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INDUSTRIAL ACCIDENTS AND HYGIENE SERIES

WOMEN IN THE LEAD INDUSTRIES

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WOMEN IN THE LEAD INDUSTRIES.

Lead is by far the most common industrial poison, being responsible, according to Teleky,[1] for no less than 95 per cent of all the poisoning due to occupation. Layet[2] tells us that there are 111 occupations in France in which lead poisoning may occur, and at the time the Commission on Occupational Diseases in Illinois made its report (January, 1911), more than 70 occupations carried on in that State had been found to give rise to lead poisoning. Not only in Europe, but also in this country, industrial lead poisoning is a fairly familiar occurrence; but while in Europe women have been long employed in the lead trades and have suffered from the effects of lead, in America there have been but few women in such occupations, and lead poisoning among them is not at all common. Now, however, women are beginning to enter the occupations in which exposure to lead is inevitable, and it is very important to look carefully into the question of their employment in such occupations, and to determine whether it will be better to safeguard them by requiring employers to use every known means to reduce or eliminate the hazard of lead poisoning or by prohibiting the employment of women entirely in those occupations in which lead poisoning constitutes a considerable hazard.

WHAT IS INDUSTRIAL LEAD POISONING OR PLUMBISM?

It is well to begin with a brief description of what lead does to the human system. When a person is exposed to lead-laden dust, or habitually eats his food with lead-soiled hands, the poison accumulates in his system and usually attacks the digestive tract and the blood first. It seldom happens nowadays that very acute or severe forms of lead poisoning are caused by exposure to lead during work. Some years ago men did at times develop severe symptoms of colic and even convulsions after only a few weeks' exposure to lead dust in

[1] Teleky: Handwörterbuch der Sozialen Hygiene. Leipzig, 1912, Vol. II, p. 737.
[2] Layet: Hygiène des Professions et des Industries. Paris, 1875.

the smelters or white-lead works, or in storage-battery plants, or in enameling sanitary ware. But the improvements in factory hygiene that have been made of late years have caused such distressing occurrences to become almost a thing of the past. A typical case of industrial lead poisoning comes on slowly. The man acquires a peculiar pallor which foremen and workmen soon learn to recognize, and which is caused partly by poverty of the blood because of destruction of the red blood corpuscles, and partly by contraction of the surface blood vessels. He begins to lose his appetite, especially for breakfast, for his mouth is foul when he first gets up and he may vomit if he tries to eat solid food. A peculiarly disagreeable sweetish taste is one of the early symptoms and increases the repugnance to food. Then he begins to lose strength, to get tired easily, and to have headaches, and pains in his limbs. He is almost always constipated, and this trouble increases till it may culminate in an attack of agonizing colic, with complete stoppage of the bowels. This so-called lead colic is what the men themselves and many physicians mean when they speak of acute lead poisoning, although a man has usually been suffering from lead poisoning for some time before the colic develops, and may be severely poisoned without ever having colic.

If, after an attack of acute lead colic, the man goes into more healthful work he will probably recover completely from the effects of the lead, though there are authorities who insist that even one attack leaves permanent, even if slight, changes in the blood vessels and in the liver. But if the man goes back to the same work, he develops the chronic form of lead poisoning, with perhaps recurrent attacks of colic. Chronic lead poisoning is essentially a disease of the blood vessels, leading to degeneration of the organs, the liver, kidneys, and heart especially, to atrophy of the digestive glands, and to premature old age.

With either the acute or the chronic form of lead poisoning there may be involvement of the nervous system. If the poison attacks the nerves and their endings, paralysis comes on, most commonly in the arms and wrists, sometimes in the shoulders and legs. If it attacks the brain there are severe headaches, disturbances of sight, dizziness or loss of consciousness, with convulsions which may be fatal, or which may be followed by mental derangement, more or less lasting.

These forms of lead poisoning are fairly easy to recognize, but there are others less clear. Indeed, there is no known poisonous substance which can give rise to such a variety of symptoms as lead. The rule laid down by specialists is that the occupation must always be considered in making a diagnosis of lead poisoning; that is, that if a patient is known to be working in lead, symptoms which would not be considered of great significance ordinarily must be taken seriously,

because they may point to the beginning of lead poisoning. Oliver[1] says that pallor and sallowness, with metallic taste, especially in the morning, are common early symptoms. If the distaste for food is increasing, the individual should retire or be suspended from work, for it is one of the earliest indications that the resistance to lead has become diminished. Obstinate constipation and a sense of tiredness out of proportion to the amount of energy expended are also complained of.

The typical paralysis of the lead worker is known as "painter's palsy," because it is much more common in painters than in any other class of lead workers. It begins in the wrist, affecting the muscles that lift the hand, so that as it increases the hand tends to fall and hang helplessly, a condition known as "wrist-drop." The reason painters get wrist-drop is that they use the muscles of the wrist more than any others, and this overuse determines the localization of the palsy. Men who use other muscles, such as those of the shoulders or legs, get the paralysis in those muscles. Among white-lead workers weakness of the muscles of the leg and ankle is quite as common as weakness of the wrist, for these men do not make fine movements with the arms as painters do. They may also have a widely distributed paralysis involving the muscles of the trunk, back, and shoulders.

Lead poisoning of the central nervous system is a very distressing form, fortunately much less common now than it was a few years ago. It is more likely to develop after excessive exposure to lead dust, such as used to occur in the making of white lead and red lead, in mixing paste for storage batteries, in shaking lead enamel over red-hot bathtubs and sinks, in cleaning out the flues and bag houses of lead smelters, or even in putting lead glaze on pottery and tiles. The victim would suffer from something resembling an attack of epilepsy, or would become delirious and regain consciousness only partially or be out of his head for some days, or death might occur during the convulsion or during the unconsciousness that followed it.

Another form of lead poisoning of the central nervous system is very much more gradual in its development, and is seen chiefly in men who follow a lead trade for many years and suffer from a slow chronic poisoning. In such cases the blood vessels of the brain gradually harden, and the brain tissue is starved for blood, so that mental deterioration takes place, and the man becomes increasingly helpless and demented. It is among painters that this lead insanity most often occurs.

[1] U. S. Bureau of Labor, Bul. No. 95; Industrial lead poisoning, with descriptions of lead processes in certain industries in Great Britain and the western States of Europe, by Sir Thomas Oliver, M. D., p. 98.

One more rather obscure form of lead poisoning should be mentioned, namely, the neurasthenia of chronic lead poisoning. According to Hirsch [1] this is quite a common condition, but one often not recognized by the ordinary physician. The victim suffers from obstinate headaches, from morning vomiting, and from pain that is not typical colic. He is depressed and irritable, sleeps badly, has tremors of the muscles, and is easily exhausted. Such cases are very apt to be regarded as ordinary neurasthenia, but they do not clear up unless the patient is taken away from lead work.

Lead lowers the resistance of the body to infections, especially such infections as tuberculosis and blood poisoning. Certain industries, as, for instance, the typographical trades, have always had a far larger proportion of tuberculosis than can be accounted for in any way except on the ground of a lowered resistance to tuberculosis caused by the absorption of lead. Suppurative inflammations also are more common among lead workers than among men not exposed to lead. The men themselves say that if a lead worker cuts himself the cut always festers, because the lead gets in and poisons the cut. What really occurs is that the germs of suppuration get in and the tissues, being affected by the lead, do not offer much resistance to them.

INDIVIDUAL SUSCEPTIBILITY.

The most superficial study of lead poisoning in industry is enough to show how widely men differ in their susceptibility to this poison. Every foreman knows that there are men who can stand hardly any exposure to lead, while others can handle it for years with impunity. In even the worst factories there are at least one or two old workmen who have apparently breathed and swallowed lead compounds for from 25 to 40 years, and yet have remained apparently healthy. In one white-lead factory the records show that one of the employees began to feel symptoms of lead poisoning at the end of two weeks' time. He died of acute plumbism after five and a half months' work. In the same factory was a man who had worked in clouds of white-lead dust for 32 years, ever since he was a boy of 12, and had felt no ill effects.

Hirt, who had long experience in industrial lead poisoning, says that 20 to 30 per cent of all lead workers are not susceptible. Of the remaining 70 to 80 per cent a little over one-half (about 40 per cent of the whole number) sicken quickly, the others more slowly. This means that in every force of workmen there will be some who will be seriously injured by the poison if they remain in the industry, and who ought to be weeded out as soon as this fact is recognized, others

[1] Hirsch, in Deutsche medizinische Wochenschrift, vol. 40, 1914, p. 369.

who will not seem to be harmed by it at all, and still others who probably can be protected from poisoning if all proper precautions are taken, but who must be watched and examined by a physician occasionally to make sure that they are being adequately protected.

It is wholly inadmissible for employers to hold that because some employees of unusual resistance escape poisoning employers are not responsible for those who fall victims to it. Individual susceptibility plays a large part in many forms of sickness. If there is typhoid-infected water in a village of 500 inhabitants, there will not be 500 cases of typhoid fever, even though everyone drinks the water. There may not even be 50 cases. But for all the typhoid fever that does develop the infected water must be held responsible.

It may be well to give some illustrations of unusual susceptibility to lead poisoning. Such cases are not typical, of course, but they do occur often enough to make it necessary for us to take cognizance of them. For instance, painters usually do not develop symptoms of lead poisoning till after several years, sometimes even 15 or 20 years in the trade. Yet, out of 100 painters with lead poisoning whose histories were secured, 12 had sickened in less than a year's time. Among 167 cases of lead poisoning among smelters the majority were exposed for more than three months before they became poisoned, but 18 sickened after only one to three weeks' exposure. Among 186 sanitary-ware enamelers the majority had worked for more than five years before they were poisoned, but 21 had worked less than six months. A white-lead worker in Philadelphia went to a hospital with acute lead poisoning after three days' work emptying the dry pans in a very insanitary factory. Another very rapidly developing case was a bathtub enameler who came down with lead colic after four days' work.

Work in a tin shop is not regarded as involving much danger of lead poisoning, yet a record was obtained of one tin-shop worker who was treated not only for lead colic but for lead rheumatism and anemia, after only two months' work. A storage-battery worker, who mixed lead oxides into paste by hand, was a tall and strongly built man, who said that he had never been sick in his life before; but after two weeks' work he began to feel ill, with loss of appetite, headache, and digestive disturbances, and at the end of 11 weeks he went to the hospital with typical lead colic.

There are other instances which show an unusually severe reaction to the entrance of lead into the system. A Hungarian found in a Pittsburgh hospital had worked for four years in a paint factory near Pittsburgh. He came to the hospital with colic, vomiting, and diarrhea. He was emaciated, dull, and apathetic, understanding what was said to him, but answering sluggishly. He was anemic,

with 70 per cent hemoglobin; his limbs were soft and flabby; his muscles were wasted. The most serious change, however, was a general hardening of the arteries, one consequence of which had been hemorrhages into the retina, impairing his sight.

Another instance is that of a man who was employed in insanitary white-lead works for eight weeks. He also said that he had had no illness since childhood. He went to the hospital with colic, constipation, pains in his shoulders, arms, and legs, and increasing loss of power in the limbs. He remained in the hospial four weeks, and when discharged he had double wrist-drop and partial paralysis of the ankles. A strong, young Slavic workman was employed for five months pouring lead glaze over roof tiles. He began to feel sick, had a bad taste in his mouth, was nauseated, could not eat, felt weak, and "no good." He kept on working, however, for eight weeks more, and then one day, just as he had reached home after work, a violent attack of colic came on and he lost consciousness. This was followed by maniacal delirum for 48 hours, during which time he seemed to be in great pain. After this passed over he was dazed and confused, with loss of memory and impairment of vision, for about two weeks. His mind then cleared, but three months later he was still pale and had not recovered his strength.

It is a generally recognized fact, based on wide experience in the older countries, that the young of both sexes are more susceptible to lead poisoning than are fully developed men and women. Legge and Goadby[1] say with regard to this: "The clinical conclusions of appointed surgeons in the various lead factories would be, we believe, that the susceptibility of young persons is at least twice that of adults, and there is some ground for supposing that the tissues of an adult, when growth has ceased, more readily adapt themselves to deal with the absorption and elimination of poisonous doses of lead than do the tissues of a young person."

LEAD POISONING IN WOMEN.

British observers who have had much experience with women exposed to lead in the white-lead industry, and even more in the potteries, hold that women are more susceptible to lead than are men. Oliver[2] says: "So far as occupation exposure to lead is concerned, my opinion is (1) that women are more susceptible than men; (2) that while female liability is greatest between the ages of 18 and 23 years, that of men is later; and (3) that, while females rapidly break down in health under the influence of lead, men can work a longer time in the factory without suffering, their resistance apparently being greater."

[1] Legge and Goadby: Lead poisoning and lead absorption. London, 1912, p. 35.
[2] Oliver: Dangerous Trades. London, 1902, p. 296.

Legge and Goadby[1] also hold that women are more susceptible to poisoning by lead than men. Legislation in Great Britain has followed these authorities, and women are barred from some of the most dangerous lead work. On the other hand, the Germans believe[2] that the apparently greater susceptibility of women to lead poisoning is to be explained not by their sex, but by the fact that they are usually more poverty-stricken than the men, are undernourished and obliged to do work for their families in addition to their factory work. Then, also, a woman's skirt and hair collect the lead dust, so that she carries it home with her after work. Observations in the pottery industry in this country[3] seemed to bear out the German theory, for while a much larger proportion of women than of men were found suffering from lead poisoning in the East Liverpool and Trenton districts, it was also found that in these districts the men are members of a strong union, are well paid, and have good living conditions, while the women are unorganized, underpaid, poorly housed, poorly fed, and subject to the worry and strain of supporting dependents on low wages. In the unorganized pottery fields, in the tile works, and in the art potteries of the Zanesville district the men and women were in the same economic class, all making low wages, with everything which that implies, and here the rate of lead poisoning was slightly greater among the men.

Whether or not women are more susceptible to lead poisoning than men, it seems to be true that they are more likely to have the nervous form of lead poisoning than are men. Women suffer more from lead convulsions and lead blindness, men from lead paralysis and lead colic. The following are some figures that Prendergast,[4] a British physician, who practiced many years in the Staffordshire pottery district, has published. They are based on 640 cases of lead poisoning:

	Men.	Women.
Colic	77.6 per cent	69.8 per cent
Paralysis	57.0 per cent	30.0 per cent
Lead convulsions	15.0 per cent	34.9 per cent
Blindness (total)	2.3 per cent	7.7 per cent
Blindness (partial)	3.5 per cent	10.2 per cent

But the most disastrous effect that lead has upon women is the effect on the generative organs. Women who suffer from lead poisoning are more likely to be sterile or to have miscarriages and stillbirths than are women not exposed to lead. If they bear living chil-

[1] Legge and Goadby: Lead poisoning and lead absorption. London, 1902, p. 35.
[2] Agnes Bluhm, in Weyl's Handbuch der Hygiene, vol. 8, 1897, p. 88.
[3] U. S. Bureau of Labor Statistics, Bul. No. 104: Lead poisoning in potteries, tile works, and porcelain enameled sanitary ware factories, by Alice Hamilton, M. D., pp. 56–58.
[4] Prendergast, in British Medical Journal, vol. 1, 1910, p. 1164.

dren these are more likely to die during the first year of life than are the children of women who have never been exposed to lead. This means that lead is a race poison, and that lead poisoning in women affects not only one generation, but two generations. Very striking proof of this fact is given by English authorities on industrial disease. Legge [1] abstracted from the reports of British factory inspectors for the year 1897 the following statistics concerning woman lead workers: Out of 77 married women, 15 never became pregnant. Of the 62 who became pregnant, 15 never bore a living child. Among all the 62 there were 212 pregnancies, but these resulted in only 61 living children; the stillbirths numbered 21, the miscarriages 90, and of the 101 children born alive, 40 died soon after birth.

Another striking report comes from the British factory inspection service. Oliver [2] gives the following figures:

	Miscarriages and stillbirths.
100 mothers in housework	43.2
100 mothers in millwork, not lead	47.6
100 mothers in lead work before marriage	86.0
100 mothers in lead work after marriage	133.5

In a recent English publication [3] the case is described of a woman employed since marriage in making capsules colored with lead colors. She had been pregnant eight times, the children had all been born prematurely, and all died in the first year of life.

A French authority, Tardieu,[4] reported to the French Government, in 1905, that 608 out of 1,000 pregnancies in lead workers resulted in premature birth. In certain Hungarian villages, where pottery glazing has been a home industry for generations, children born of lead-poisoned parents are not only subject to convulsions, but, if they live, often have abnormally large, square heads, and this condition is associated with a lowered mentality.[5]

It is unnecessary to emphasize the importance of these facts. Every one will admit that a poison which may destroy or cripple a woman's children is a far more dangerous poison than one which only injures the woman herself. This is why it is necessary to forbid the entrance of women into the more dangerous kinds of lead work and to surround their employment in the less dangerous ones with all possible precautions.

[1] Legge, in Journal of Hygiene, vol. 1, 1901, p. 96.
[2] Oliver, in British Medical Journal, vol. 1, 1911, p. 1906.
[3] Woman's Industrial News. London, July, 1918, No. 81, p. 11.
[4] Tardieu: Poisons Industriellcs. Paris, 1905.
[5] Chyzer. Chirurgische Presse. Budapest, vol. 44, 1908, p. 906.

LEAD COMPOUNDS USED IN INDUSTRY, AND THEIR COMPARATIVE DANGER.

Formerly it was thought that the more soluble a lead compound the more poisonous it is, but experience shows that the physical properties of a lead compound are also important. Of two compounds which are about equally soluble in human gastric juice, the dustier one is the more dangerous. English experts believe that a less soluble lead salt may be actually more dangerous than one which is more soluble, but less easily powdered. For instance, lead acetate is very soluble, but it has a disagreeable taste, so that the workman can not swallow it unawares, and it is sticky, not powdery, so that in handling it he is not exposed to dust-laden air. On the other hand, the oxides, the basic carbonate, the chromate, sulphate, and monosilicate are all dusty and some of them are very light and fluffy. They are also almost tasteless, and the workman who handles them dry breathes into his mouth and swallows quantities without noticing. The English authorities, Oliver, Goadby, and Legge, regard the lead salts as dangerous in proportion to their dustiness. They concentrate their efforts on the abolition of dust and with amazing practical success.

Probably the most poisonous lead compound used in industry is the suboxide (Pb_2O), that fine, light-gray powder given off in fumes from heated lead. This is so light that it is carried into the air by the waves of heat, and so finely divided that it is easily absorbed when breathed and swallowed. It is this oxide which causes poisoning in lead smelters, zinc smelters, brass molders, and, to a less extent, in workers with molten lead such as lead molders, lead burners, stereotypers, electrotypers, and those employed in making lead pipe and wire, sheet lead, shot, and the makers and users of solder. It is this same oxide that forms a grayish coating on solid lead, and rubs off on the hands. Men who handle solid lead sometimes get a very slow chronic form of poisoning from this oxide.

It is a question whether second place should be given to the higher oxides of lead, litharge (PbO) and red lead (Pb_3O_4 or Pb_4O_5), or to the basic carbonate, white lead. The last named is decidedly more soluble, and dose for dose it is more poisonous, but it is not so light and fluffy as red lead and litharge and it seems to be somewhat less harmful. In those American factories in which both white lead and oxides are manufactured, the rate of poisoning in 1911 was higher in the oxide than in the white-lead department and the average period of employment shorter.[1] White lead is much the best known of the lead salts, and probably is responsible for more indus-

[1] U. S. Bureau of Labor, Bul. No. 95: White-lead industry in the United States, by Alice Hamilton, M. D., p. 259.

trial poisoning than the oxides, because it is used in great quantities in the painting trade and in the glazing of pottery, and its manufacture has always been considered one of the most dangerous lead trades; paint grinding, unless very carefully done, is also a dangerous trade. The oxides, litharge, and red lead are used very largely in making storage batteries, and they enter into the composition of rubber, glass, varnish, certain kinds of pottery glaze, the enamel used on sanitary ware, and the paint used to cover iron and steel on bridges, ships, structural-iron work, and certain parts of railway cars.

Lead sulphate is beginning to displace white lead to a certain extent in paints. It is also used in compounding rubber, and is produced in large quantities when lead ores containing sulphur are smelted. It is not nearly so soluble as the lead compounds already mentioned, but it is poisonous and has given rise to a good many cases of plumbism in American industry. Lead chromate used in paint is about as poisonous as the sulphate. The least harmful lead compound found in industry is the sulphide, which makes up the greater part of the lead ore now being mined. This was long considered quite harmless, but we know now [1] that it can be absorbed by the human stomach and set up poisoning.

HOW DOES LEAD ENTER THE BODY?

The popular idea about lead poisoning, held especially by foremen and superintendents, is that the workman poisons himself by eating his lunch without carefully washing his hands. There is not space to give here all of the experiments that have been made to test this theory, but it is safe to say there is abundant proof that lead dust and lead fumes, not lack of personal cleanliness, are responsible for most of the industrial lead poisoning in this country, as in all countries. If a man employed in lead smelting, for instance, were to get into his mouth every bit of the soluble lead that is clinging to his hands at the end of his day's work he would not get so much lead as he breathes in during two hours' exposure to the dust and fumes in the air.[2]

It may be laid down as an absolute rule that the dustier the work the greater will be the amount of lead poisoning. In the pottery trade in the United States the writer found one case of lead poisoning for every seven women employed in lead work, while in the British potteries the proportion of cases to those employed was only 1 in 64. The American women were scraping and brushing dry white-lead glaze, and letting it fly about in the air and fall on the floor and on their clothes and hair; the English women were scraping off damp

[1] U. S. Bureau of Labor Statistics, Bul. No. 141: Lead poisoning in the smelting and refining of lead, by Alice Hamilton, M. D., pp. 82–84.

[2] Idem, pp. 50–53.

glaze, and letting it fall into troughs of water. In the smelting industry the rate of poisoning among the blast-furnace men exposed to fumes and dust was found to be 31.1 per cent, and among the men who had to clean out the flues where dust is excessive, 62.5 per cent, while the refiners and desilverers handling pure lead but not exposed to much dust or fumes had a rate of only 14.3 per cent.

The lead dust and fumes (lead fumes consist of a very fine suspension of lead dust) do not produce their effect through the lungs, for less than one-fourth ever reaches the lungs. The rest is caught in the nose and throat, is mixed with the mucous secretions, and is swallowed.[1] Absorption through the skin may be practically ignored in considering industrial lead poisoning. In England, under the leadership of Oliver, Legge, and Goadby, all of the efforts of the Government inspectors are directed toward the prevention of dust and fumes and provision for thorough washing before meals and at the end of work. In the summer of 1910, during a visit to three white-lead factories in England, the writer observed men smeared with white lead up to their shoulders, but these men were made to wash thoroughly at noon and when they quit work. In the whole district of Newcastle-on-Tyne, where 1,320 men were employed, there were only 5 cases of lead poisoning during that year. The German regulations of the lead industries are also based on the theory that lead enters the body by way of the mouth, not the skin. In France, Gauthier[2] reported in 1901 that "while out of 1,000 white-lead workers who work with wet white lead, 50 have had lead poisoning, of 1,000 who handle it dry, or grind dry lead in oil, 105 have had lead poisoning.

LEAD INDUSTRIES IN THE UNITED STATES.

American industry differs a good deal from industry in other countries, and it is not safe to assume that what European writers say about the dangers of certain kinds of work is true of the same sort of work in this country. What follows relates closely to American experience, though sources of information are scanty.

It is impossible to give a list of all the occupations in the United States which involve exposure to lead in some form. Every year cases of lead poisoning from hitherto unknown sources are reported in the medical journals. Aside from the well-known lead industries, there are certain ones which are not ordinarily thought of as lead trades, yet which involve quite as much poisoning as do the more familiar ones. For instance, in the enameling of sanitary ware a very high rate of poisoning was found, sometimes even 36 per cent, a rate hardly equaled in any other industry. Lithotransfer work is recognized in Europe as a dangerous lead trade, but its danger is so

[1] Saito, in Archiv für Hygiene, 1912, vol. 75, p. 134.
[2] Gauthier, in Breton's Maladies Professionelles. Paris, 1911, p. 154.

little known in this country that cases of lead poisoning due to it are sometimes not recognized. Of five girls who were treated in a public hospital for supposed appendicitis (two of them even were operated on because of this mistaken diagnosis) all had been poisoned with lead from the colors they dusted on the lithotransfer paper. Many cases of brass poisoning have been reported which proved on investigation to be lead poisoning. Brass contains varying quantities of lead, and when brass is poured the thick white fumes which rise and fill the room contain lead oxide. A few instances have been observed of brass polishers becoming poisoned with lead, because the exhaust on their wheels did not carry off the dust, and this dust contained lead. Lead colors are known to cause poisoning in makers and handlers of artificial flowers and of wall papers. Commercial artists, whose work is retouching photographs for catalogues and advertisements, often use white lead paint, frequently in the form of a very fine spray, without knowing that it is poisonous. They also have a habit of bringing their brush to a point by sucking it. Their physicians do not know that they have been exposed to lead when they complain of colic or weakness of the wrists. Fifteen cases of lead poisoning were found among members of this profession in Chicago, one of whom had died palsied after having had three abdominal operations on various wrong diagnoses.

Another source of lead poisoning, not usually recognized, is the polishing of cut glass with so-called putty powder, which is composed of 3 parts oxide of lead to 1 part oxide of tin. This powder, made into a paste, is applied to the glass, and the glass is held against a polishing wheel, so that the thin paste scatters in all directions and dries and forms a light dust. E. E. Pratt,[1] of the New York State Factory Investigating Commission, found many cases of lead poisoning from the use of lead as a hardening and tempering agent, especially in the making of magnetos. The steel magnets are hardened in a bath of molten lead, plunged into water to cool, and then rubbed with sandpaper to remove the lead. A similar process is used in the making of piano wires and springs. Pratt also found lead poisoning in linoleum and oilcloth manufacture, for litharge is used in compounding and the paints consist largely of lead colors.

The following are brief descriptions of the principal lead industries as they are carried on in the United States, together with statements as to which occupations are specially hazardous and should not be given to women, and which may be rendered safe enough to permit of women's employment. Only the danger from lead is discussed in what follows. No attempt is made to pass on the different

[1] New York State Factory Investigating Commission Preliminary Report, Albany, 1912, Vol. I, pp. 428–430.

occupations as far as muscular effort involved, or exposure to heat, or other harmful features are concerned. It may be that an occupation free from the danger of lead poisoning is too heavy for a woman to undertake, or that for some other reason it is not suitable for women. The statement that "a woman may do this work" means only that she may do it without much risk of lead poisoning, not that she is strong enough to do it.

LEAD MINING.

Probably lead mining is the least important of the lead industries so far as the employment of women is concerned, and yet it is possible that women may find employment in some such work as emptying ore cars. It is enough to say, however, that there is little danger of lead poisoning here, unless the mined ore is so handled in the course of concentrating it or transporting it as to expose the workers to a very great deal of dust. The lead ore now mined is chiefly lead sulphide, the least poisonous compound of lead found in industry, and though cases of lead poisoning have been found among miners in the Missouri lead belt[1] they are rare. Western ores still contain some oxides and sulphate and carbonate, all of them more soluble than the sulphide, and western miners are more likely to have lead poisoning.

The danger in handling lead ores can be prevented by sprinkling to keep down the dust.

LEAD SMELTING AND REFINING.

Women have never been employed in lead smelting and refining and probably never will be employed in smelting; but it is not so certain that they may not be employed in refineries before long.

The dangers in a smelting or refining plant come from the fumes and dust, and in most plants every employee is more or less exposed to them, though in a clean, well-managed place there are parts which are almost free from danger. As a rule, a refinery is worse than a smelter. This should not be the case, for the smelting of ore requires a great deal more heat and produces far more fumes than does the refining of bullion and scrap. But a smelter is usually a large plant, and managed with a good deal of care, while a refinery is often insignificant in size, very neglected and dirty, and carelessly managed.

In handling the ores as they reach the smelter, dust is the danger, and this varies according to the dampness of the ore, and its composition, i. e., whether it is sulphide or mixed compounds. The ore is then either smelted at once on open hearths with great production of poisonous fumes, or it is first prepared by preroasting. In preroasting, in roasting, and in smelting there is danger from dust while the charges for the furnaces are being prepared and while the

[1] U. S. Bureau of Labor Statistics, Bul. No. 141: Lead poisoning in the smelting and refining of lead, by Alice Hamilton, M. D., pp. 82–84.

furnaces are charged, and there is great danger from fumes during roasting and smelting, and of both when the furnaces are emptied of their dusty and fuming product. In the later processes of refining the danger is chiefly from fumes. An effort is made to save the lead that passes off in the fumes by means of flues and bag houses, where the fine lead powder collects and has to be cleaned out and transported back to the furnaces. This is the most dangerous kind of work in the industry.

The occupations in a smelter which could not be held by women without great risk are: The tending and discharging of the Huntington-Heberlein pots; the tending and discharging of hand-rabbled reverberatory furnaces; the tapping of blast furnaces; work on the Scotch hearths or open hearths; and work in the flues and bag houses. Occupations which they might undertake, if conditions were made as safe as they have been in the best plants, are the following: The handling of damp ore; the feeding of blast furnaces, provided the charges are damp, the feed floor is open and clean, the charge automatically dumped, and the suction into the furnace sufficient to prevent any escape of fumes; the tending of the sinter-roasting machine (Dwight-Lloyd), provided the charge is damp, the suction exhausts strong enough to carry off the fumes, and the discharge automatic and not productive of dust. Grate cleaning for the Dwight-Lloyd machines, however, should not be given to women.

In refining there are several processes that might be undertaken by women under proper conditions, but such conditions are almost never present in American refineries. Refineries handle not only clean lead bullion, but usually great quantities of lead scrap of all kinds, dross, dirty white-lead powder, poorly roasted oxides, old storage batteries, dusty stuff of all kinds, which is bad to handle and usually fills the place with poisonous dust. This is why a refinery is often a more dangerous place to work in than a good smelter, though it need not be. If, however, great care were used to keep the place free from dust, and to carry off fumes, women might be employed in some of the processes. They should not do any of the furnace work nor handle the dross. Where the electrolytic process is used they might be employed in the battery room, though not on the dross furnaces, nor in handling the "anode mud," the product of electrolysis. Desilverizing may be so carried on as practically to be free from dust or fumes; in fact it is probably the safest work in the whole industry, and women might be employed here. By-product and residue furnaces are not safe for women to work at, and it would be even less advisable to employ women on copper converters. On the other hand, retorting and cupeling has, in one American plant at least, been rendered free from dust and fumes. As a general thing, however, the dangers in this part of refining are fairly great, and with the exception of the plant mentioned none have been observed

in which women could be properly employed. They should never be put to breaking up the cakes of litharge from the cupels.

In considering the employment of women in smelting and refining lead it must be remembered that even in the best plants accidents may occur which suddenly change a safe place into a very dangerous one. Flues fail to work and gases are driven back into the plant, the furnace gets out of order and not only do fumes escape but it is necessary to shut down and clean out the furnace, causing a great deal of dangerous dust. Even under the best management this industry can not be regarded as one in which women can be employed without risk.

TRADES IN WHICH METALLIC LEAD IS USED.

Lead in its metallic form is not absorbed by the human body, but after only a short exposure to the air it becomes covered with a coating of gray oxide, which is soluble in the human body. Heat greatly quickens this oxidizing process, and molten lead always has a more or less thick covering of what is called dross, which gives off, when it is stirred, those delicate bluish-gray clouds that are quite visible if one watches the stirring or ladling or skimming of a lead pot. The lead poisoning that takes place in those occupations that require the handling of lead in solid or in molten form is usually slow and chronic, and often the symptoms are not very marked or typical. Very rarely, in an oversusceptible person, typical acute lead poisoning may occur.

The dangers in connection with the metallic-lead trades come from the presence of fine lead oxide in the air near the melting pots and of dust containing lead, which rises from the floor and workbenches and contaminates the air, and also from the grayish oxide which rubs off from the lead onto the hand and may reach the worker's mouth if he handles his food or chewing tobacco without washing his hands. It is almost universally believed by men in the lead industries that molten lead does not contaminate the air unless it is heated to the fuming point, and that therefore there is no need of having hoods over melting pots unless the heat in the pot is at least 800° F. To substantiate this theory a number of foreign reports could be quoted, for several lead experts in Germany and Austria have collected the air over melting pots and have failed to show the presence of lead even at a temperature of 1,000° F.[1] This is true, however, only when the molten lead is left quite undisturbed. If it is skimmed or stirred or ladled out and poured into molds, the fine coating of oxide is detached and floats up into the air on the currents of heat, and its presence can be shown by chemical tests. Experiments proving this were carried on by Dr. Earle D. Phelps, of the Hygienic

[1] Bureau of Labor Statistics, Bul. No. 209: Hygiene of the printing trades, by Alice Hamilton, M. D., and Charles H. Verrill, pp. 21-26.

Laboratory of the United States Public Health Service,[1] and he was able to prove that if lead is heated to 590° F. lead fumes are given off when the melting pot is agitated in any way. These experiments justify the rulings made by the British factory inspection service and by some State labor departments, which require that all receptacles of molten lead be covered with a hood having a suction pipe to carry off the lead in the fumes.

Dross from the lead pot is skimmed off and thrown usually on the floor, though sometimes into a receptacle, but even in the latter case a good deal of it often splashes on the floor. Here it is ground up by the feet of the workmen passing to and fro, and every draft of air lifts a little of it and blows it about, so that if dust is gathered from surfaces where no lead has been handled this dust may be found to contain an appreciable quantity of lead. For instance, lead can be found in the dust from the tops of cabinets in printing shops, or from the surface of the magazine of a linotype machine, or from the tops of flue pipes in type foundries. Another source of lead dust is lead scrap and trimmings, which are allowed to fall on the floor, and which the workmen tread on and grind into dust. While there is probably never a large quantity of lead in the air of such workshops, it must be remembered that lead is a cumulative poison and that very minute doses repeated day after day may result in a quantity sufficient to cause quite as serious symptoms as would larger doses given at intervals.

There are so many industries in which metallic lead is used that it is impossible to give a list even approximately complete. The following are occupations in which industrial lead poisoning has been known to occur in the United States, sometimes in quite serious form:

Lead burning.
The making of solder and Babbitt.
Soldering.
The making of lead pipe, sheet, wire, machine parts, plumbers' goods.
Lead tempering of machine parts.
The making and laying of electric cables.
The making of leaden trimmings for coffins.
The making of leaden picture frames.
The polishing of diamonds embedded in a lump of lead.
The making of tin foil, which is really extremely thin sheet lead.
The using of tin foil as wrapping.
The making of car seals and can seals.
Brass founding.
Brass and nickel buffing.
Tinsmithing.
Plumbers' trade. (This is increasingly a brass industry, but lead is still used and lead poisoning still occurs among plumbers. Nineteen out of 560 cases of lead poisoning in Illinois were in plumbers.)

[1] Bureau of Labor Statistics, Bul. No. 209: Hygiene of the printing trades, by Alice Hamilton, M. D., and Charles H. Verrill, pp. 21–26.

The use of solder and Babbitt is productive of much more lead poisoning than would be expected from the nature of the work. The Illinois factory inspectors' report for the year 1913–14 gives the record of 184 cases of lead poisoning from four establishments in which tin cans were soldered. In one crowded workroom, with 12 soldering machines, 100 persons were employed, and here 18 cases of lead poisoning developed during one winter month, when the windows were closed. Another industry in Illinois—the making of car seals and bearings—has a disproportionate amount of lead poisoning. There were 28 cases of lead poisoning in one year among an average force of 188 employees. Both these industries employ women chiefly, and many of these women are under 21 years of age. The percentage of cases is far beyond that reported by the notoriously dangerous lead trades in Illinois.

A few instances may be given of serious lead poisoning in occupations that are not usually considered by employers as involving any particular danger, but in which metallic lead is used. For instance, a man was treated in a Chicago hospital for lead poisoning who had for two months been employed in sweeping up the shavings from casting and finishing machines in a factory making lead fixtures. Another man sickened after four weeks' work. He had been gathering up and wheeling away dross from melting pots. In a Philadelphia hospital a man was treated for acute lead poisoning who had worked for only three weeks, making lead stoppers and perforated filters for washbasins. Again, in the same Chicago hospital, there were treated for lead poisoning a man who had handled lead, copper, and brass junk in a refinery; another who had lifted pig lead in a shipping room; a lead filer; a brass filer; and a lather and shingler who had the habit of holding lead-covered nails in his mouth.

Lead burning is a notoriously dangerous trade. Skilled lead burners almost never escape the effect of the lead fumes given off when they apply a hot flame to melt together the seams of the lead lining in tanks or other receptacles. The lead burner is obliged to hold his head close to his work and to climb into the tank he is lining, or to put his head into the receptacle if it is too small for him to enter. This is the work generally understood when the term lead burning is used, namely, making lead linings for receptacles which are to contain corrosive substances. But there are other forms of lead burning that do not require so much skill and are not nearly so dangerous. The burning of lead connectors in storage-battery manufacture is a typical example. Here the worker uses a tiny flame and lets it play over the pure lead that is used to connect the battery plates. A certain amount of lead fume is given off in the course of this work,[1] but the amount is not large and, with abundant ventila-

[1] See section on storage-battery manufacture, pp. 32–35.

tion, it can be diluted to a point of safety for all but those very susceptible to lead.

THE PRINTING TRADES.

Probably the most important of the industries using metallic lead is the printing industry, including the allied branches of linotype casting, monotype casting, stereotyping, electrotyping, and ordinary type founding. In all countries the printers' trade has long been considered as productive of more illness than would be expected in an industry in which wages are high, hours usually not long, and in which there is no great contamination of the air, nor exposure to excessive heat or cold, nor excessive muscular effort.

The unhealthful features of the industry are the following: It is an indoor occupation, often carried on in vitiated air; it does not require much physical exertion, and in consequence the printer's circulation is likely to be sluggish, and he is oversensitive to cold; the nervous strain is great; the printer exposed to the effects of various poisonous substances, the most important of which is lead. How important lead is as a factor in the ill health of printers can not be stated with any positiveness. Yet the evidence gathered from all civilized countries and extending over a number of years tends to show that it is important as a cause of sickness. An examination of 200 working printers in Boston and Chicago showed that 18, or 9 per cent, were suffering from chronic lead poisoning; 107 of the 200 had symptoms of ill health.

Lead poisoning may be acquired by printers if they handle food or tobacco with hands which have become smeared with lead, or if they breathe lead dust and fumes. The sources of lead dust are: In the composing room, the dust from type cases; in the linotype room, the scraps of lead from the machine which fall on the floor and are ground up by the feet of passers-by, and the dust from cleaning the linotype machines and plungers; in stereotyping and electrotyping, the scraps from trimmers, routers, and saws, and the dross from the kettles. In addition, most shops melt and recast their old type and scrap, and this is another source of lead dust.

The sources of lead fumes are: All pots of molten metal, if the metal is agitated by stirring or by skimming off dross, or by ladling and pouring. In stereotyping, electrotyping, and remelting and casting type there is enough agitation of the molten lead to cause lead contamination of the surrounding air, but in linotype and monotype work the metal in the pot is hardly disturbed at all, and repeated tests made of the air over these machines shows that lead fumes are not given off.[1] This does not mean that linotypists may not suffer from a slowly developing chronic lead poisoning. But

[1] U. S. Bureau of Labor Statistics, Bul. No. 209: Hygiene of the printing trade, by Alice Hamilton, M. D., and Charles H. Verrill, p. 37.

this is a result of lead dust, or of fumes coming from pots in the linotype room where scrap is melted. If the linotype composing room were kept clean and no work were carried on there except hand composition and machine composition, there would be no risk of lead poisoning except from the cleaning of machines and plungers.

Linotype casting.—Linotypists insist that unless the fumes from the pots are carried off they suffer from symptoms of ill health, and that in shops where exhausts have been installed the failure of the air current to work for a single day will be enough to bring on headache, lassitude, dullness, and inability to work at the usual speed; but the fumes of lead in as small quantities as those given off from molten lead never produce symptoms quickly, their effect being very slow and subtle. What the linotypist complains of is really the contamination of the air by carbon monoxide from the naked gas burners under the melting pots, and there should always be a fume pipe with an exhaust over such a burner. It is probably unnecessary to install exhausts over type-metal pots in which the melting is done by electric current.

Hand composition.—In the composing room there should be very little risk of lead poisoning. The danger in the work of the typesetter should be limited to the handling of lead type. That risk is inherent in the trade, and can not be done away with. If it were the only risk, it would be possible to protect the compositor fully from all danger of slow chronic lead absorption simply by providing him with ample washing facilities. Then, if he did get lead poisoning, it could be assumed that he was eating his lunch or handling his chewing tobacco without washing his hands. But the case is in actual practice not nearly so simple as that. A typesetter may be a man of scrupulously cleanly habits, and yet he may get lead poisoning because there is lead dust in the room where he works, or because he has to blow the dust out of old type cases, or work near a melting pot or near a pile of lead skimmings blown about by drafts of air.

Monotype casting.—Like linotype casting, monotype casting does not result in lead fumes except when the dross is skimmed off, but gas is almost always used for heating and all that has just been said in the section on linotype work about the evils of gas fumes and the need of carrying them away applies to monotype casting machines. Monotype machines drop lead scrap continually on the floor, but as a usual thing casting is carried on in a separate room, and the lead scrap is not scattered beyond this room. As a rule, also, the monotype casting room is well placed and well ventilated. Indeed this department seems to be planned and managed better than any other in job printing and newspaper work.

Stereotyping.—The reverse is the rule in stereotyping, for this department is likely to be the worst housed and the worst tended of

any in the printing shop. The evils in stereotyping are the very disagreeable and indeed harmful fumes given off when old plates are being melted down or "burned off," fumes which come from the ink and contain acrolein, an irritating poison; the lead oxide which experiments have shown to be given off at the temperatures often used in stereotyping; the dust caused by trimming and routing the plates; and the heat from the kettles. All these evils are avoidable, and all have been avoided to a large extent in a few model plants. This has been done by placing hoods with strong exhausts so that they will carry off not only the disagreeable fumes at the beginning of the process, but the more dangerous though less noticeable lead fumes that come off later on, or by placing a powerful fan in an outer wall of the room. Dust is prevented by careful gathering up of the scrap and trimmings, and by throwing dross into a receptacle instead of on the floor.

Electrotyping.—The important features in this work are the pot in which the lead is heated for the backing of plates, the hot pans on which the molten lead is poured, the trimming and routing of the plates, and the sawing and beveling. As in other departments in a printing shop, old plates have to be remelted and the metal used again. When these ink-covered plates are melted down, the same sort of gases are given off as in melting stereotype plates. The lead in the melting pots in an electrotype foundry is often allowed to run up to a higher temperature than is necessary, because it is easy to cool it down to just the right temperature in the backing pans. Experiments show that lead fumes are given off at these higher temperatures when the lead is agitated, and, therefore, to make electrotyping safe some method for carrying off these fumes is necessary. An electrotype foundry can be made free from lead fumes, and the lead scrap can be so carefully handled that lead dust will be but a slight danger. In the majority of electrotype foundries little or no attention is given to carrying off the poisonous fumes. A disagreeable feature of the work is the use of black lead, which is very light and flies about, darkening walls and ceilings and settling on the windows. Other disagreeable features are the heat, and the blast of steam that in some places is used to clean plates.

There is an increasing tendency, now that the price of lead has risen so high, for newspaper plants and large job houses to refine the dross skimmed off the melting pots instead of selling it to junk dealers. Sometimes they simply remelt it, recover a small part of the lead, and sell the rest, but in some plants a cupeling furnace is installed and the dross is actually smelted. This is work attended with all the dangers described under lead smelting, and it should be safeguarded by the methods described there. It should always be done quite apart from any other work.

Women in the Printing Trades.

Women found their way long ago into the printing trades, though not into monotype casting, stereotyping, or electrotyping, nor are they as yet employed in large numbers in any branch of actual printing. They are accepted as members of the typographical union on exactly the same terms as men, and must go through the same apprenticeship, and, after becoming journeymen, they have the same hours and receive the same pay as men. They are found in large numbers as proof readers, and are usually the operators on the monotype keyboards, but do not work in the monotype casting room. In nonunion shops they are press feeders, sometimes doing all of that work. As compositors and linotypists they are not numerous. In the course of an investigation made in 1916 of the printing industry in seven American cities, only 14 woman linotypists were found out of a total of about 1,532 operators, and only 103 hand compositors out of a total of about 3,800.

As is true of so many of the skilled trades, a wide difference of opinion exists concerning the entrance of women into the printing trades. This difference was brought out clearly at the meeting of the International Association for Labor Legislation in Lugano, in 1910, and at the following meeting in Zurich, in 1912. The Italian delegates took the stand that, for the good of the race, women must not be allowed to work in this industry, since the danger of lead poisoning is too great; they admitted, however, that they had no evidence of an undue amount of lead poisoning among the few women employed in Italy. The Austrians also were in favor of forbidding women to work at any occupation in printing in which contact with lead is involved, and the regulations now in force in Austria contain this provision. The British delegates, on the other hand, maintained that it was entirely possible to do away with the danger of lead poisoning in the printing trade, and that efforts should be directed toward making the industry healthful for both men and women, rather than toward shutting women out from occupations in which they had long been employed, and which were in many ways suited to their powers. The French and the American delegates stood with the British.

The typographical industry is not the only one in which efforts have been made to prohibit the entrance of women on very insufficient grounds. The danger to health in this industry is avoidable, and the logical thing to do is to institute such sanitary measures in printing shops as will make them safe for both sexes. The Austrian statistics of lead poisoning in woman printers, on which so much stress has been laid, depend on the fact that Austrian women used to be employed in the type foundries, finishing type by hand, and this work is dangerous for men as well as women, and should be replaced

by machinery. Machine composition, hand composition, monotype casting, and electrotyping can be carried on, and in the best shops are carried on, in such a way as to reduce the danger of lead poisoning to a minimum. In stereotyping this would be more difficult, but the greater physical strength needed by the stereotyper makes it highly improbable that this occupation will ever be given to women.

TYPE FOUNDING.

Type founding is closely connected with the printing trade, and indeed a few newspaper offices have their own type-founding machines in addition to the monotype and linotype machines. As a usual thing, however, type founding is a separate business in the United States, though in Europe it is often carried on in connection with printing.

Statistics of lead poisoning in the printing trades in Europe always show a high percentage among the women employed in type founding. In Austria the woman foundry helpers have much the highest rate of lead poisoning in the whole industry, 1 case out of 9 women employed, while the compositors have only 1 out of 35 employed. In Germany five times as many founders as compositors have lead poisoning. In this country the only cases reported of lead poisoning among women engaged in the printing and allied trades have been among type-foundry employees. The danger of work in a type foundry is very much like that in stereotyping, except that there is far more fine lead dust. The heat in the casters often runs up to the point at which lead oxide is given off, and it is not customary to place hoods over the molten lead. The evil of gas fumes is the same as that described under linotype work. But the worst feature in the type foundry is the lead dust from the hand finishing of type. The type cast by the older kind of machine, the Bruce machine, has to go through various processes of filing, "dressing," or grooving, and "kerning," or smoothing, and inspecting, assorting, and packing. This is fine work and all of it is productive of dust. The woman finishers sit bent over their benches, with their heads close to their machines or tools. They use pads of plush to hold the type, and these get full of lead dust and are shaken and beaten clean from time to time, and the fine gray powder that collects on the benches is brushed off. This finishing work is often carried on in the same room with the casting machines, with their gas fumes and possibly lead fumes.

So long as casting machines of the old pattern are used and hand finishing has to be done, type founding will be the worst branch of the printing trade. The newer make of caster, known as the Barth machine, casts type which is already finished, and needs no further handling.

SUMMARY OF THE METALLIC-LEAD INDUSTRIES.

To sum up the features which are common to all the trades in which lead in metallic form is used: The form of poisoning found in these occupations is slow and insidious and sometimes shows itself only in an increased tuberculosis rate, because the resistance of the body to infection has been lowered by mild chronic lead poisoning. The dangerous feature is lead oxide in the form of fine dust, which rises from the surface of molten lead and is rubbed off from the surface of solid lead. It is perfectly possible to prevent all, or almost all, air contamination by this oxide dust. When it can not be entirely prevented the proportion in the air can be reduced to the margin of safety for all but the oversusceptible by ample ventilation. The employment of women in these industries can be permitted, because there is no reason why the risk of lead poisoning in working with lead metal should not be reduced to a minimum.

MANUFACTURE OF WHITE LEAD.

This is probably the most notoriously dangerous of the lead industries, the one that has attracted more attention than any other, in European countries, and that has led to special legislation for the protection of the men and women engaged in it. It can not be assumed that the description of the white-lead industry in Great Britain or France or Germany applies to conditions in America, because our methods of manufacture differ in several important respects from theirs. On the one hand, we use a dry method where they use water, and this means more danger from dust in our plants; but on the other hand, we have developed machinery to a far higher point than they have, thus doing away with hand work and reducing the number of employees required.

Old Dutch process.—The Old Dutch process is still the one most commonly used in the United States. The lead is cast in thin disks or "buckles." Women may properly work at casting provided only clean lead is used, not scrap with white-lead dust clinging to it, and provided the precautions described in the last section are observed. These buckles are packed in pots with acetic acid and stacked in layers in old tan bark where they are left for about 100 days to "corrode" or change from the metallic form into the basic carbonate, white lead. This work is known as "stack setting" or "setting the blue beds," and the English law allows women to do it. So long as only clean blue buckles are used for the blue beds there seems no reason why women should not do the work. Unfortunately in some of our plants it is the custom to mix with this blue lead parts of buckles which have been imperfectly corroded and which are more or less covered with white lead. When this is done, the character of the work is quite different, for the stack setters then are handling not

only clean metallic lead, but white lead, which is often dusty. Women should not be allowed to work in the blue beds when old buckles are used.

When corrosion is complete the tan bark has to be taken off, and the pots lifted and emptied. In England and Germany the white lead must be sprinkled with water before emptying to keep down the dust, yet even so the English law forbids the employment of women in "stack stripping" or "stripping the white beds," as this work is called. In our factories we can not sprinkle the white lead, because the corroded buckles must go through a series of grinders and screens to separate the white lead from the unchanged metal in the center of the buckle, and dampness would result in clogging the screens. Great improvements have been made of late years to do away with the dust in American stack stripping, but in spite of that the work is dangerous, and does not admit of the employment of women.

Dry-pan room.—The second danger point in white-lead manufacture is the dry-pan room, where the white lead, after repeated washings, is pumped into great hot pans, and left to dry for many hours, then conveyed by various methods to the barrel packing machines, or to the place where it is to be ground in oil. In some factories the white lead, still suspended in water, is ground as "pulp lead," the oil displacing the water gradually and no drying process being needed. Work in the dry-pan rooms has been very much improved of late years in the best factories. Where formerly the dry white lead was shoveled out and dropped into trucks, it is now drawn to the edge of the pan by a long-handled hoe, and falls into a conveyer which carries it to the barrel packer or to the place where it is to be mixed with oil. Both pans and conveyers are covered except for a small opening during the time that emptying takes place, and under this cover is an exhaust which prevents the dust from escaping.

In spite of these improvements, however, nobody would advise the employment of women in the dry-pan room of a white-lead factory, nor in the two following processes: Packing the dry white lead, which, no matter how carefully done, is inevitably dusty work, and grinding white lead in oil. The department in which they may be employed, provided conditions are as they should be, is the final filling of small kegs or pails with lead and oil. If women are to be allowed to do this, however, the work must not be carried on in the same room with the grinding of dry lead, nor with barrel packing, nor must any other source of white-lead dust be permitted there. The record was obtained of a young girl who contracted lead poisoning doing this very work, and it was assumed that she had absorbed the lead paint through her hands. But when closer inquiry was made it was discovered that she was working near the door of the grinding room, and she said that very often clouds of white dust would come

blowing in through that door. Her poisoning is attributed to the inhaling of dust, not to the absorption through the skin.

Carter process.—Another process for corroding lead is gaining ground in the United States. This is the so-called Carter process, based on the same principle as the Old Dutch process, but bringing about corrosion in two weeks' time, while the Old Dutch process takes about 100 days. This rapid corrosion is effected by atomizing melted lead in a blast of superheated steam, and subjecting this fine lead powder to the action of acetic acid in large revolving cylinders. Streams of carbon dioxide are driven into the cylinder, and a spray of acetic acid is introduced from time to time. The first corroding period lasts five or six days and the lead is then in little balls of carbonate with uncorroded particles in the center. This must now be ground and corroded again. The final corrosion over, the white lead is ground in water.

The advantage of the Carter process is that, being largely mechanical, it reduces the number of employees who must be exposed to poisoning during the process; and from year to year mechanical improvements make actual contact with the lead less and less necessary. The disadvantages are that the lead is in the form of powder from the very beginning, and that there are certain points in the process where it is hard to avoid dust, even when everything goes well, and where it is impossible to do so if anything goes wrong with the machinery. It would not be advisable to employ women in connection with the atomized blue lead, nor in the cylinder room, nor on the thrashers. In fact, the only place in which they should be employed is in packing lead in oil, provided the precautions given above are observed.

GRINDING OF PAINT.

The only risk in this work is in handling the lead compounds—white lead, lead chromate, or chrome yellow, and red lead—or in breathing air contaminated with these compounds. In a well-managed paint factory, weighing of lead colors is done in such a way as to make the escape of dust impossible, and grinding in oil takes place in covered chasers. These processes are carried on in rooms separate from that in which the keg filling is done. Under such circumstances there is no reason why women should not work at keg filling. It is very important to separate the dusty work from the safe work. In a Chicago paint house a girl engaged in pasting labels on the paint cans contracted lead poisoning because they had put her to work so near the open scales where the white lead was weighed as to expose her to the dust from the dry white lead.

PAINTING TRADE.

It is so very improbable that women will ever engage in house painting or ship painting that these two branches of the painting industry need not be dwelt on. But there seems no reason why, so

far as their strength is concerned, they should not be employed in much of the painting that is carried on in factories, especially in painting furniture, picture frames, moldings, etc. They may also undertake the painting of wheels for wagons and carriages. This sort of painting has, up to now, been done very largely by unorganized and more or less unskilled painters, and the substitution of machinery for hand work has increased very greatly in recent years. Much of the painting of carriages, wagons, automobiles, and agricultural implements is done by mechanical dipping into tanks of paint, and painting by hand is sometimes limited to the decorations on the last coat. A great deal of leadless paint also is used for these articles. The painting of furniture, picture frames, moldings, and other small objects is of very little importance from our point of view, because leadless paints are used almost entirely.[1]

The danger in the branches of painting in which women are likely to be employed lies in the process of sandpapering dry paint which contains lead. Even when the actual painting is done by machinery the paint, after drying, is often rubbed with sandpaper to prepare it for the next coat. This is especially true in painting wheels. Carriage and wagon wheels are sometimes given several coats of paint rich in white lead or red lead, and each coat except the last is rubbed with sandpaper and the dust is brushed off with a soft brush. The body of the vehicle, though painted chiefly with leadless paint, may be given first a coat of white-lead paint and white-lead putty to fill in the inequalities of the wood, and these are rubbed with sandpaper.

Not only white lead, but red lead and a lead oxide known as orange mineral, and yellow lead chromate, and the mixture of chromate and Prussian blue called chrome green, are used in paints. Finally, lead sulphate, sometimes called sublimed white lead, has come into increasing use of late years as a substitute for white lead. The most soluble, and consequently the most poisonous of these forms of lead, is white lead. Next come the oxides, and work with oxide paint may be more dangerous than with white-lead paint, because red-lead paint does not keep well and is usually mixed fresh each day by the painter. The chromates and lead sulphate are less soluble, but quite poisonous enough to require all possible precautions in handling.

The most important of these precautions is the avoidance of dust from dry sandpapering. In Germany, France, Belgium, and Austria the law forbids dry rubbing of lead paint. If it is to be sandpapered, the sandpaper must first be moistened in some mineral oil

[1] As stated at the beginning, lead is the only poisonous substance considered here. Cheap paint is usually leadless, but may contain harmful volatile liquids, such as benzene and naphtha, which set up a train of symptoms when these paints are used in poorly ventilated rooms.

to prevent the dust; but rubbing with pumice stone and water is much more usual in those countries, except for the first coats of paint, where water can not be used, for it would raise the grain of the wood and cause metal to rust. Other sources of dust in connection with painting are the chipping off of old paint that contains lead, the wearing of dirty working clothes, and the shaking out of drop cloths that are full of lead paint. It is absolutely necessary for painters to have good washing facilities for their use at noon and on quitting work, because paint clings to the hands and can easily contaminate the food unless it is carefully washed off before the lunch pail is opened.

In employing women in any branch of the painting trade it will be necessary to prohibit dry rubbing down of lead paint, mixing dry lead compounds with paint, using dirty drop cloths, and chipping off old lead paint. It will also be necessary to insist on the provision of hot water, nailbrushes, soap, and towels for their use.

COMMERCIAL ARTISTS OR RETOUCHERS.

This highly skilled branch of painting, which gives employment to many women, has already been mentioned. It is enough to say here that every effort should be made to substitute zinc white for white lead in the work of retouching, and that where white-lead paint is used it should not be used in an air brush. The artists should know, as they often do not, that they are using white-lead paint, and they should be warned never to put the paint brush into the mouth. Several instances have occurred of men and women who, severely poisoned with lead, have assured their physicians that they were using only zinc white, and in consequence the source of their symptoms was not discovered and they were allowed to keep on with their work until seriously poisoned.

LITHOTRANSFER WORK, OR DECALCOMANIA.

This consists in preparing transfer paper which is used in impressing patterns on pottery. The colors used are largely lead colors, and they are ground dry and dusted dry onto prepared paper. When the work is done by hand even at a table provided with a glass screen and an exhaust there is decided danger of poisoning from the fine, light dust. Fortunately, machine dusting of colors has been introduced of late, and this has lessened the dust, though it does not entirely prevent the escape of dust. Lithotransfer work is regarded in Europe as one of the most dangerous lead trades. No recent information is available concerning the industry in this country. In 1910 eight girls and one man were found in Chicago who had suffered from acute lead poisoning during employment in one large lithotransfer factory.

MANUFACTURE OF RED LEAD AND LITHARGE, OR "ROASTING OXIDES."

In the United States the roasting of oxides is not carried on in connection with lead smelting, as it is in most other countries, except for one smelting plant. It is either done separately or in connection with the making of white lead. The dangers in the work consist in the fumes from the furnaces, and in the dust from dumping, grinding, screening, and packing the oxides. There is no lead industry in the country which shows such a variety of conditions as does the roasting of oxides. There are grinding rooms so free from dust that one would never know red lead was manufactured there, while there are others covered with scarlet powder from ceiling to floor. There are also furnace rooms practically free from fumes, with mechanical rabblers, with hoods over the feed doors, and with mechanical discharging under cover, and again there are furnace rooms with no devices for carrying off the fumes that escape when the furnace man opens the door and works the charge back and forth or rakes the oxides out into an open truck.

The charge for the furnace is not always pig lead; much of it may be dry scrap, dross, refuse from white-lead works, and imperfectly roasted oxides, and this dusty stuff lies in heaps on the floor of the furnace room. An almost invariable source of dust is the dump into which trucks of oxide from the furnaces are emptied, to be ground and screened, and another is the dump from the screening and bolting machines. In rare cases grinding takes place in water, but this has the disadvantage of necessitating the use of drying pans like those described in the section on white lead (p. 28), the emptying of which is always dusty and dangerous.

Lead oxides are very light and fluffy, and it is hard to prevent dust in dry grinding and bolting and packing. Even where mechanical barrel packers are used the work is dusty, and packing small kegs by hand is very unsafe work. In an intensive study of the white and red lead industries, in 1911, there was found a great deal of lead poisoning in connection with white-lead work, for the safety devices now found in that industry had not yet been introduced.[1] There was, however, an even higher rate among the workers in red lead, and the manufacture of red lead and litharge has not undergone as much improvement in the years that have elapsed since then as has the manufacture of white lead. It does not seem safe to recommend the employment of women in any department of the manufacture of lead oxides.

MANUFACTURE OF STORAGE BATTERIES.

This is the trade in which lead oxides are used in great quantities, and in which women have already entered and will probably enter

[1] U. S. Bureau of Labor, Bul. No. 95: White-lead industry in the United States, by Alice Hamilton, M. D., p. 259.

in very considerable numbers in the near future. It is regarded in European countries as one of the most dangerous of the lead trades, and strict regulations are in force both as to the sanitation of the places in which the work is done and as to the methods of work permitted in them. It is only rather recently that we in America have awakened to the knowledge of the danger involved in this work. In 1913 it was found that in five storage-battery factories, at least 17.9 men in every hundred employed in work exposing them to lead had suffered from lead poisoning, and this figure was far below the truth, because it was impossible to get anything but very scanty information from three of these factories.[1] In one factory where records had been kept, the rate in a single department was as high as 40 per cent. This department has been made much safer in the five years since the study was made. The type of lead poisoning found is usually acute, with colic, and in severe instances lead convulsions, but not palsy except sometimes a slight form. This is explained by the fact that the employees are a shifting force. They seldom remain long in this kind of work and if they become poisoned it is because they have been exposed to large quantities of soluble lead, which is quickly absorbed and causes acute symptoms.

The work in a storage-battery factory is fairly complicated, but for the purpose of this study the processes may be divided into three classes: Those which have to do with acids or paint, not lead; those in which metallic lead only is handled; and those in which lead oxides, litharge, and red lead are handled. The first class may be ignored, for there is no lead danger involved so long as these processes—forming and charging and painting—are carried on, as they usually are, in rooms separate from the lead rooms. The second class includes casting or molding the lead grids for the Faure plates, trimming them of superfluous lead, casting and "spinning" the Planteé plates, and lead burning the final connections on the receptacle. This last is a soldering process in which pure lead is used instead of ordinary solder, and the heat is applied by means of an air-hydrogen, gas-hydrogen, or oxy-hydrogen flame. The third class covers the mixing of oxides with various liquids to form a paste, the rubbing of this paste into the lead grid to make a Faure plate, and the inspection, cleaning, assembling, and lead burning of these pasted plates.

By far the most dangerous work is mixing the paste and applying it to the plates. There is no need of describing these processes fully, because the employment of women in such work should never be allowed. However, exposure to lead-oxide dust is not confined to

[1] U. S. Bureau of Labor Statistics, Bul. No. 165: Lead poisoning in the manufacture of storage batteries, by Alice Hamilton, M. D., p. 23.

these two departments. The pasted plates are dried, and though the surface after drying is hard and firm, yet the plates can not be handled without raising dust, the shelves on which they rest are always covered with dust, and the work of lifting them from the racks and carrying them to the assembling room is dusty. The work in the assembling room involves handling these pasted plates in various ways.

The two departments in which women are likely to be employed, and, indeed, are already employed, are the molding and casting of grids and the assembling of formed plates. In the molding room there is only metallic lead, and the dangers here can be dealt with fairly easily. Melting pots must be properly hooded; molding should, if possible, be mechanical, not hand work; the lead scrap from saws and trimmers should be caught in receptacles, not allowed to fall on the floor, and dross from the melting pots should be handled in the same way. The room should be large and amply ventilated, especially if gas is used under the kettles. In short, the employer should act on the principle that melting and molding lead, no matter how well done, results in some contamination of the air, and the only safe thing is to dilute this contaminating lead to the greatest possible extent with quantities of fresh air.

In the assembling room it is not so easy to do away with the danger of lead poisoning, because here is found not only metallic lead but more or less dry lead oxides from the pasted plates. These plates are inspected and the imperfect ones are rejected, or straightened, trimmed, and filed. Small plates, which have been pasted in pairs, are sawed apart. The edges and the projecting piece of the grid called the "lug" are cleaned to get rid of the paste and leave a shining metallic surface, so that good connections may be made by the lead burner. This work may be done by hand or by machine. The actual assemblers also handle these dry oxide plates, but not in such a way as to involve much dust. They group the plates together and slip a thin wood or rubber separator between each pair of plates. Then these groups are fastened together by the lead burners.

In 1913, in two factories employing 620 men in lead work, the proportion of cases of lead poisoning in these different classes of work was as follows:[1]

Casting—metallic lead only	1.7
Mixing paste—dry lead oxides[2]	40.0
Pasting plates—lead oxides, dry and wet	19.4
Assembling and lead burning	10.7

This shows how much greater is the risk in assembling and lead burning than in casting, the added element of risk being the presence

[1] U. S. Bureau of Labor Statistics, Bul. No. 165: Lead poisoning in the manufacture of storage batteries, by Alice Hamilton, M. D., p. 24.

[2] This included the men who filled so-called "ironclads" with dry oxides, at that time very dusty, dangerous work, but much less so at present.

of lead-oxide dust. If women are to be employed in the assembling and lead-burning department great precautions will have to be taken. The space allotted to each worker must be much more generously calculated than in an ordinary factory. Not only must there be no overcrowding, but there must be a very ample supply of air. No oxide dust must be allowed to accumulate on floors or benches, and no dry cleaning must be allowed. Benches must be wiped off with moist cloths and the floors mopped or flushed. Racks of dry plates must never be stored in this room, nor the drying cabinets be placed in this room. After the dried plates have been removed from a rack this rack must be wiped with a wet cloth before it is used again. Lug cleaning must be done by machine and the dust carried off by suction. It is far better to separate the actual processes of assembling from the work of inspection, trimming, sawing, and lug cleaning. If this is done, assembling and lead burning will probably prove to be as free from danger as the work in the molding room.

GLAZING OF POTTERY AND TILES.

The pottery industry of the United States has never, up to now, given employment to large numbers of women in those occupations where lead poisoning is a danger. In 1910 and 1911 the white-ware industry, which was carried on chiefly in the region around East Liverpool, Ohio, and in and about Trenton, N. J., had 393 women engaged in lead work in 68 potteries, while 2,112 men were working in these same processes.[1] At that time lead poisoning in the potteries, so notorious in England and Germany, had attracted no attention at all in this country, perhaps because the industry was not large and was concentrated in two regions. Many improvements have taken place in American potteries since that date, especially in white-ware potteries where the labor is strongly organized. The so-called yellow ware, and art and utility ware, is made in the Zanesville, Ohio, district chiefly, and the labor is entirely unorganized. Tile factories are much more scattered, being found in many States. Here, too, the labor is unorganized.

The glaze used in the white-ware potteries which were visited contained from 1.75 to 33.3 per cent of white lead. In the potteries making art and utility ware (yellow ware) and in the tile factories the glazes contain from 5 to 60 per cent of white lead. The dangerous processes are mixing the glaze, dipping ware into glaze, cleaning the dipped ware to get rid of the excess of glaze and stacking it on boards or trays to be fired, and decorating it by the processes known as color blowing, or tinting, and ground laying.

Mixing is done by unskilled laborers under the direction of a skilled foreman. The mixed glaze is poured into tubs for the dip-

[1] U. S. Bureau of Labor Statistics, Bul. No. 104: Lead poisoning in potteries, tile works, and porcelain enameled sanitary ware factories, by Alice Hamilton, M. D., p. 6.

per, who is a highly skilled workman. He immerses the ware in the glaze, brings it out in such a way that the coat of glaze is evenly distributed all over the surface, and puts it on a board or tray to dry. This work is not done by women in the United States except sometimes in art-ware potteries when the vase is both dipped and brushed with glaze. The dippers' helpers, however, are women, except in sanitary-ware potteries, where the large and heavy ware could not be lifted by women. The women do what is called finishing, that is, they remove the excess of glaze either by sponging or by rubbing it with a dry, rough fabric, or by scraping with a knife, and blowing or brushing away the dust. These women also stack the ware on boards for the glost-kiln men, they clean the boards on which the dipped ware is carried, sometimes by sponging, but sometimes by pounding against the floor or wall to shake the dust off, and they sweep up the glaze room. The rate of lead poisoning among these women employed in the potteries in 1911 was just below 20 per cent, while among the men dippers it was only 6.5 per cent. In the art and utility ware potteries this difference between the two sexes did not appear. The rate there was a little over 20 per cent for both sexes. The workers in the latter industry are exposed to greater dangers than those in white ware, because the glaze is richer in lead, more decorating is done with lead colors, and a lower standard of living, due to wages being decidedly lower than in the white-ware potteries, makes them more susceptible.

The glazing of tiles is sometimes fairly safe work, sometimes very bad. For white tiles the glaze may contain as little as 5 per cent of lead, and it may be applied by machinery. But colored glazes may contain 50 or even 60 per cent of lead, and dipping is done by hand. "Fettling," that is, scraping off the excess of glaze, is more dangerous than the actual glazing of the tiles because it is dustier. In all English tile works and in many German ones it is the rule to scrape the excess glaze while it is damp and let it fall into a pan of water. In all the tile works visited in this country much of the fettling, if not all, is done after the glaze is dry, and the glaze dust is allowed to fall anywhere.

Color blowing, or "tinting," has given way largely to decalcomania—decoration by means of lithotransfer paper. Though the making of lithotransfers is dangerous work, their application to pottery ware is perfectly safe. In tinting, the colors are applied in the form of a spray driven through an atomizer by compressed air. The ware is held under a hood, and an exhaust is supposed to carry off all the spray that does not fall on the surface of the ware. Ground laying consists in dusting dry colors on a prepared surface by means of pads of cotton. Both kinds of work involve a good deal of risk unless great precautions are taken.

A visit to an English pottery or tile works will convince anyone that it is possible so to construct dipping rooms as to allow of thorough flushing down, and to carry on dipping in such a way that the room is kept clean, and finishing in such a way that the women who scrape the glaze from ware and tiles run very little risk of lead poisoning. In English potteries in 1910 the rate of plumbism was 0.8 per cent for men and 1.5 per cent for women, while in 68 American potteries and tile works in 1911 the rate was 8 per cent for men and 14 per cent for women—almost exactly ten times as much. The difference between the two countries at that time was very striking, but conditions in American potteries have improved since then and the contrast is not so great now.[1]

MANUFACTURE OF PORCELAIN ENAMELED SANITARY WARE.

This is a very dangerous lead trade, in which women have never been employed and probably never will be, for the work requires a good deal of physical strength. The processes involving exposure to lead are grinding the enamel, which contains varying proportions of soluble lead, and sifting it thickly over red-hot ironware, in the course of which great clouds of dust are given off. The work is done on piecework basis; the firing of the ware is heavy work and very hot, both the heat and the great exertion increasing the susceptibility of the enamelers to lead poisoning. The rate of poisoning among 1,012 men employed during 1911 was 21.4 per cent, but 148 men who were examined carefully showed a rate of 36 per cent.

COMPOUNDING OF RUBBER.

The compounding of rubber is the only process in the rubber industry that involves exposure to lead. Litharge (lead oxide), lead sulphate (commonly called sublimed lead), and in rare instances white lead are sifted or bolted, weighed, and mixed in mixing mills with the crude rubber. The risk here is from lead dust, and it can be minimized by careful handling, scrupulous cleanliness of the premises, and the use of exhausts at the scales and mixing mills. This work has never yet been done by women and it is not advisable that they should be employed in it.

PREVENTION OF LEAD POISONING.

It is not hard to remember the rules for protecting workers against lead poisoning, if one bears in mind the fact that lead enters the human body chiefly through the mouth, either in the form of dust and fumes or smeared on the surface of food and tobacco. All the rules formulated for the lead trades by sanitary experts are based on the prevention of lead dust and fumes and the necessity for bodily clean-

[1] Ohio State Board of Health. A survey of industrial health hazards and occupational diseases in Ohio, by E. R. Hayhurst. Columbus, 1915, pp. 229–256.

liness on the part of the workers. Briefly stated, the following rules should be enforced in every lead industry where women are to be employed:

Scrupulous cleanliness of floors, walls, workbenches, window sills, tops of pipes, and all other surfaces where dust might collect. Cleaning should be done wherever possible with water or oil. Dry cleaning should be forbidden during working hours.

Ventilation should be more ample than that required for work that is free from lead.

All dusty work should be carried on under cover, or with an exhaust so placed as to catch the dust at its point of origin.

All receptacles for molten lead should be hooded, and the hood connected with an air exhaust; dross skimmings should be thrown into a receptacle.

Lead scrap and trimmings should be caught in receptacles, not allowed to fly over the floor.

No dry rubbing of lead paint and no scraping or brushing of dry lead glaze should be allowed.

A full suit of working clothes of washable material should be worn by every woman engaged in leadwork. This suit should be laundered at least once a week. If there is any exposure to lead dust a washable cap should be worn and laundered at least once a week. So far as the work permits, gloves, preferably washable, should be worn and should be washed at frequent intervals.

No food should be taken into a workroom; no worker should eat lunch without first washing her hands thoroughly with soap and hot water and the use of a nailbrush. Women should be advised to rinse the mouth or brush the teeth before eating lunch.

A physician should be employed to supervise the woman lead employees. He should examine on employment, or shortly after employment, every woman who is to engage in leadwork, and should reject those who are anemic or show evidence of disease of lungs, heart, or kidneys, or who are pregnant. It is advisable to reject also women suffering from obstinate constipation, women with very defective teeth, and married women who are in the childbearing period. The physician should reexamine women engaged in leadwork at frequent intervals. It is better to make a cursory examination once a week than a more thorough one once in two months.

In deciding as to the length of the workday for woman lead workers it must be remembered that the longer the hours the greater the dose of lead absorbed, and the shorter the period for elimination of the dose before the next workday. It must also be remembered that fatigue increases susceptibility to lead poisoning, and so does a heated or humid atmosphere.