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Industrial Health Hazards and Employer Responsibility

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Abstract

Dust has been in existence since man first walked the earth, according to the author, but it was not until the invention of the machine that dust became an industrial hazard. In this paper, the author discusses the action of dust in the lungs and points out that all dusts are not dangerous. Silica dust is one of the dangerous dusts but only when present in certain concentrations of certain particle sizes. The point that complicates the silicosis problem is the fact that in many cases there is also decided evidence of the presence of tuberculosis. He points out that in foundries many men with normal lungs work for years and do not contract silicosis although there may be evidence of fibrosis. The author explains the action of the dust particles inhaled on previous pulmonary injuries and states that workmen who are disabled by occupational fibrosis contracted in the foundry generally are those who exhibit evidence of concurrent pulmonary infection or injury. With regard to the executive's responsibility, he should inform himself on dust hazards, should conduct surveys of his plant and should inaugurate a program of control. In the latter section of the paper, the author groups employes and prospective employes into three general groups and explains which groups are good or fair risks and which should not be employed. He concludes with the recommendation that an educational program, similar to that used in "Safety First" campaigns, be inaugurated to combat the dust hazard.

1. Centuries ago, when man was just emerging as the dominant figure in the welter of life about him, we can visualize a thick-set figure clothed in animal skins setting forth from his cave in the early morning. He carried a rounded stone in his hand as he passed along a trail in search of food, and relied largely upon his keen senses to warn him of approaching game or danger. He inhaled deeply of the air brought to him by the fresh morning breeze, and suddenly tensed as he became aware of the approach of a hare. As the animal fled before him, he hurled the stone but misjudged the distance, and missed his prey.

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2. In searching for his weapon, he discovered that it had struck a rock and splintered into sharp angular pieces which attracted his attention as useful objects. Later that afternoon, his appetite satisfied, this early man experimented with stone chipping in an effort to produce more perfect weapons or tools. During the process of fashioning a flint spear-head, the early artisan must have inhaled a certain amount of fine flint dust, but there is little to lead us to believe that his health or welfare was seriously affected thereby.

DUST IN ATMOSPHERE.

3. Before the first tool or machine was devised, the lungs of this early man had already accumulated considerable dust from the apparently clear air about his home. The elementary forces and the activities of living things were constantly producing dusts which were added to the atmosphere in varying quantities. Concurrently, these same forces were operating to rid the air of part of the contamination. Since none of the forces tending to eliminate the dust were perfectly efficient, particulate matter constituted a normal component of the atmosphere enveloping the earth and, because man exercised little or no control over the forces producing dust, he inhaled a portion of it with the first breath of life and continued to do so throughout his existence.

4. Not all of the dust which he inhaled was retained, for a considerable quantity was filtered out and expelled by the air-conditioning apparatus of his upper respiratory tract, which was provided with hairs, moist mucous surfaces, a whipping sea of cilia and the mechanism of cough. Moreover, a further portion of dust was returned to the atmosphere in the exhaled air, but a certain proportion entered the ultimate air sacs of the lungs and was retained there to be disposed of by the interesting processes provided by the pulmonary anatomy.

BEHAVIOR OF DUST IN THE LUNG

5. If we could have observed the living tissues of this early man under high magnification, we would have noted that wandering cells or phagocytes moved out from the walls of the air sacs and engulfed the particles which had entered the lung, thereby furnishing the dusts a possible means of transportation and more intimate contact with the body fluids but at the same time protecting the pulmonary structures from purely mechanical irritation. Some of the dust containing cells might have appeared to be greatly

stimulated by their ingested particles and would have migrated toward the nearest portal of entry, into the drainage system or lymphatics. Some of these stimulated cells would have come to rest at small catch-basins along the drainage system, but the greater portion of them would eventually have lodged in the cesspools or lymph nodes near the root of the lung.

6. At these points, there would have been a sufficient concentration of particles to pigment the structures so that the color of the dust could have been discerned with the unaided eye, had the lymph node been exposed to view. Other dust containing cells would have appeared quite differently than those just described, however, for they would have displayed little or no stimulation and would have remained in the air sacs lethargically taking in a new particle from time to time but failing to show any evidence of concern over their burden.

PARTICLE SIZE

7. If the lung of this early man could have been examined with all the microscopic, petrographic, and chemical skill of the present day, many interesting facts about the dust that they contained, would have been disclosed. This dust would have been discovered to have a well defined size distribution with none of the particles larger than 10/25,000-in. (0.0004 in.) in diameter, while 70 per cent of it would have been less than 1 to 2/25,000-in. (0.00004 to 0.00008 in.) in diameter.

TYPES OF DUSTS

8. The particles would have shown a great variety of constituents, some of them being derived from living things or organic, while others would have been earthy, or inorganic in nature. Part of the organic dust would have been shown to be living bacteria highly stimulating and capable of causing the death of their host cells, while other parts of the organic material would have been composed of animal or vegetable cells. The inorganic components would have consisted largely of small particles of various rocks.

9. Certain of the dusts would have been readily soluble in the body fluids, and would have dissolved in the containing cells, forming either poisonous or innocuous products which in turn either stimulated and killed the host cells or left them unaffected. Other dusts would have been relatively insoluable and would have

remained in the pulmonary framework throughout the life of the tissues containing them. Some of these latter particles would have appeared totally inert, while others would have stimulated the phagocytes and created further change in the tissue.

MACHINERY INTRODUCED

10. Our early man was quite unconcerned about all these interesting phenomena and probably continued to chip flint objects for his tribe until he reached a ripe old age. With the passage of time, better tools were fashioned and a third great force for the production or elimination of dust was introduced in the form of machines.

11. The social group was organized to perform industrial activities and craftsmen appeared who devoted all of their working hours to specific skilled occupations. Frequently, these occupations involved the production of dust and the concentration in the atmosphere about the craftsman was often much greater than that which the artisan of the stone age created, because this modern workman was aided by more efficient tools. It was significant also that the craftsman continued steadily at his work, whereas the early artisan exercised his skill only as his fancy dictated in the hours not consumed by the struggle for the necessities of existence.

12. Certain of these craftsmen soon were observed to have an excessive mortality from one cause or another, and occupational diseases were recognized. About 400 years ago, Georgius Agricola in his famous "De Re Metallica" wrote as follows:

> "When the dust is corrosive, it ulcerates the lungs and produces consumption, hence it is that in the Carpathian Mountains there are women who have married seven husbands, all of whom this dreadful disease has brought to an early grave."

Later, Ramazinni, who wrote the first text-book of industrial medicine, attributed the high mortality from consumption among miners and stone workers to the sharp cutting action of the small bits of stone which these workmen inhaled. Other observers described the unusual appearance of the lungs of men who had worked in dusty trades of various kinds and Zenker coined the work *pneumonoconiosis* to describe the pulmonary changes which follow the prolonged inhalation of any dust or mixture of dusts.

13. Recent investigators have pointed out that excessive exposure to silica appears to constitute the greatest of all industrial

dust health hazards, and the term "silicosis" has been adopted to designate the specific condition which men develop after long exposure to this dust.

EFFECT OF SILICA DUST

14. In the normal individual, the reaction to inhaled crystalline silica is characterized by the development of a peculiar type of fibrosis or scar which appears in those areas where silica is deposited within the pulmonary structures. Silica-containing air enters the lung in turbulent motion and the dust is deposited uniformly throughout the entire organ. Since these particles are capable of stimulating phagocytes, they are rapidly transported into the drainage system or lymphatics, and the first detectable evidence of characteristic fibrosis appears in the lymph nodes situated at the root of the lung. Later, this reaction will manifest itself throughout the entire lymphatic system which encircles the blood vessels and bronchi.

15. As the reaction throughout the lymphatics proceeds, the effectiveness of this drainage mechanism is interfered with and the dust entering the lung is eventually unable to reach the lymphatics, and is thereafter deposited by the phagocytes in selected areas throughout the lung substance itself. Small, discreet, and uniformly distributed fibrous nodules from 2 to 6 mm. in diameter may eventually develop in large numbers within the lung, presenting in this stage the characteristic picture of advanced silicosis.

X-RAY SHOWS CHANGES

16. An excellent x-ray film of the normal individual's chest represents a projection of the pulmonary structure cast as shadows of varying density. Prominent among these densities, are those cast by the blood vessels, which compose the so-called vascular tree. The fibrous changes initiated by pure silica can be detected in the early stages on a good roentgenogram, by the increased densities shown at the root of the lung where the lymph nodes are situated. Further changes throughout the lymphatic system will become evident by an increased prominence of the vascular shadows caused by fibrosis developing in the lymphatics surrounding these structures. Finally the roentgenogram will reveal, as small round densities, the uniformly-distributed, discreet, fibrous nodules present throughout the lung in advanced silicosis, giving the characteristic "snowstorm" appearance described by roentgenologists.

ACTION OF INERT DUSTS

17. Inert dusts such as coal, hematite, gypsum, alumina, and limestone, produce no stimulation of the phagocytes and hence tend to remain within these cells for long periods without promoting any further action. When mixtures of silica and these inert dusts are inhaled together, the reaction so characteristic of silica is modified by the inert material which tends to slow down the changes which would result if the silica were present alone. These modified reactions are apparent not only to the pathologist, but also to the roentgenologist, and constitute the great bulk of all cases of occupational fibrosis. Experience has demonstrated that individuals with modified silicosis do not suffer from the excessive mortality which characterizes those groups with true silicosis.

TUBERCULOSIS

18. If tubercle bacilli are inhaled, they are handled in much the same manner as dusts. Once in contact with the tissues, however, they are either killed and disposed of or they set up localized foci of infection. The organisms are transported by phagocytes into the lymphatics and the tissues then attempt to wall off these foci of infection by laying down an ever thickening mantle of fibrosis. This reaction is much the same as that which follows the inhalation of silica, except that it is generally localized to one or more portions of the lung and may be visualized and interpreted as tuberculosis with remarkable accuracy in a good x-ray of the chest.

ACTION OF SILICA ON TUBERCULOUS LESIONS

19. Obviously, the lung which has been injured by a pulmonary infection, such as tuberculosis, is far less competent to deal with a dust, such as silica, than is the normal lung. Moreover, it has been proved both clinically and experimentally that the inhalation of pure crystalline silica tends to re-activate a pulmonary tuberculous lesion which would otherwise heal, and frequently renders such infection progressive and fatal. Even if the tuberculous lesion has successfully healed prior to the time when silica is inhaled, a far greater reaction to the dust occurs about the site of the old tuberculous scar than occurs in normal tissue, since the drainage system in that area has already been damaged and since the two processes apparently stimulate the tissues to produce an excessive amount of fibrosis.

20. Recent investigations have disclosed that individuals who have simple silicosis, uncomplicated with tuberculosis, are not generally disabled, even though their condition may be quite advanced. A careful physical examination frequently fails to reveal anything abnormal about such individuals, and the changes which have occurred in their lungs can be detected only by the x-ray.

PREVIOUS PULMONARY INJURIES

21. Silicotic workmen who complain of shortness of breath, chest pain, cough, or other disabling symptoms are generally found to have either a complicating pulmonary infection, usually tuberculous in nature, or some evidence of a previous pulmonary injury which has left a localized scar. These cases can be discerned on an x-ray film by the characteristic appearance of silicosis to which has been added the densities cast by the localized masses of pulmonary fibrosis which exist about the sites of the infection or previous pulmonary injury. Frequently, such cases fail to show tubercle bacilli in the sputum until shortly before death. In many instances, the disease is unusually chronic and only slowly progressive, manifesting itself largely by a progressive shortness of breath. Cases of this type are the prominent feature among the men actually disabled by a modified silicosis hazard.

22. Widespread misconception of the disabling effects of uncomplicated silicosis has arisen from the studies of early investigators who were unable to distinguish cases of silicosis from those complicated with pulmonary tuberculosis or other infections with the equipment or knowledge then available. These earlier investigations revealed silicotics who displayed shortness of breath, chest pain, cough, and other disabling symptoms which were ascribed to silicosis alone, since tubercle bacilli could not be found in the sputum. It should be realized, at the present time, however, that silicosis assumes a serious position as an occupational hazard largely because of its effect on pulmonary infections, predominately tuberculous in character.

DUST HAZARDS IN THE FOUNDRY

23. Though the foundry must always be considered as a dusty industry, the nature of its operations are such as to induce, for the most part, only a modified silicosis. Both mortality studies and clinical examinations of foundry workers fail to disclose the type of hazard associated with a pure silica exposure. Many men

in advanced age groups who have spent their entire working lives in the foundry industry are still capable workmen, suffering from no occupational disability, although most of them will be found to have some degree of pulmonary fibrosis. The workmen who are disabled by an occupational fibrosis contracted in the foundry are generally those who exhibit evidence of concurrent pulmonary infection or other injury. It must be recognized, in spite of these alleviating circumstances, that a certain occupational hazard does exist in all foundries.

THRESHOLD DUST CONCENTRATIONS

24. Any working atmosphere which contains more than a certain threshold concentration of silica will induce the formation of pulmonary fibrosis in workmen exposed to it over long periods of time. Information gathered from field studies made in many parts of the world indicate that a normal man may work for many years in air containing pure crystalline silica dust without impairing his health, providing the concentration does not exceed 5,000,000 particles per cu. ft. of air as determined by the standard method used in the United States.

25. This concentration constitutes a special value for the health hazards created by silica which may be designated as the primary threshold. The value of this threshold will be increased for those industries in which the silica hazard is reduced by the presence of modifying factors. The development rate does not always appear to vary directly with the concentration but increases slowly with the elevation of the dust level up to a certain value where the acceleration becomes very marked.

26. Concentrations of 100,000,000 or more pure silica particles per cu. ft. of air appear to be extremely hazardous and constitute a second special value which may be designated as the secondary threshold. Concentrations of pure silica above this secondary threshold lead to the rapid development of silicosis and men working in these extra hazardous atmospheres have been known to acquire true silicosis in less than two years. Examples of this type can be found among men dry drilling tunnels in quartz rock or sandblasting without protective equipment. Demonstrable silicosis usually develops in workmen exposed to pure silica in concentrations between the primary and secondary thresholds in from 5 to 30 or more years depending up the individual's susceptibility and the degree of the exposure.

27. Experience has shown that diminishing a hazardous dust exposure results in extending the time required for silicosis to develop and that even when it does occur, there is generally little evidence of disability among the workmen who contract it, unless they have a complicating pulmonary infection or other injury. All of the preceding remarks with regard to dust concentration apply only to those individuals without pulmonary abnormalities. The presence of pulmonary infections or other pathological conditions generally alters the normal susceptibility of dust diseases.

28. It appears to be true that the individual with arrested tuberculosis might be subjected to a health hazard in an atmosphere containing less than 5,000,000 particles of pure quartz dust per cu. ft. of air; while he might suffer no ill effects from exposure to fairly high concentration of inert dusts, such as coal, alumina, limestone or hematite. Obviously, the values given cannot be used arbitrarily to measure the degree of any hazard or to form the basis for legislative codes of good practice but they serve as one of the aids in bringing a given dust hazard under control.

RESPONSIBILITY OF EXECUTIVES

29. What then are the responsibilities of the executives of those industries in which the dust hazard is suspected? In the author's opinion, the first duty imposed upon the operator requires that he secure a thorough knowledge of the nature of the disease itself.

30. Many executives whose interest should be deeply aroused by this subject, unfortunately, assume the attitude that silicosis is just another "racket" and delegate the duty of keeping the organization out of trouble to minor officials. The subordinate officers, having been impressed with the general attitude of the management, are frequently powerless to inaugurate a comprehensive program designed to cope with all of the existing circumstances and delay constructive action by refusing to recognize that their operations are in any way affected.

31. The futility of this procedure is evidenced by the fact that claims eventually arise which compel recognition of the disease and the adoption of a proper policy at a time when conditions are much less favorable for its successful application than would have existed at an earlier date.

32. Some managements apparently regard the silicosis ques-

tion as a purely legal matter and rely largely on such counsel for determination of policy. This procedure tends to distort the problem by illuminating it largely from a single aspect. Obviously, it is equally inadvisable for a management to depend entirely upon the judgment or suggestions offered by either the medical, engineering or production members of its staff.

ADMINISTRATIVE REQUIREMENTS

33. The most important requisite to good administration of silicosis problems lies rather in an informed management advised and directed by authoritative opinion representing the legal, medical, engineering and production divisions of the industry and assisted by consultation with some organization qualified by long experience with the problem, if necessary.

34. Having divested themselves of preformed conclusions concerning their particular situation, the second responsibility of employers consists in inaugurating a thorough survey of their plant to determine the existence, nature and extent of the dust hazard. A survey of this type may include the physical and x-ray examination of the employees, the taking of occupational records, the determination of the nature and concentration of the dust suspended in the working atmosphere, an analysis of the mortality records in the district, and if possible, post-mortem examinations of old employees dying from any cause.

35. The actual importance of silicosis as an industrial problem has been greatly over-emphasized for several reasons, chief among which has been the reluctance of administrative officers to investigate and reveal the existing facts in their operations. The mantle of secrecy which has shrouded existing conditions wherever many dust hazards are involved, has served to exaggerate their significance. Coupled with this lack of accurate and complete information, there has been, in the United States, an unwillingness to provide well-framed legislation to regulate the compensation of workmen affected by exposure to dust. This, in turn, has resulted in the filing of numerous claims in civil court which allege that a personal injury has been incurred through the negligence of the employer in permitting men to work in a hazardous atmosphere.

36. The enormous amount of money involved in these civil actions, together with the confusion created by the varied decisions handed down by judicial bodies attempting to deal with this com-

plex question, has given an altogether unwarranted notoriety and importance to this subject. Unfavorable experience with civil actions, has prompted the hasty passage of occupational disease legislation in some of the United States where the facts are still unrevealed, and there is every reason to expect that unreasonable decisions based upon poor medical testimony, misinformation concerning the dust hazard, and a general tendency to attribute all ills to industrial conditions, will tend to discredit these laws and thus further prolong the unusual prominence accorded silicosis.

37. Administrative officers must further recognize that the situation which has been created in the United States, is now of an emergency nature, and that there is neither a sufficient amount of reliable information, nor a large enough number of properly trained and informed authorities in many localities to deal with the silicosis problem. Under the press of emergency, many so-called silicosis experts have appeared over night and technical publications have been flooded with silicosis articles, few of which have added materially to the general understanding of the subject, but many of which have served to confuse and confound everyone interested in evaluating the actual issue.

38. As is true of nearly all diseases known to the science of medicine, certain phenomena associated with dust diseases are not understood or are imperfectly explained by medical authorities. A much more unfortunate difficulty arises out of the fact that many members of the medical profession, whose authority cannot be questioned in their particular field, are erroneously informed on this subject and offer opinions which are accepted as true, to the further bewilderment of all.

39. The same criticism may be offered against engineers, public health officials or attorneys, whose knowledge of silicosis has not arisen out of long and intimate first-hand experience. For this reason, it may be advisable to consider consultation with some organization competent to analyse the information available so that a proper policy may be determined.

ADVANTAGES OF SURVEY

40. If no hazard is discovered by a thorough survey, both the employer and the employee are protected by the information secured. On the other hand, if a hazard is detected, the original study serves as a guide to the future program of control which should be promptly initiated.

CONTROL PROGRAM

41. A control program in a dusty industry whose hazard has been defined, will include the reduction of the dust concentration in the working atmosphere and the application of protective devices, the establishment of certain physical standards for new employees, the selective placement of old employees on the basis of their physical condition and the adoption of an educational program to properly inform all those vitally concerned with the effects of a dust hazard.

42. Thoroughly reliable methods of determining dust concentrations are available and engineers equipped to utilize these procedures can discover the sources and extent of the contamination and devise means of either reducing the hazard to within safe limits or applying adequate protective devices. A constant check of the dust concentration in the atmosphere should be maintained and records should be kept to show the condition of the working atmosphere, the nature of the protective equipment and the total duration of time each workman is required to spend in a hazardous occupation.

43. A pre-employment examination, including an occupational history and excellent stereoscopic chest roentgenograms, should be given to every new employee. In general these examinations will serve to classify men into three main groups composed of (1) those whose chests are apparently normal, (2) those who have an occupational fibrosis without any other pulmonary abnormality, and (3) those who have tuberculosis or other pulmonary abnormalities either with or without occupational fibrosis.

44. In considering the desirability of employing men whose chests are apparently normal, it should be borne in mind that young men, probably up to the age of thirty or thereabout, are not altogether perfect risks for employment in a hazardous dust since they are in an age period during which they may still contract tuberculosis.

RISKS CLASSIFIED

45. In the author's opinion, men who show evidence of simple occupational fibrosis and who are past the age of thirty, as most of them will be, are excellent risks since the author does not believe that uncomplicated silicosis is ordinarily dis-

abling and since these men are past the age period during which they are likely to develop tuberculosis. These men may show some progression of their fibrosis after employment in a dusty industry but they will not tend to develop disability if they have been rigidly examined to exclude those showing any x-ray evidence of tuberculosis or other pulmonary injuries.

46. If this class of persons is to be discriminated against, it will create a most unfortunate social problem, since many skilled craftsmen perfectly capable of a lifetime of useful activity will be thrown out of work to become embittered and the prey of unscrupulous lawyers and doctors who will further complicate the situation by making the workmen claimants and neurotics. It is the author's belief that these men should not be eligible for compensation but if they are made so under the law, then legislation should also be provided to permit them to waive their right to compensation for an occupational disease, so that they may have the privilege which should be accorded to all free men—that of working at the task for which they are best suited. Providing this group is carefully selected to exclude infection and remains under medical supervision while in the dusty industry, their experience should be as favorable as any that the employer could choose.

47. As to the third group of men, an injustice is done to both the employer and the prospective employee by placing any person at work in a hazardous dust who has tuberculosis or other significant pulmonary abnormalities whether or not occupational fibrosis is present.

PLACEMENT OF MEN

48. In the presence of a known dust hazard, old employees should be placed, as far as possible, in those occupations most compatible with their health and welfare on the basis of the physical examinations which they have undergone. Men with normal chests who are past the age of thirty, or those with uncomplicated occupational fibrosis may be employed at any occupation, while young men under thirty should not be exposed to the operations which produce the most harmful dust and should be re-examined fairly frequently.

49. Those cases of inactive tuberculosis, either with or with-

out occupational fibrosis, should be carefully evaluated and every effort made to provide working conditions such that their health will not be impaired or their ability to earn a living wage interfered with. Men in this group should also be re-examined at frequent intervals.

50. Cases of active tuberculosis should not be employed in a dangerous dust either for their own safety or that of their fellow workmen, and should be encouraged to enter a sanatorium or to place themselves under the care of a competent physician.

EDUCATIONAL PLAN

51. The occupational disease problem is now much the same as that presented by industrial accidents when the first compensation act was passed. Disabling conditions created or aggravated by exposure to harmful dust can be prevented or controlled but the final success of any plan designed to accomplish these purposes, will depend upon maintaining a broad educational program similar to that adopted in the "Safety First" movement. These policies are not only humanitarian but they are practical, and have been placed in operation in many hazardous industries employing thousands of men. The author sincerely recommends them for consideration.

(Discussion of this paper begins on page 180)

HEALTH HAZARDS AND EMPLOYER RESPONSIBILITY

DISCUSSION

D. M. Avey, President of A.F.A. and Editor of The Foundry, Cleveland, acted as chairman of the meeting at which the papers of Dr. McConnell and Mr. Cummings were presented.

PRESIDENT AVEY: In starting the discussion of these papers by Dr. McConnell and Mr. Cummings, I think the fact that we are meeting on Canadian soil is singularly fortunate, because we have available in Canada considerable experience which will be exceedingly valuable, I feel sure, to those foundrymen from the states. I would like to ask Dr. McGhie, Deputy Minister of Health for the Province of Ontario, to lead the discussion.

DR. MCGHIE: On behalf of the Department of Health of the Province of Ontario, I wish to express our appreciation at being invited, as officers of that Department, to listen and take part in the deliberations of your Association.

The Department of Health of the Province of Ontario is charged not only with the provision of adequate treatment for those who are sick but, what to me seems a far more important task, the prevention of illness. As a result, one of the most important divisions of the Department of Health is the Division of Industrial Hygiene, and closely associated with that is our Division of Tuberculosis Prevention.

I am particularly interested myself in this Division of Industrial Hygiene because, to me, it seems to be one entirely of research. Our experts in that Department, headed by the Director, Dr. Cunningham, do not claim to have the last word to give to you on the solving of your problems, but they are anxious to sit in with you to find out what the problems are and to study them as they appear in the various plants. The officers in that work tell me that the readiness with which the managers and directors of the various industrial organizations place at their disposal the facilities for studying the problem in the plant, facilitates the solving of these problems to a very large extent.

Our organization here, working as it does with the Compensation Board, I think comes close to the ideal, and those members of the staff who are here are far better able to explain its ramifications to you than I am.

DR. J. G. CUNNINGHAM[1]: Dr. McConnell and Mr. Cummings have given addresses which, to me, are exceedingly interesting. They are full of material which is very valuable and, really, I believe, leave very little to be discussed as far as the work of our Department is concerned. We are interested, of course, as a section of the Department of Health, primarily in the control of silicosis and other occupational diseases.

In the foundry industry, there is silicosis. Molders, for instance, as far as our experience is concerned, average for the development of silicosis nearly 30 years, which is a long exposure and compares very favorably

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with 10, 11 or 12 years' exposure necessary to produce the disease in certain occupational groups, and even shorter times in certain other small groups with heavy exposures. I think this should be recognized.

In certain other occupations in foundries, the occupational exposure is shorter but still around 20 years. However, on the other side, certain cleaning operations, particularly sand blasting, without adequate protection, result in the very rapid development of silicosis.

We recognize these conditions and undertake to deal with them as they exist. It is perfectly possible to do this and without any great disruption in the industry, either from the expense necessary for the use of special equipment or on account of legal complications arising out of claims. The very fact that it takes molders and grinders and some of the others a good many years to develop the disease suggests that even a moderate reduction in the amount of dust exposure would cause the disease to develop only after so many years that it would not be a practical problem. We, however, feel that dust production in foundries should be reduced wherever it is possible to do it. Admittedly, it is difficult to carry on foundry operations with no dust production, but if we can make a substantial reduction in the ordinary processes I am sure that this would have a real influence on the disease produced as a result of these longer exposures. The dangerous short exposures, such as occur in connection with sandblasting, demand a specific program for dealing with the dust.

Now, a word with reference to tuberculosis. As has already been indicated, tuberculosis is the main problem in relation to dust inhalation. It has been stated that silicosis on its own account, except in certain exposures—and they are few—would not be the serious problem were it not for the development of tuberculosis. It should be recognized first of all that tuberculosis occurs in foundry workers the same as in every other section of the community, quite apart from dust exposure, and, indeed, that fact is recognized in workmen's compensation legislation in Ontario.

On the other hand, there is an impression abroad that silicotics with tuberculosis do not spread the disease in the way that ordinary individuals without silicosis and with tuberculosis spread it. Studies, even locally, do not support that idea and, when we come to the control of tuberculosis, which has already been indicated as the main problem, we must recognize the value of physical examination. It becomes so much more important when one realizes that individuals exposed to silica are more susceptible to tuberculosis, so that one man with tuberculosis in the plant, whether it arises partly as a result of dust inhalation or not, is a menace to all the rest of those exposed to dust in that plant. Therefore, one of the main functions of the physical examination to which reference has already been made, is to see that that individual is not allowed to continue under those conditions.

Physical examination gives us information with which to start a man on employment; it assists us to control the tuberculosis problem as these men are examined from time to time; and finally it enables us to arrive at some sort of rational method of handling or dealing with the individual who perhaps has silicosis but has not tuberculosis, such as

would be spread from one to another, because, as Mr. Cummings says, it does seem to us very important that a reasonable disposition should be made of those individuals who are found to be affected but who are still able to do their work.

G. W. CANNON[1]: I have listened with keen interest to these able papers and the discussion, for as a foundryman, I am intensely interested in the rapid engineering advance being accomplished in the problem of dust control and disposal. I have been in the foundry industry all my life and in the years gone by we never heard of any foundry workers dying from the effects of dust. They did not seem to die from any cause, —they just dried up and blew away.—we were a pretty healthy bunch of mechanics as a class.

The modern production methods now used in our industry have, however, changed the conditions under which our employees must labor. Speed in production has brought about a concentration of effort in such operations as pressure blasting, whether it be pneumatic propulsion or mechanical projection. Speed at the shakeout has also greatly increased the generation of dust, heat and noise and it is in this hot, dust-laden atmosphere of these and other similar operations that it is necessary our workmen perform their labor; a condition which did not maintain in foundry practice in the years preceding the introduction of continuous and high speed equipment.

The problem of dust control and disposal is one in which we (I am speaking as a member of a firm employing 2,000 men) feel is a tremendous responsibility and one which cannot be thrust aside with indifference. In fact and to the contrary, we feel it must be met and conquered as soon as possible and that, with the aid of the best knowledge that can be procured through scientific research carefully analyzed and engineered by technical men skilled in this particular line of endeavor.

It is my opinion, however, that the successful solution of the problem cannot be achieved by the individual foundry and I suggest that within our own Association there be fostered an organization of men trained in this highly technical subject who would be compensated properly for the time and attention that must be devoted to the effort necessary to bring about a dustless foundry plant; such a setup would pay big dividends. I appreciate, as must all of us engaged in the foundry business, that satisfactory results in conquering the existing dust conditions and associated evils which militate against healthful conditions in which to work will involve large expenditures of time and money. It is not improbable that the larger foundry organizations can undertake this work independently with success, but the smaller foundries also have the same conditions to correct. The large and small units of the industry are interlocked in competition and expensive equipment installation has its reflection in competition. Successful correction measures in one plant will be of benefit in another so I would urge that our Association get into action in an orderly way, through proper organization processes to assist us in creating the best possible working conditions for the employees of the foundry division of American and Canadian industry.

[1] Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

In our plant we are only at the beginning of a program of betterments and we have a long way to go. We are undertaking the correction of the greatest evils first. Suitable designs for our mold shakeouts and core knockouts, one of our worst dust and heat producing sources, are being considered and it will involve the rebuilding of the molding units to gain the desired results: the cost will doubtless be high but we will have to stand the pressure.

In the Cleaning Department, we are confronted with an equally serious problem, that of taking the operators out of the blasting rooms. This will require the building of special fully automatic machines to handle, not just one design of a cylinder block or head, but a large variety of sizes and shapes. In this particular department we have progressed to the stage of selecting the most desirable design. The disposal equipment handling the disintegrated abrasive from grinders and the dust from our few remaining tumbling mills is also being revamped. We feel keenly that our responsibility in the betterment of working conditions is by no means finished if we are successful in the elimination of the dust-health menace. We are constantly engaged in battling with a problem that goes hand-in-hand with it,—the education of the men to take care of their own health.

Years ago the majority of our employees were foreigners. They dressed well from a health standpoint at least, they fed well on good food from the old-fashioned dinner pail prepared by the old-fashioned wife who took good care of them. Today the young men in the foundry are high school boys. They are tenderfeet; not strong enough of body to withstand the abuses that the old-timers were used to. In this campaign, our director of personnel is posting a new placard each week, advising them how to dress and what to eat as the seasons change and in general how to care for themselves. The work of the personnel supervisor does not end with the posting of placards; he sees that the messages which they carry are read and absorbed. We have even gone so far as to provide woolen undershirts,—the good, old-fashioned, perspiration-absorbing kind that many of us here present wore and found comfortable in the years gone by.

Successful operation means that conditions must be bettered from every standpoint in order that we may give our employees better places in which to work. Better working conditions will induce a better and higher grade product,—better products create greater profit.

PRESIDENT AVEY: That discussion is very pertinent, and it is one of the purposes, of course, underlying this general assembly, that we have here tonight. The whole problem is too large for the individual, and it is a rather large one for the entire industry. These matters are going to have to have the best consideration and the best brains of the best leaders we have in the industry.

JAMES MURPHY[3]: We all know that dust is the principal cause of silicosis and long before I ever heard of the word "silicosis," I took measures for the elimination of the extreme amount of dust that was in the foundry that I was operating at that time. That was back in 1907.

[3] Hamilton, Ohio.

The workers themselves have a faculty for creating a lot of dust that good management could avoid. In the cleaning of castings, it is far easier for them to stick an air hose into the casting and blow the dust all over the place than it is to dig it out by some other means. To eliminate that dust, I adopted a method of cleaning castings by means of a water blast. Castings that had formerly taken six or seven days for two men to clean, we cleaned in 35 minutes by this water jet. This method can be used in a great many foundries for the elimination of dust, particularly on large castings. Certain parts of the foundry, such as the shakeout, of course, cannot be reached that way, but they can be reached through dust arresters.

I believe that the State of Wisconsin has recently adopted some regulations for the use of water sprays. The sprayer can be used to keep down dust in a very good way, being a much better method for spraying gangways and keeping them moist than by taking a pail and sprinkling water over them, which may make them too wet. The use of sprayers for gangways is getting to be quite common. The principal thing is to keep the foundry damp.

MEMBER: We were faced with the same dust problem. Our foundry is a brass foundry. We started by washing the whole foundry from the ceiling down to the floor, taking all the dust off the beams, making a general clean-up. We had had our cleaning room on one side of the foundry but not separated from it. We moved that and closed it and separated it entirely from the foundry, with a partition, with swinging doors between, and the doors are always closed when the room is not in actual use.

We do a little barrel sandblasting. To overcome a big dust trouble there, we built a room outside of our foundry so that the operator has to go through two doors to get into the sandblast room. The valves that control the air are on the inside, so that at no time is anybody in the sandblast room while it is in operation. Beside the exhaust fan on the sandblast, we put an exhaust fan on the room, so that any dust that comes from the sandblast—and it does come from all of them, no matter how good they are—is pulled out of the room, or at least a good portion of it is.

We have cement floors and we sweep our floors at least three times a week and we sprinkle them all down before they are swept. The one problem that we do not think we have solved satisfactorily is our shakeout, because we do not have a conveyor and the shakeout is done between the molders. We are seriously considering putting in a conveyor, not so much for protection, but from the fact that we believe we could bring our shakeout operations into one room and have two to three men only around that operation.

A. B. ROOT, JR.[4]: It may be that the members will be interested in our experience in Massachusetts. Reference has been made to the necessity of keeping in contact with your state legislature and I suggest that it might be perhaps equally as important to keep in touch with your Commissioners of Insurance.

[4] Hunt-Spiller Mfg. Co., Boston.

A little over a year ago, the insurance companies through their rating bureau requested the Commissioner of Insurance in Massachusetts to approve an occupational assessment rate of $4.00 per hundred dollars of payroll, in addition to the manual rate for industrial accidents. That request was made without any contact with the foundries or with the foundry organization that was known to exist there and had it not been for the fact that our Insurance Commissioner was very well acquainted with one of the foundry executives, it might very easily have gone through. Fortunately, the Insurance Commissioner called one of us up and said, "Do you know anything about it and will you come over and see if you think this is a reasonable request on the part of the companies?" As a result of the negotiations which started from that beginning, the rate, instead of being $4.00, was made $2.00.

And bear in mind that the rating bureau, and, through them the insurance carriers, had no statistics from their experience on which to base any request for an increase in rate. They were doing it simply to provide a back-log on which to fall in case they had cases of silicosis to settle in the future.

As a result of that, our Association appointed a committee to confer with the rating bureau on what might be done, first to reduce that below the $2.00 rate and, if it could be done, on what basis it might be done. We suggested to the rating bureau a rating plan of credits by which the carrying out of certain dust prevention features would entitle the foundries to credits on that $2.00, and the plan which they submitted to us was the most terrific thing you ever saw, such suggestions, for instance, as ventilating a portable sand cutter moving up and down the shop. They were the most impracticable suggestions, I believe, that were ever put out. I think there is where our danger lies, through the insurance companies requesting increases in rates through the Commissions.

I would like to ask a question as to how the foundry interests of the country can best coordinate their efforts for the protection of their own interest through preventing unusually heavy increases in rates. The insurance carriers are organized. How can the foundries organize so as to have some common basis on which to protect their business interests against unusually heavy or unnecessarily high rates?

Another question I would like to ask of our two guest speakers tonight relates to the question of analysis of these cases. I have understood that the method of analysis was to take a sample of the rafter dust, make the dust count from the air floated dust, and to make their analysis for the silica content from the rafter dust. I have understood that there is a great deal of difference between the silica content of such rafter dust and the dust collected from air-floated samples. Is there any basis or any agreement that the chemical analysis of the silica content should be taken of that same air-floated dust from which the count is made?

DR. MCCONNELL: The chief reason for using the rafter dust for analysis is because of the difficulty of collecting a sample in the impinger apparatus. One of the Westinghouse engineers has developed a method, I think of electrical precipitation, which is capable of collecting

a sample sufficiently large for a silica determination. On the other hand, while we have been considering using this method, I still believe that we should have, at least in addition, an analysis of the rafter dust, for the reason that the dust on the rafters has been accumulating for over a period of years and you get a fairly representative sample of dust that has been arising from the various processes over a long period of time.

In collecting a sample at any one time, it is quite possible that the silica content may be extremely low during that particular process or that particular location, whereas on another day, under similar conditions, the dust may contain a much higher percentage of free silica. Therefore, I feel that we still should determine the amount of silica in the rafter sample.

At this time, I wish to mention some of the general protective measures that foundries are using, enumerating them only in a general way. Some foundrymen are substituting less harmful substances for harmful substances. A good example of that is in parting compound. I was told that foundry workers are very temperamental and at first it was said that it would be impossible to get them to use a non-silica parting compound. I have had some foundrymen tell me that they had to disguise the non-silica parting compound to get the men to use it and, when they did not know that it was different, they found it very effective.

Another method is the isolation of processes where it is possible to do so. One example cited here this evening was that of removing the cleaning room to one end of the foundry and separating it by partitions and exhausting the room. Where the dust concentration is high, it is always possible to protect the men working in that particular location, but you also protect a large number of men in the general foundry.

Another method is that of hydraulic cleaning. We have taken a number of dust counts during this hydraulic cleaning process and have found the counts to be extremely low. Wherever it is possible to clean castings with water, I believe it is an excellent method of control.

Another method is, of course, that of local exhaust ventilation. Where it is possible and practicable, all processes should be exhausted.

Some foundries are using a combination of air and water for cleaning the foundry. I think the apparatus is called a ginny and it is very effective.

In some foundries, it is found practicable to do the shakeout operations at night. I think wherever it is possible and practicable to mount your castings on a moving platform to one section of the foundry that may be isolated and protect the men doing that particular operation, it is an excellent method; but where that is impracticable, I believe the shakeout operation can in many instances be done at night or at least at the end of the shift, thereby exposing many less men.

It is also possible under certain conditions to substitute steel shot for sand. Here again, however, a number of foundrymen believe it is impracticable. On the other hand, we must remember that there are different types of sand. Some sands fracture more easily than others and those sands are much more of a hazard than those which do not fracture easily. So that, with your isolation, your substitution, your local

exhaust,—and we must not forget general ventilation, but we must also be careful that the general ventilation does not interfere with the local exhaust systems,—your combination of water and air for cleaning purposes, and the removal of unnecessary equipment, or, in other words, good order in your foundries,—you have all these very valuable methods in reducing and controlling your dust hazard.

V. HYDAR[1]: I believe we have instituted at the Falk Corporation some things that will prove interesting for they have proved effective in removing or at least minimizing the dust hazard.

The spray which was referred to a while ago is a home-made gadget. We use a welding tip for the tip of the spray. Water is fed to this device by means of a little manifold body to which the welding tip is attached. It is discharged through the small holes around the periphery of the tip, and air from the air line through the center hole. This atomizes the water. Quite a spray can be shot up into the air to help bring down dust. Also it can be used for spraying castings that are in the process of chipping without getting them too wet. In those cases where the chilling effect of water on the casting would be detrimental, one can still dampen them without chilling them seriously.

Our silica wash problem, I feel, has been quite well met in that we have gotten away from the old idea of mixing the dry silica flour with molasses and water in order to produce our silica wash. We buy a prepared compound which is rather pasty in substance, put it into a mechanically operated agitator, add enough water to it to give it the proper consistency, and the men can draw it out of a tap at the bottom of the agitator as they need it.

Perhaps the most outstanding thing that we have done is putting dust arresters and exhausting equipment on our sand mixers. We have tried two different types of housing on our sand mixers, and both have been quite efficient and effective. One of them goes up vertically from the top edge of the sand mill and terminates in a very flat conical top which has an air exhaust fitted to it. The other goes up in about a 45 to 50 degree cone from the rim of the mixer and also is connected with an exhaust fan. The dry ingredients are fed to the mixer through batching hoppers which have double compartments, or, rather double traps to them. The first trap opens from the bins to a compartment which contains or can contain just so much of the ingredient: and then a trap opens from that compartment into the mixer. The housings are equipped with sliding doors that can be closed once the batching has been completed and mixing proceeds. But we have found, in testing them, that even with the doors open, there is a sufficient draft to keep all dust from getting out into the foundry.

We have gone through the usual cleaning up and painting up process. We have used a lot of white paint and aluminum paint, largely with the idea that dust will show up more readily on light colors, and in that way we know just where to concentrate our efforts in order to keep down the hazard. Our big problem is still shakeout control.

MR. CUMMINGS: I would like once more to re-emphasize the import-

[1] Falk Corp., Milwaukee, Wis.

ance of physical examinations in preventing the occurrence of occupational diseases. A young man who enters a dusty industry, with a small lesion of tuberculosis may develop a larger lesion in a relatively short time. He may develop disability or may die and in all probability it will be necessary to assume that the course of his disease has been unfavorably influenced by his occupation. On the other hand, one may find many men past fifty years of age who have worked in high concentration of dust in foundries or other industries throughout their lifetime and who are still capable workmen in spite of the large amounts of dust which they have inhaled, because they were properly qualified for their tasks from the onset of exposure to dust.

The significant thing for you to consider is the fact that you must select your employees in order not to offer them an unusual risk. No matter how safe your foundry appears, it may still have enough dust in it to injure the man whose chest has already been damaged by an infection. If you will carry that one thought away with you tonight, you will have carried more valuable information than all of the engineering suggestions that could possibly be offered for the control of occupational disease.

H. S. WASHBURN[4]: On this question of examination before employment, which, of course, I believe we all think is necessary, how frequent re-examinations should be made of employees in order to be effective? Mr. Cummings speaks of having a later examination.

MR. CUMMINGS: That is a difficult question to answer. Tuberculosis is a disease which may be contracted at any time. A man may be examined today and contract tuberculosis tomorrow and he may work in your employment during the time he is contracting it. There is an opinion that tuberculosis is usually contracted in the early age groups. I do not wish to imply that the disease manifests itself at early ages only. One may become ill with tuberculosis at 50 or 60 or any other age period, but present information indicates that if one does become ill at 50 or 60, the disease was probably present at 20 or 25. I believe that young men are more likely to contract tuberculosis than others and, for that reason, they should be examined rather frequently.

Men in your employ who have tuberculosis which may be arrested or which may not be active enough to justify their being removed from the industry should also be examined rather frequently.

The general conclusion is that where men of all age groups are employed and are working full time, they should be examined at least annually, and that specific cases may need examination more frequently. In any event, men should be examined at least once every two years to screen against those possible cases of tuberculosis which may have developed since the last examination. The physical examination is intended to discover tuberculosis rather than silicosis and experience in each plant or industry will soon dictate how frequently examinations must be made. If examinations are made annually and no new cases of tuberculosis are found, a decision may be reached to examine every other

[4] Plainville Casting Co., Plainville, Conn.

year, but in the end, examinations should be made often enough to pick up cases that may be developing particularly among the younger men who enter your employment.

MEMBER: In examination of these employees, on our first examination we find three or four cases of silicosis. What do we do with them?

MR. CUMMINGS: Dr. McConnell can probably answer that question better than I can, but we have both had experience with examining thousands of men. At the present time we are conducting a general survey of a rather large industry employing somewhere between five and six thousand men, all of whom have been examined, many of whom are silicotic, some of whom are tubercular. We try to do what I outlined in my paper. We separate these men into three main classes, those who have normal chests, those who have evidence of occupational fibrosis, and those men who have some evidence of tuberculosis. The men who are young and who have normal chests, we try to initiate into the industry by placing them in the less dusty positions where we still have them somewhat under observation. The men who have silicosis, obviously have it already, they are good workmen, and we do not discriminate against those men in any way. We let them continue at their work. We do everything we can to improve the conditions under which they are working, obviously.

Men who have tuberculosis are dealt with as individuals through the medical division in the industry. Each of those men is judged on his merits. If he has active tuberculosis, we would simply suggest that he must be immediately removed, and there is generally no question about that, because it is realized that he is endangering his own health and that of his fellow workmen.

A man who has inactive tuberculosis, which may be a small lesion or it may be rather an extensive one, is dealt with on the basis of his physical condition. If he is rather badly affected, we suggest a job such as a night watchman or some such thing as that. If his lesion is small and not regarded as active, he is given a place of selected employment.

There is not enough tuberculosis in any dusty industry that I have encountered to make it impossible to place a number of men that are found in that industry at selected jobs. It is rather surprising to find that with slight improvement in the conditions under which these men work, their subsequent examination inevitably, or almost inevitably, reveals improvement in their condition rather than retrogression.

We do not discriminate against silicotics.—I would like to make that point clear,—unless they are disabled, and we find in the most instances that such men have what we regard as some complicating condition.

MEMBER: Should an x-ray examination be made?

MR. CUMMINGS: We make the most careful x-ray examination that we are permitted to do. We use the best equipment. We think that is essential. We ask for competent interpretations. The diagnosis of silicosis or tuberculosis is in the realm of the medical expert and I think it will have to remain there for some time. The ordinary practitioner,

capable as he may be, is generally unfamiliar enough with this particular field to qualify, originally at least, for that work.

MEMBER: Are there any authentic published negative reproductions that would guide, not the amateur in x-ray but a physician who has pursued it beyond the experimental stage, in differentiating between silicosis and tuberculosis?

MR. CUMMINGS: Yes, I think there are. The question of differential diagnosis of silicosis is one that is difficult and though one might get reproductions of cases which were typical for any given industry, it would be quite possible to bring forth films which simulated the appearance of the films that were used for demonstration which might consist of quite another pathological process, and hence I would still suggest that this particular field be left in the realm of experts, much as Ontario has delegated its authority to people who have made a special study of it.