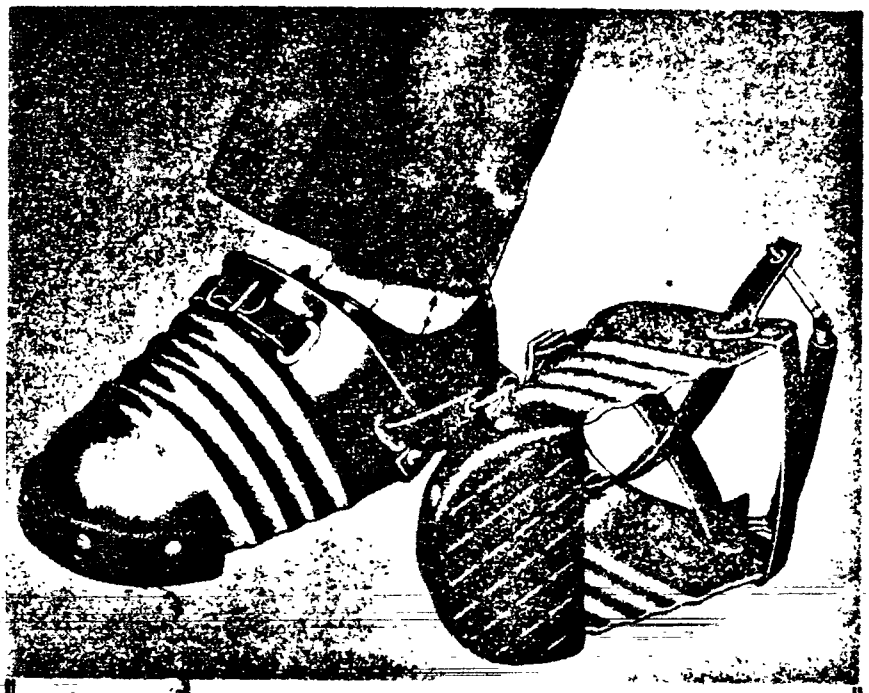
Frequently solder removal operations require the use of portable tools on large objects and a local exhaust system would not be effective, as is the case in the fabrication of automobile bodies. General contamination of the factory with lead dust has been eliminated by enclosing the entire operation in a large booth and exhausting a sufficient quantity of air from the enclosure to insure a constant inward flow of air from the factory into the booth. Under these circumstances no practical amount of air could be removed from the booth to reduce the lead concentration to a safe level, and therefore it is necessary that the men working therein be provided with adequate personal protective devices.

Heat Treating

High temperatures are a frequent source of complaint from employees in heat treat departments but such conditions and their control are not within the subject under discussion.

Fumes from cyanide pots are often associated with cyanides used as fumigants or as the lethal agent in death chambers, and supervision as well as the employee becomes apprehensive. Fumes from such a source are irritating and because of this property should be adequately ventilated. The irritant nature of the fume is caused by alkali formed upon decomposition of the cyanide.

Molten lead is sometimes used as a hardening medium for metals. Frequently charcoal or some similar material is placed on the surface of the metal to conserve heat and prevent



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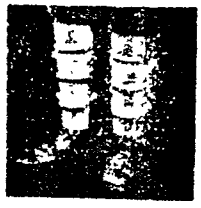
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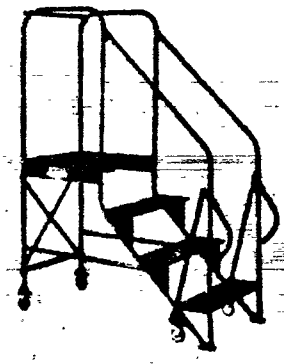
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oxidation. A covering of this type reduces the volatilization of lead while the bath is quiescent, but has no effect while the bath is in use. Adequate ventilation should therefore be provided for baths of this type. As complete an enclosure as is practical for the operation being performed is advisable with air quantities dependent upon the open areas in the hood. To prevent contamination resulting from volatilization of lead accumulating in the combustion chambers the products of combustion from gas fired lead pots should be vented to the outdoors and not be allowed to dissipate into the workroom.

Asbestos

Asbestos used in the formulation of brake lining is a potentially harmful compound. This material is the offending agent in the production of the lung ailment known as asbestosis. The harmful effect is comparable to that of silica and a permissible limit of 5,000.000 particles of asbestos dust per cubic foot of air is generally recognized.

Dust exposures to asbestos and other ingredients of the brake lining exist when the dry materials are handled and emptied into the mixers and in the subsequent operations of slitting, grinding, or surfacing. Compounds of lead are sometimes used in brake linings, and contamination from this source should not be ignored. Local exhaust systems with properly designed hoods or enclosures are used to remove the dust from these operations.

Iron Foundries

The principal ingredients of foundry dusts are silica, sea coal, clays, and parting compounds. The predominant material will be dependent upon which phase of the foundry operation is being studied and what operation is being performed. The control of dust is the major problem, whereas fume is of secondary importance.

A discussion of all the aspects of the industrial hygiene problems in such plants would require a separate treatise. For the present discussion it should be sufficient to state that all obvious sources of dust dispersion should be reduced to a minimum by adequate localized exhaust systems. In a mechanized foundry such places would be sand conditioning and mixing equipment, tumbling mills, shakeouts, core removal and knockout stations, transfer points of dry sand, abrasive blasting operations, and all grinding operations performed on castings containing appreciable quantities of sand.

Maintenance of ventilation equipment is a major item in foundries because of the abrasive action of the dust. It is imperative that a good program be maintained so as to keep the equipment functioning at maximum efficiency.

Because of the heat associated with large scale foundry activities it is a common sight to see pedestal fans or air cooling ducts directed in such a manner as to create cross drafts which interfere with the efficient removal of dust. Better placement of these fans or ducts will go far in reducing dust concentrations in the areas where they are used.

Respiratory Protective Devices

After the obvious has been corrected, it is advisable that a survey of the foundry be made by an industrial hygienist so that an accurate evaluation of the exposure may be obtained.

As has been stated, the atmospheric

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other materials may be reduced to a safe level by adequate exhaust ventilation. In some cases it is possible to correct the condition by substituting a less toxic material. If these measures are not practical, respiratory protective devices may be used. They may also prove valuable in giving protection during an emergency or to provide protection for intermittent exposures or to supplement other methods of control. They should, however, not be considered as the desirable means of controlling a health hazard.

Ceramic Plant

—From page 37

Handling materials is recognized as a prolific source of accidents in industry; consequently it is a fundamental that handling should be kept at a minimum to avoid accidents as well as to keep down operating costs.

3. Nearly every ceramic plant must store large quantities of finely ground material. Many storage systems are of the deep bin type. Some of the materials do not flow freely, and because of forces developed in deep granular material, arching takes place. Often devices are not provided to keep material moving to the bottom of the bin. As a result, a worker must enter the bin from the top to get the material moving. This is a dangerous operation but when necessary, safety harness and life lines should be used and attendants stationed where they can help in an emergency.

4. Silicates and silica or quartz are primary materials in nearly all of the ceramic industries. Also, these materials are generally used in a finely ground state. As a result there are many dust problems. When the free silica in these dusts is finely divided, workers exposed to them are potential victims of silicosis. Either workers must wear respirators or dust must be removed from the work place by exhaust ventilation with a system of dust collectors.

Control of dust should be a major consideration in the ceramic plant. Not only is dust injurious to workers, but it is also harmful to machinery, complicates housekeeping, and produces generally unsatisfactory working conditions.

5. Operation of kilns, tanks and furnaces presents other hazards. Often there is the possibility of explosions and refractory failures. All such equipment must be designed and constructed for safety as well as for processing requirements. Protective equipment should be provided for use in case of power failure or faulty combustion conditions.

6. It is hardly necessary to say that moving parts of machinery should be guarded. Wherever practicable, such guards should be built in to the machinery.

7. In general, building structures and equipment used in the ceramic industry are subjected to rigorous use. Fumes, heat, dust and heavy loads create problems; consequently a relatively high factor of safety or factor of uncertainty should be incorporated in the design.

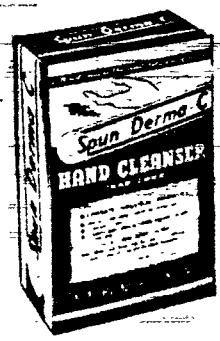
The solution of many of these problems will require the cooperation of the safety, production and engineering departments. Compromises, if required, should be those necessary for process reasons, since it is acknowledged that the process is the prime reason for the plant.

Planning the original design and layout and selecting equipment with the safety angle in mind will safeguard the investment as well as reduce the accident risks.

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