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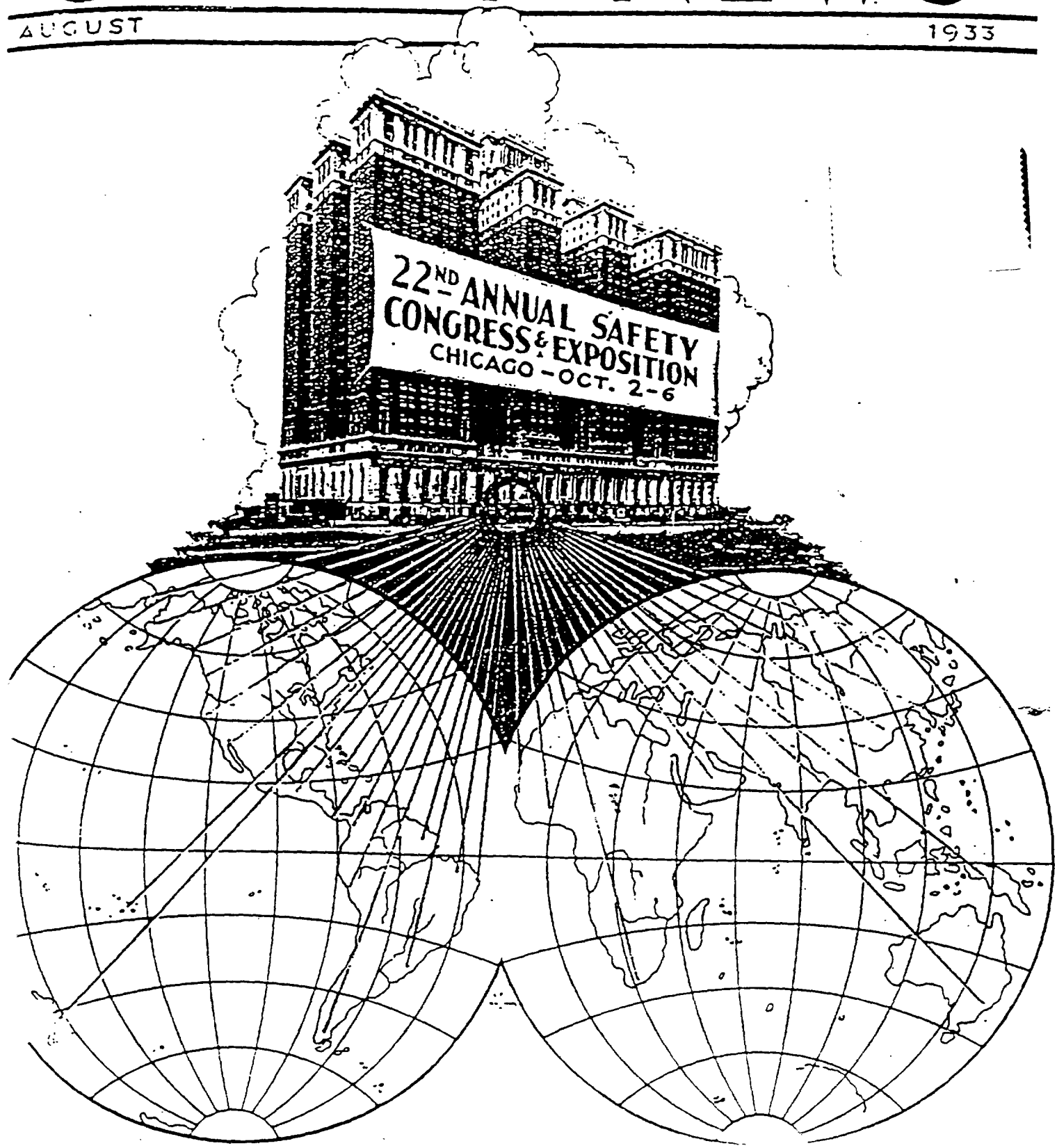

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New York Office, 9 East 41st Street

The Mechanical Control of Occupational Diseases

By DAVID S. BEYER*

• Both the engineer and the physician are needed in protecting the health of the worker and the pocket book of the employer. In this article Mr. Beyer presents the engineering side of the problem. In the June issue Dr. W. Irving Clark discussed it from the point of view of the physician

THE mechanical control of industrial disease cannot be covered adequately in a single article; all we can hope to do is to touch upon a few of the important points encountered by the plant managers who are struggling with this problem today.

There are some forty different diseases scheduled in the compensation acts of various American states; in Massachusetts, Connecticut and several other states there is no definite list of diseases that are compensated, but these diseases are considered as "personal injuries" under the law and compensation is paid without any specific schedule of diseases.

Many of these diseases are of infrequent occurrence. Probably most of us outside the medical profession have never even heard of "Gonioma Kamassi" (African boxwood) on "miner's nystagmus," which appear on some of the state lists. A half dozen of the more important diseases, however, will probably cover ninety percent of the total payments being made throughout industry for all industrial diseases today.

An analysis of approximately $300,000 in losses of one insurance company doing a general workmen's compensation and liability business, for recent industrial disease claims, showed 54 per cent for cases involving pneumoconiosis (including silicosis, asbestosis, etc.) 26 per cent for lead poisoning, 9 per cent for various forms of dermatitis, 5 per cent for benzol, and the remaining 6 per cent for scattering causes such as carbon monoxide, carbon tetrachloride, chrome and chlorine.

We will accordingly look at the subject from the standpoint of these few important causes, bearing in mind that the most important of all is covered by the general heading of pneumoconiosis, or diseases caused by dust. Of these diseases the most serious come from inhaling the silica found in sand, granite dust, abrasive powders, etc.

When the subject of dust is mentioned most of us probably think of visible particles. In fact, much of the dust removal work, even by companies specializing along this line in the past, has been directed at this form of dust.

Medical research has shown us, however, that the dust that is most dangerous, through its deep inhalation into the lungs, is so small that the individual particles are invisible and can only be seen by the naked eye if they are gathered in a dense cloud, which may have the appearance of a gray fog.

We are told that the amount of dust found in the lungs of miners who have died of silicosis is about 13 grams†, or approximately half an ounce—about enough to fill a ten-cent soda-mint bottle.

Microscopic Menaces

Some idea of the problem of collecting such infinitestimal particles may be had when we further learn that these 13 grams contain some 20 million million particles; many of them are about the size of the tiny globules of tarry substance that make up cigaret smoke, that is, about a hundred thousandth of an inch in diameter. If they were equipped with legs they could march fifty abreast through the hollow center of a human hair!

So little has the seriousness of this hazard been appreciated in the past that it is not uncommon to go into a plant and find four or five tons of this fine dust which has floated in the air and settled on the roof trusses and overhead structures of the building. Here it may be dislodged by gusts of air or vibrations from moving cranes, etc. If one stops to figure how many 13-gram bottles are contained in a ton of this dust, its potentialities are appalling. The first need is to get rid of these unnecessary accumulations, and then try to prevent their recurrence.

Many a plant manager will say, "Why go to all the trouble and expense necessary to catch this dust when, in most cases, it isn't worth anything after it is caught?" The answer is that it is better to spend the money and effort in getting rid of the dust than to be overwhelmed by occupational disease claims, as is the case with many industrial concerns today.

In one section where there is a so-called "dusty" trade employing only about 2000 men on an annual basis, there have been 92 occupational disease claims during the latest available five-year period (68 of them for death or permanent total disability) with combined losses of nearly $300,000.

In some industries the cost of industrial disease is now four or five times that of all other industrial accidents combined. Many concerns that have serious occupational disease hazards extending over a period of years find themselves virtually uninsurable, because of the heavy liability for claims that has been built up as the result of past exposure.

A Matter of Self-Preservation

It follows, therefore, that as a matter of self-preservation plants in these industries must start immediately a comprehensive program of improvement that will at least check the development of new cases.

In general, the most reliable way to

*Vice-President and Chief Engineer, Liberty Mutual Insurance Company, Boston, Mass. (A paper read at the Twelfth Annual Safety Conference of the Massa-

†See Dust Respirators

equipment that will capture the dust at the point where it is generated. This has been worked out very effectively for such equipment as grinding and buffing wheels.

Unfortunately a complete system of dust collecting and separating for a large department costs a lot of money—more than many plants feel they can possibly afford under present business conditions.

Temporary Expedients

For such cases there may be other alternatives or temporary expedients that will at least tide matters over until improved business conditions warrant the installation of a permanent dust removal system.

For instance, the manager of a plant recently visited by the writer stated that they had already spent $80,000 in exhaust equipment and had not yet fully solved the dust problem. In this industry, the use of oil which has been sprayed on the material in some cases in the past, to improve its handling in the machinery and processes, offers a promising solution to the dust problem. Dust counts in some plants using the oil show reductions of 90 per cent or more in millions of particles per cubic foot, and if further tests corroborate these results it offers a simple and comparatively inexpensive method of correcting the dust hazard in one industry.

In other operations, such as the shaking out of foundry castings, it may be possible to do this work at night, by men who are protected by respirators, and thus eliminate a common exposure to employees engaged in other operations in the same room. The use of enclosed mechanical conveyors and material handling systems, properly exhausted, instead of the old individual hand methods where the workers were brought into close contact with dusty substances, offers a solution in other cases.

The treasurer of one concern with whom I recently discussed the hazard of his foundry said, "Maybe we have the answer right here," and he brought out the design of a machine which was fabricated entirely from sheets, plates, angles and other structural shapes, riveted and welded together, which would entirely eliminate the castings of which it was largely composed in the past.

Where the dusty work is in a permanent location, and too great freedom of movement is not required, the air-fed respirator may give satisfactory results. For cases of temporary dust exposure, as for sweeping and cleaning up dust, the improved types of filter respirators may be adequate. In some cases substitutes may be found for the substance causing the trouble. This has already been done in some processes where benzol was formerly used, and efforts are being made to extend the use of this principle.

The use of water to overcome dust hazards is one of the first suggestions that is usually made. I recently tried to explain this problem to an industrial manager and after telling him that the dust which causes the trouble is less than 10 microns in size, a micron being about 1/25,000th of an inch, and being encouraged by his nods which seemed to indicate that he was following my explanation perfectly, I was a little disconcerted at the end to have him say, "Why can't you get rid of those microns by washing the air?" Apparently after all my efforts he still thought a micron was something like a microbe!

Water has been found rather effective for laying the dust in some operations such as mining, sweeping up dusty floors, etc. In other cases, it has been a disappointment as, for example, on grinding wheels, where a dry exhaust system has proved to be more satisfactory than wet grinding.[2]

During the conference in South Africa in 1930, one of the speakers pointed out the futility of trying to completely remove dust clouds by water sprays or atomizing, adding the further comment that a tiny droplet of water may collect as many as 800 dust particles and then being inhaled is like bombarding the lungs with shrapnel instead of single rifle fire.

Unwarranted Confidence

Where exhaust equipment is installed, poor maintenance of these systems whereby their value is reduced or entirely vitiated is altogether too common. An inquiry in a plant recently as to how the dust filtering apparatus was working brought the reply, "Fine! —we haven't had to even look at it for six years!" When we climbed a ladder to the roof to see this miraculous equipment, a touch on the screens shook a pail-full of dust from the "clean" side of the separator.

Another common and dangerous practice in many dust removal systems is that of returning the filtered air to the plant in order to conserve the heat that would be lost if it were discharged outside the building. In five such systems where dust counts have been made during the past few months there was only one where there was even a question as to whether or not the air was fit to be returned. In one case over forty-seven million dust particles per cubic foot were found in the air that was being re-circulated, or many times what we would consider a safe limit!

Ineffective Installations

The salesman who had put in the equipment had persuaded them that the filtered air was so much purer than God's product as represented by the outside atmosphere that he had even piped it into the office, so the manager was breathing the dust as well as the factory employees. (Perhaps that might be called cooperation!)

While it may be going too far to say that no filtering equipment can make dusty air suitable for re-breathing, the constant chance of the system getting out of order makes it almost as questionable a practice as an attempt to recover drinking water from a sewage system.

Installations that are clogged, leaking and otherwise ineffective are common. One of our engineers found that the belt connecting the exhaust fan to the motor in an overhead installation had been off for an indefinite period. The motor switch had been thrown regularly but no one noticed that there was no exhaust at the grinding wheels it serviced.

In another installation seen by the writer recently, a handkerchief held before the wheel stood out horizontally showing that the dust was being blown out toward the operator instead of being drawn *in* away from him.

An important point that should be borne in mind in designing an exhaust system is that it is highly desirable to capture the dusts or vapors as close to the point at which they are generated as possible, before they have had a chance to be diffused throughout the air of the room.

General ventilation may be helpful in reducing the concentration, but it is obviously of little value to draw the objectional substances up through a roof fan as is sometimes done, thereby carrying them past the faces of the operators who must draw them in with every breath.

The design of a proper exhaust system

(Please turn to page 54)

[2] See Health of Workers in Dusty Trades U. S. Public Health Bulletin No. 157, p. 34.

[3] See "Silicosis" — International Labour [illegible]

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to effectively control dust requires a thorough understanding of certain engineering principles that are completely lost sight of in many of the installations now in use.

For example, where the dust collector can be so arranged as to enclose the source of dust completely, or almost so, a very complete dust elimination may result, but where the inlet is five or six inches away from the source of the dust its efficiency may be reduced by as much as 90 to 95 per cent, and be wholly ineffective.[4]

Where the exhaust equipment has been looked on in the past as more or less of a nuisance because it is non-productive and could accordingly be slighted at will, it must now be recognized as a primary operating problem, and responsibility must be placed on someone to see that it is kept in first class condition at all times.

And so, to summarize the results of this brief survey of the mechanical control of occupational disease hazards, it is the opinion of the writer that chiefly in this direction lies safety from some of the most serious diseases, if one also includes rearrangement of the processes under "mechanical control," in contrast with the "medical control."

While agreeing that medical supervision of new prospects for employment is of primary importance, in order to prevent placing new employees who have some physical impairment in a position where they will quickly break down as a result of the work hazard, and granting the value of medical follow-up of employees subjected to exposures such as lead and benzol, which bring about a temporary condition that may be checked by medical supervision and a change of occupation, it seems evident that in the most serious industrial disease hazard, that of exposure to silica dust, chief dependence must be placed on elimination or control of the dust.

In installing such equipment it will save money and grief in the long run, to employ a competent engineer who understands the difficulties of collecting impalpable dusts or vapors, and can have a reasonable assurance of getting an effective installation without too much of the "cut and try" method.

[4] See "Velocity Characteristics of Hood Under Suction," J. M. Dallavalle, American Society of Heating and Ventilating Engineers, 1922, and "Studies in Design of Local